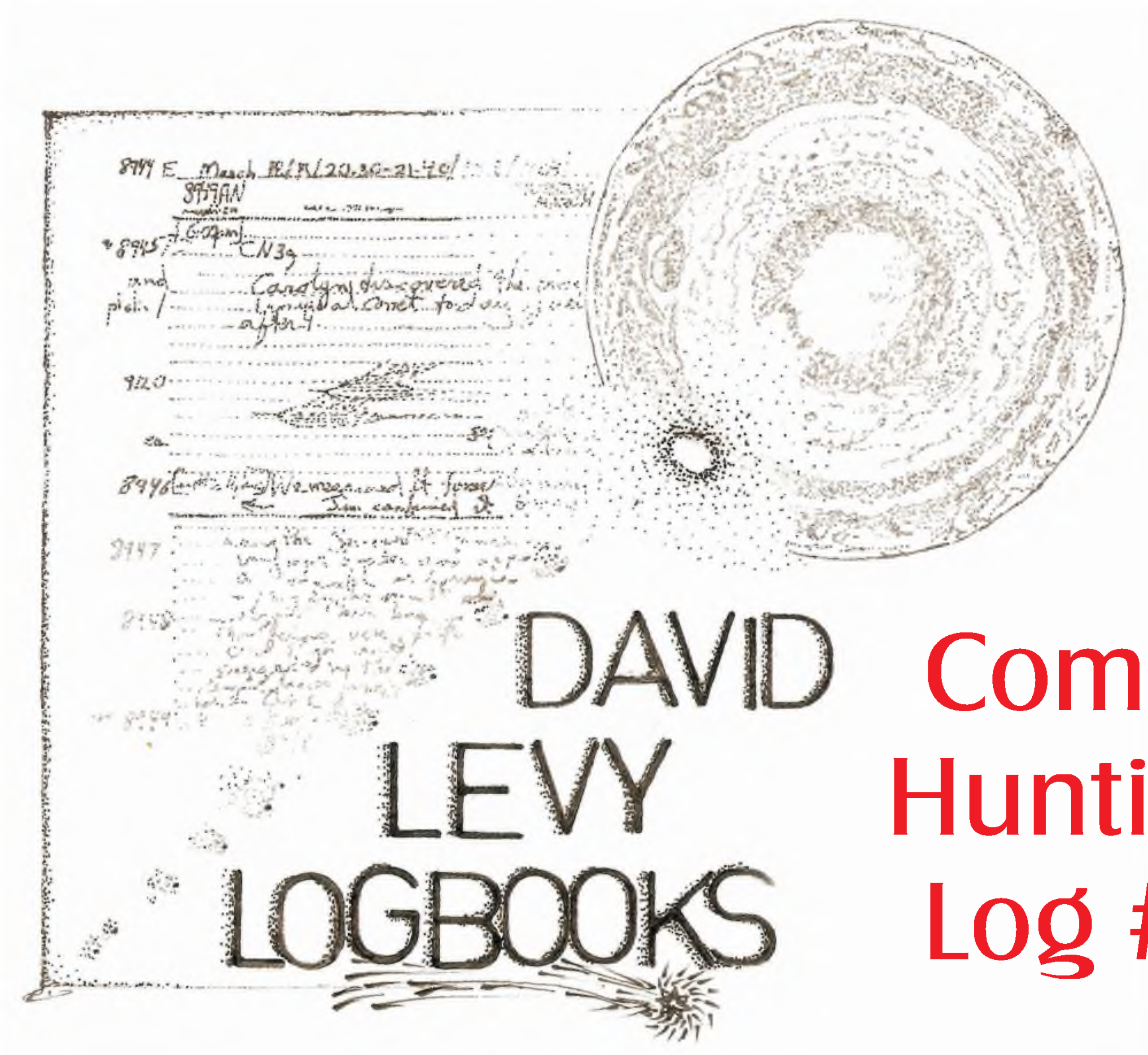

Comet Hunting Log #2

Prepared 2016 by David H. Levy

MEMORANDUM

To: Brian Marsden

From: Clark R. Chapman
Planetary Science Inst./SAIC
620 N. 6th Ave.
Tucson, AZ 85705 USA
[Phone: 602-622-6300; FAX: 602-622-8060]
[E-mail: cchapman@psi.edu]

Date: 23 June 1994

Subject: Fairness in cometary naming procedures

Brian, I understand that you will be in Flagstaff for a few days next week, and I would hope that we could find half-an-hour before I leave late Wednesday to discuss a situation of great concern to me. In preparation, I offer the following comments about the issue and my view of it.

First, as a matter of personal policy, I avoid issues of lunar and planetary nomenclature. The matter has some importance, but I choose to leave those issues to those among us who find the topic more interesting than I do. However, I do feel strongly that scientists must treat each other with fairness and respect. On the basis of what I now know, I believe that you and Dan Green have taken actions towards David Levy that are antithetical to those principles, and I wish -- in the strongest possible way -- to urge you to cease and desist.

A colleague advised me of the problem some days ago, and I recently pressed David for pertinent information, which he reluctantly provided to me. It is apparent to me that Dan Green has acted wholly unprofessionally toward David. Perhaps the cause is simply "flaming" (see William Safire's nationally syndicated column about that term -- meaning hasty, emotional responses on e-mail -- published about a week ago). But one would not have to be as sensitive a person as David to feel greatly abused by Green's attacks, and his innuendo that David should keep the matter under wraps. More to the point, you have adopted a CHANGE in procedures that I think violates elementary principles of fairness and due process, and also is wholly inappropriate and especially unfortunate on the eve of 1993e's impending impacts with Jupiter.

I take no position on how comets should be named. Let them be named for birds, whatever. But how they have been named in the past is a matter of longstanding tradition (albeit one which necessarily runs up against inevitable changes in comet science). It is entirely appropriate for the relevant entity (IAU) to revise or wholly change the nomenclature process. But it should do so through a fair, deliberate, and open process. The proposed changes in procedures should be widely promulgated, there should be an extended period of public discussion, and then the matter should be dealt with in a fair and open fashion according to established procedures. It is wholly inappropriate and unfair for you, as an individual, to take it on yourself to change prior practises. It is even worse that it should be done in a hasty, arbitrary, and secretive way.

I understand your position, and that of Dan Green, to be that you have not changed the procedures. Instead, you seem to argue, your office has been making a mistake throughout much of the ten years of the Shoemaker-Levy-Holt collaboration, and indeed has made mistakes streching back to the 1960's. This is hogwash. If there has been any consistency in recent years, it has been that you -- believing yourself to apply traditional nomenclature procedures correctly to the new approaches to comet discovery -- have been consistently naming comets discovered by the Shoemaker-Levy team as Shoemaker-Levy. To suddenly, and more-or-less arbitrarily, change that IS a CHANGE, and it is a most unfair one.

Let me note, parenthetically, that I do not wish to dispute the naming of any particular comet. It is for the Shoemaker-Levy team and for your office to decide what kind of team participation was intended by the consistent application of the Shoemaker-Levy appellation in the past and to apply it to, say 1994k, as you best see fit. What I object to is what I understand to be a pronouncement that future comet discoveries of the Shoemaker-Levy team will be handled differently than in the past. There has even been a suggestion that the Shoemaker-Levy team adopt a different procedure in their work in order to satisfy nomenclature concerns. This totally violates what I understand to be your authority and is, by common understanding, a violation of due process.

The sorriest and most unfortunate aspect of this whole situation is that you have chosen to embark on this new procedure with JUST THE WRONG GROUP EFFORT AND AT THE WORST POSSIBLE TIME. In June and July 1994, as comet science makes a rare appearance in the public consciousness, THE COMET of interest is Comet Shoemaker-Levy 9. By attacking the Shoemaker-Levy generic naming convention, you are playing into the jealousies of other individuals and potentially undermining much of the joy that we all, and David Levy, are sharing as we await this unprecedented event. Can't you guys leave well enough alone? Shoemaker-Levy 9 will live on in the history of science (whatever happens four weeks from now) long after comet nomenclature procedures have changed a dozen times. Can't we just enjoy this time, honor Carolyn and Gene Shoemaker -- and David Levy -- without having this tempest-in-a-teapot and the ugly correspondence from Dan Green?

I urge you to (a) publicly reaffirm the de facto nomenclature procedures that have been in effect during recent years, (b) privately renounce the new procedures you have privately promulgated to the Shoemaker-Levy team, (c) wait a decent time if you feel the nomenclature procedures must be changed, and (d) then proceed to change them through the auspices of the IAU in an open, fair, and deliberative way. And tell Gene, Carolyn, and David immediately that there will continue to be Shoemaker-Levy comets if they continue to discover them (for which we are all grateful!) in the future in the same way they have discovered them in the past -- UNTIL the appropriate authority has decided differently.

Please, may we discuss this issue in Flagstaff?

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Message 1:
From brian%cfaps1.DECNET@cfa.harvard.edu Thu Jun 23 14:46:24 1994
Received: from dracula.psi.edu by tycho.psi.edu.psi.edu (4.1/SMI-4.1)
      id AA06641; Thu, 23 Jun 94 14:46:23 MST
Received: from cfa.harvard.edu by dracula.psi.edu (4.1/SMI-4.1)
      id AA06297; Thu, 23 Jun 94 14:45:30 MST
Return-Path: <brian%cfaps1.DECNET@cfa.harvard.edu>
Received: from CFAPS1.DECnet MAIL11D_V3 by cfa.harvard.edu; Thu, 23 Jun 94
16:50:14 -0400
Date: Thu, 23 Jun 94 16:50:13 -0400
Message-Id: <9406232050.AA09934@cfa.harvard.edu>
From: brian%cfaps1.DECNET@cfa.harvard.edu
To: psi.edu::cchapman%cfa.DECNET@cfa.harvard.edu
Cc: BRIAN@cfa.harvard.edu
Subject: RE- Fairness in comet naming procedure
Status: R
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Dear Clark,

I should be glad to discuss this matter with you next week in Flagstaff.

I think the whole trouble with comet naming dates back long before the 1960s. It really dates back to soon after the establishment of the IAU in the 1920s. The point was that the IAU never really did adopt any naming rules, yet at that time the previous procedure (dating back to the 1830s or even earlier) was in fact unofficially changed. There has been quite a bit of discussion by interested parties in the IAU during the past couple of years to rectify the situation, and the topic will certainly be discussed in The Hague. Let me just say that a number of people would like to see comet names dropped altogether, while others would like to give comets totally different names. My personal view is that I should like to revert to the pre-IAU naming tradition, while at the same time adopt a new designation system that would both tend to de-emphasize the names and to be more complementary to the designation system for asteroids (something that is important to do, given that the dividing line between comets and asteroids has in some instances become quite nebulous). Dan Green feels more strongly than I that David Levy has been unfairly treated by having his name attached to the Shoemaker comets during the past few years, and he is in part speaking on behalf of the amateur astronomers who hunt for comets visually, several of whom seem quite incensed that David should supplement his eight honest-to-goodness visual discoveries with 13 comets found by Carolyn Shoemaker and for whom he is serving as an assistant.

The case in point is comet 1994k. The fact that this should have come at the time 1993e is approaching its unfortunate destiny was entirely fortuitous. Carolyn Shoemaker found this comet last month when she was in Flagstaff, some days after the Palomar observing run; David was many miles away at the time, as was also Tim Spahr, a student who also assisted at

Palomar during the run. This was the second time in a row that Carolyn had
discovered a comet well after the run (the other was 1994d), and on each occasion the Palomar observations of the object had been obtained on a single
night. (Actually, three of the last four Shoemaker comets were observed by
them on one night--the third being 1993e itself, which was ably "rescued" by
Jim Scotti, whose continued association with this comet has been infinitely
more extensive than that of David Levy.)

The Shoemakers' point is that the discoveries are made by a team, and
it is clear that Carolyn would not find these comets if Gene and others did not obtain the films. For reasons that are not entirely clear to me, David Levy is No. 3 member of the team, Hank Holt is No. 4, and the students
don't count. If they want to emphasize the "team" aspect, I wish to point out that the "team" is much more extensive than those locally present at Palomar. Such is certainly the case when they obtain observations on a single night. We expect professional astronomers (and advanced amateurs) to
observe an asteroid (NEA or otherwise) on two nights in order to have the discovery credited (except for the very rare object, well observed on the discovery night, but not observable on the second night because it has whipped around the earth). If they obtain only a single night, help has to
be solicited from others, help that includes Jim Scotti's work at Spacewatch,
the reobservation of 1994k by a Japanese amateur, the inspection by Rob McNaught in Australia of U.K. Schmidt plates that might contain prediscovery
images--not to mention the extra calculation and communication that has to be done here. I point out that at least three other teams made independent
discoveries of 1993e, that all of them had images on two or more nights, and
that two of these three independent discoveries preceded that attributed to
Shoemaker and Levy.

Please understand that I regard David Levy as a personal friend and that I am not trying to embarrass him at this very special time with comet 1993e. There are several sides to the story, and they all need to be taken
into account. Many people hunt for--and find--comets, not just the Shoemaker
team. I am trying to be fair and equitable--and to work in the framework of the IAU. If you have evidence that Dan "has acted wholly unprofessionally
toward David", I should like to know of this and will discuss it with him.

I wanted to give you this background. Let's discuss it further next week.

Brian

Message 2:
From GSHOEMAKER@astrog.span.nasa.gov Thu Jun 23 14:35:05 1994
Return-Path: <GSHOEMAKER@astrog.span.nasa.gov>

Received: from dracula.psi.edu by tycho.psi.edu.psi.edu (4.1/SMI-4.1)
 id AA06507; Thu, 23 Jun 94 14:35:04 MST
Received: from mx.nsi.nasa.gov by dracula.psi.edu (4.1/SMI-4.1)
 id AA06259; Thu, 23 Jun 94 14:34:12 MST
Received: Thu, 23 Jun 94 14:34:23 PDT from ASTROG.dnet by mx.nsi.nasa.gov
(4.1/1.2)
Message-Id: <9406232134.AA03588@mx.nsi.nasa.gov>
Received: from ASTROG.dnet by AMES.dnet with MAIL-11
 (utk-mail11d v1.7); Thu, 23 Jun 94 14:34:35 PDT
Date: Thu, 23 Jun 94 14:34:35 PDT
From: GSHOEMAKER@astrog.span.nasa.gov
X-To: AMES::"cchapman@psi.edu"
Subject: Letter to Brian
To: cchapman@psi.edu
Status: R

Dear Clark,

BRAVO! You said it all! This whole thing is unequivocally a personal attack on David. I don't know who all the green-eyed monsters are out there,
but we sure as hell know who one of them is. Carolyn and I are indeed grateful to have someone with the outside perspective tell it like it is. We, ourselves, have gotten nowhere in arguing this case with Brian.

Many thanks, Gene and Carolyn

From GSHOEMAKER@astrog.span.nasa.gov Thu Jun 23 19:00:31 1994
Return-Path: <GSHOEMAKER@astrog.span.nasa.gov>
Received: from dracula.psi.edu by tycho.psi.edu.psi.edu (4.1/SMI-4.1)
 id AA07443; Thu, 23 Jun 94 19:00:30 MST
Received: from mx.nsi.nasa.gov by dracula.psi.edu (4.1/SMI-4.1)
 id AA06544; Thu, 23 Jun 94 18:59:14 MST
Received: Thu, 23 Jun 94 18:59:18 PDT from ASTROG.dnet by mx.nsi.nasa.gov
(4.1/1.2)
Message-Id: <9406240159.AA06669@mx.nsi.nasa.gov>
Received: from ASTROG.dnet by AMES.dnet with MAIL-11
 (utk-mail11d v1.7); Thu, 23 Jun 94 18:59:28 PDT
Date: Thu, 23 Jun 94 18:59:28 PDT
From: GSHOEMAKER@astrog.span.nasa.gov
X-To: AMES::"cchapman@psi.edu"
Subject: Brian's reply
To: cchapman@psi.edu
Status: R

Dear Clark,

Yes, there are some implications in what Brian has written. In fact some
of his implications are simply outrageous.

First of all, Brian knows damned well that we drive 450 miles to Palomar to
make our observations, and that we have only a specifically defined time each
observing run to make them. He also knows perfectly well that the basis of
our success in discovering both comets and fast-moving asteroids rests on

covering as much sky as possible in the time assigned to us. On a good run, Carolyn can't possibly scan all the fields that we take (nor could anyone else without taking multiple microscopes and using a whole team of scanners). He also knows our whole operation has been done on a financial shoestring staffed by volunteers. If we were to take two nights for every field, we would simply cut our discovery rate in half. That might make him happy, but it defeats our overall objectives.

Secondly, his statement that "David Levy is the No.3 member of the team, Hank Holt is No.4, and the students don't count" is simply scurrilous. Holt was a colleague of ours before David was and has carried the principal responsibility for several observing runs each year for the past six years. When Carolyn, David, and Henry were observing together and a comet was found two years ago, Marsden arbitrarily designated the comet "Shoemaker", leaving out both Levy and Holt, whereas the team had decided and Carolyn requested that the comet be named "Shoemaker-Holt". Marsden's action caused us considerable embarrassment. Marsden knows perfectly well that we recognized a student member of the team (Comet Shoemaker-Holt-Rodriquez) and that we were upset when he changed the rules so that only two members could be recognized. Marsden certainly knew at the time that this decision on his part would cut off students from being recognized, unless we or Henry were observing with them alone (example, Comet Holt-Olmstead). In this latter case, Henry had to decide which student would be cut out. In our view, P/Shoemaker-Levy 9 should have been named P/Shoemaker-Levy-Bendjoya, and 1994k should have been named P/Shoemaker-Levy-Spahr. Marsden's notion that either Holt or Levy or the students are simply assistants to Carolyn or to me is a bunch of crap. Our observing team is just that, and we don't recognize German or British hierarchies. We divide up the chores on the team according to skills (and in Carolyn's case and mine, unfortunately, it is coming down to limitations of physical ability--we ain't so young as we used to be).

With regard to 3 independent discoveries of 1993e, if you believe that, I would be very surprised. You heard Glo at Erice adamantly insist in the meeting that she could not detect the motion of 1993e on her films. There she spoke the unvarnished truth. At the time, I could not figure out why she was so insistent (she emphatically reiterated the same thing in a smaller group later that evening). However, when she published her best image in an Australian magazine, I finally understood what the problem was. The film was so badly guided that the comet image was smeared out in right ascension by as much as the true motion in the 30 minute interval between her two films.

In hunting comets or asteroids by the methods that both she and we use, you
know, and everyone else who understands this knows, that the object is not recognized or "discovered" if displacement is not recognized. The detection
is based on motion. Marsden must know that too. If he doesn't, he should resign his position. More than a week elapsed after the announcement of 1993e
before either Helin or the Tancredi-Lindgren team at ESO bothered to report
their pre-discovery positions. The ESO group frankly admit they missed the
comet due to their own inexperience, and we feel sorry for them. As to the
claimed "independent discovery" in Mexico, I'll let you be the judge. The fact that Marsden not only accepts but advances these claims, in the face of
well-based skepticism from disinterested parties, may carry a subtle message
about the whole nomenclature affair. David Levy could fill you in on some of this.

If you think we're sore, you've got it. These unilateral actions on Marsden's part will definitely affect our observing plans in the future. In
the near term, we will certainly not report a comet unless we've got it wired
(accurate positions on two nights or more)--nevermind what the rules are for
others. In the long term, we will have to operate with a quite different strategy with a planned photographic comet search. For a while, we were not
even sure whether we would go forward with that plan.

Don't feel that you need to keep this message confidential. You can use it in any way that you feel appropriate.

Regards, Gene

mail>r
To: GSHOEMAKER@astrog.span.nasa.gov
Subject: Re: Brian's reply

Gene, I knew some of what you have written, but thanks for writing it all down.
Clark

FROM: David Levy, 70721,1706
TO: Shoemaker-Levy name,
DATE: 06/04/94 at 16:48

SUBJECT:

From brian%cfaps1.DECNET@cfa.harvard.edu Thu Jun 2 08:36:28 1994

Received: from cfa.harvard.edu by lpl.arizona.edu
(4.1/hindmost-MX-1.4)
id AA18376; Thu, 2 Jun 94 08:36:27 MST
Return-Path: <brian%cfaps1.DECNET@cfa.harvard.edu>
Received: from CFAPS1.DECnet MAIL11D_V3 by cfa.harvard.edu; Thu,
2 Jun 94 11:35:54 -0400
Date: Thu, 2 Jun 94 11:35:54 -0400
Message-Id: <9406021535.AA25009@cfa.harvard.edu> From:
brian%cfaps1.DECNET@cfa.harvard.edu
To: lpl.arizona.edu::dhlevy%cfa.DECNET@cfa.harvard.edu
Cc: BRIAN@cfa.harvard.edu
Subject: RE- Hi
Status: R

Dear David,

Thank you for your message! Actually, for some reason or other, it did not reach me, but Dan gave me his copy.

The whole discussion of the past couple of weeks has been most unfortunate. As I think you also know, I think very highly of you. I am tremendously impressed by your visual discovery of comets (the number exceeded only by Bradfield and Mrkos, among living people), as well as by the success and accuracy and sensitivity of your writing, both of books and articles. And I think it great that you have volunteered your services so generously to Gene and Carolyn in their observing program at Palomar. This is an essential ingredient in the success of their program, particularly as they get on in years and therefore don't function with quite the agility they had in the past (although I think they are remarkable people too). It is also wonderful that you are able to make a living in astronomy as you do, without the benefit of "steady employment".

At the same time, there seem to be some very mixed messages, and with the mounting number of comet discoveries at Palomar it has been clear for some time that things are somehow getting out of hand. Gene and Carolyn are tremendously appreciative of what you have given to their program, and they haveclearly demonstrated this by their insistence that you share in the names of the comets that are found. They cannot reward you financially, but they know that this act means an awful lot to you. I know that you think enough of them and of the success of their program that you would continue to participate in it anyway, and I realize that, by not including you in the names of the comet, they feel they do not have an adequate way of expressing their appreciation. But it is also the case, I fear, that you have somehow managed to convey to members of the audiences at your recent lectures that changes are afoot, even to the extent that we are somehow treating you unfairly and proposing to give slaps in the face to amateurs generally by not applying their names to comets they discover visually.

Please do not think that I have unilateral powers to make decisions on the principles governing how comets are named. As I wrote to Carolyn right at the start of the 1994k affair, there is considerable pressure to make changes in the way both asteroids and comets are named. The proposed movement is in the direction of "committees" and "namebanks". While there may be some merit to this in the case of asteroids, some of my colleagues are proposing the same procedure for comets. Some of this reasoning follows from the observation that in some cases one cannot really tell whether an object is a comet or an asteroid. But in most cases one can, so while I can accept the idea of introducing for comets a designation system that is rather similar to that for asteroids, I think it would be unwise to have a system of designating and naming them that is absolutely identical. I basically support the tradition that comets should be named for their discoverers. I do think, however, that we have to adhere to the tradition in a more precise manner, and I feel that this is the best defence against those who would make more sweeping changes. As I told Gene the other day, the pattern that is emerging from the discussions currently going on is that there should therefore be one and only one name associated with each independent discovery of a comet. One and only one person in a team actually sees the cometary image first, and, ideally, it is therefore the name of that person that should be applied to the comet. Alternatives might be to use some generic name for the team or to share the various discoveries among the team members. The former has merit in the case of "Spacewatch", "IRAS", "SOLWIND", "SMM" and even "Tsuchinshan", although I don't look forward to the day when every comet is called "Spaceguard". As for the latter, it would clearly have been better if the CBAT in the 1920s had been more on the ball when Schwassmann and Wachmann were making their discoveries, but it is difficult to apply the idea now in cases where everybody knows who actually makes the discoveries, and in any case,the real "team" involved in getting a comet properly confirmed can be much larger than the team that actually takes the films and finds a candidate image (viz. 1993e, 1994k and to some extent 1994d); I am fully aware that such an extended team also comes into play in the case of visual discovery by an amateurwho has no way of providing accurate positions or--sometimes--even establishing that the comet is moving, but this is just another way of saying that mere mention of team effort can open a real can of worms.

Consistency of policy is important, and that is the great thing about the old days, when one had to go to extraordinary lengths to find out who was actually the first visual discoverer of a comet. But there was then also a lot of instability, and it could take months, even years, to decide what a comet should be called. The mistake was to allow "Schwassmann-Wachmann", and later "Bappu-Bok-Newkirk", while in the mean time very properly establishinga three-name limit in the case of "Jurlof-Achmarof-Hassel". The fact that no other rules were adopted is what has led to the present situation (with a few stopgap policies like "SOLWIND 1" as an "appellation"--rather than an actual name--to replace the troublesome "Howard-Koomen-Michaels"). But as I say, the IAU is now determined to make changes, and I think we all need to be very objective as we consider the situation and thereby help ensure that any changes made are truly appropriate.

Best regards
Brian

Dear Brian,

Thank you for your letter and your thoughts. I am deeply troubled however by your suggestion that I have been saying bad things about CBAT policy in my public talks. Come to think of it, you have never heard or seen one of my public talks. They are filled with high praise for what you and Dan are doing, and these comments are relevant to the many comet communications we have had over the years.

I would never mention your change of policy in a public lecture. However, afterwards, in recent days people have ac^Hsked me privately about this sudden change, and this has been difficult for me. Also, when people ask me how many comets I have discovered, I always have said that I have found 8 comets visually and that there are 13 more as part of the Shoemaker-Levy team. By the way, the Shoemaker-Levy name is a team name for when we are together, just as the Shoemaker-Holt team name. This has worked well, except for the few times when all of us are together, as what happened with 1992y. I do not tell anyone that I discover these comets. I do say that the discoveries result from our team effort

I can't believe that these people who complain would rather send me back to those desperate times after I left the Halley Watch and Steve Larson. 1991, 1992, 1992 were terrible years for me financially. I was struggling to get my writing career on a sound footing and keep up with my observing. I hope that those days won't return after 1994. This year is financially much better, but it is at the expense of parcels of obscene mail (I got one last week) and now this accusation by some people that I'm in this just for the name. You know that is not true.

You also must know that regardless, I will always enjoy the hours I spend comet hunting, and the times I spend with the Shoemakers. They are wonderful people, and it was their idea that the team name for comets be Shoemaker-Levy (or SHoemaker-Holt).

So, does all this clairify things a bit? And do you know when you're heading out to Flagstaff? If you come out Saturday I can drive you up from Phoenix, but I have to leave the meeting on Tuesday afternoon.

All the best
Daviud d
Message 4:
From dan%cfaps1.DECNET@cfa.harvard.edu Thu Jun 2 08:57:52 1994
Received: from cfa.harvard.edu by lpl.arizona.edu (4.1/hindmost-MX-1.4)
id AA10503; Thu, 2 Jun 94 08:57:51 MST
Return-Path: <dan%cfaps1.DECNET@cfa.harvard.edu>
Received: from CFAPS1.DECnet MAIL11D_V3 by cfa.harvard.edu; Thu, 2 Jun 94 11:57:14 -0400
Date: Thu, 2 Jun 94 11:57:14 -0400
Message-Id: <9406021557.AA25389@cfa.harvard.edu>
From: dan%cfaps1.DECNET@cfa.harvard.edu (D.W.E. Green/SAO/617-495-7440)
To: lpl.arizona.edu::dhlevy%cfa.DECNET@cfa.harvard.edu
Subject: some more thoughts
Status: R

David, to Brian's message that he just sent you, I would add the following, as a friend: It is beginning to circulate in various circles (separate from Brian and me!) that you are out to unethically gain as much fame and mileage as you can from your collaboration with the Shoemakers, via your having your names on comets that you did not discover. I do not wish to mention names, so please don't ask me to, but you would not be happy to hear some of the people who are becoming vocal about your going too far with this "Shoemaker-Levy" naming. I strongly advise against your saying anything negative in public about the IAU naming process and about the curtailing of naming for non-discoverers who are parts of teams; this will only make you look worse, and may damage your reputation. All of this I offer to you as advice from a friend (there are no "threats" here) who is concerned about the way things are going. There is much talk in the astronomical community about your Meade and Nature Company deals, as both there and in the press you appear to be gloating over 21 discoveries of comets (when you have only found 8). Be careful, David, please! You've AIDED the Shoemakers in finding over a dozen comets, but it makes no sense to say "21" in any context whatsoever. Stick to the eight that you've genuinely found. Hope your tours are going well, and your book writing, too.

Will you be in Cambridge anytime this year? Stellafane? Hope to see you sometime soon! Regards, Dan

FROM: David Levy, 70721,1706
TO: names.2,
DATE: 06/04/94 at 16:07

SUBJECT:

1
Message 1:
From brian%cfaps1.DECNET@cfa.harvard.edu Thu Jun 2 20:49:10 1994
Received: from cfa.harvard.edu by lpl.arizona.edu
(4.1/hindmost-MX-1.4)
id AA14321; Thu, 2 Jun 94 20:49:09 MST
Return-Path: <brian%cfaps1.DECNET@cfa.harvard.edu>
Received: from CFAPS1.DECnet MAIL11D_V3 by cfa.harvard.edu; Thu, 2 Jun 94 23:34:30 -0400
Date: Thu, 2 Jun 94 23:34:29 -0400
Message-Id: <9406030334.AA05700@cfa.harvard.edu>
From: brian%cfaps1.DECNET@cfa.harvard.edu
To: lpl.arizona.edu::dhlevy%cfa.DECNET@cfa.harvard.edu

Cc: BRIAN@cfa.harvard.edu
Subject: RE- Re: RE- Hi
Status: R

Dear David,

I mentioned a lecture by you because I received a letter, dated May 23, by a man from Yonkers, and I know that you were that day scheduled to be speaking in New York. The letter was very much in your defence, although its writer was obviously very ignorant of the real situation and basically chastized me for proposing that comets not be named for their discoverers.

Please do understand that there is nothing personal about this, and I am indeed very sad that you are also being burdoned with obscene correspondence (burdened, that is). I realize that this all started with the Shoemakers' application of what they believed to be the policy, and that this all came about because the IAU had really been remiss in not fully having defined what the policy should be. But objective logic does suggest that what was done was not really fair to other astronomers (amateur or professional), and I know that this has been upsetting some people. And we need to get some rules properly set down before the whole comet-naming procedure is spoiled for everybody.

I shall not be arriving in Flagstaff until late Tuesday morning, but if you are staying through the afternoon session (the first one of the Inventory symposium), there should be some time for us to get together at least briefly. All the best talks (Jim's, Ted's, mine) are on Thursday afternoon, so it is a pity you can't stay through this symposium.

Regards
Brian
:

From dan%cfaps1.DECNET@cfa.harvard.edu Thu Jun 2 22:14:45 1994
Received: from cfa.harvard.edu by lpl.arizona.edu
(4.1/hindmost-MX-1.4)
id AA14526; Thu, 2 Jun 94 22:14:44 MST
Return-Path: <dan%cfaps1.DECNET@cfa.harvard.edu>
Received: from CFAPS1.DECnet MAIL11D_V3 by cfa.harvard.edu; Fri, 3 Jun 94 01:02:45 -0400
Date: Fri, 3 Jun 94 01:02:44 -0400
Message-Id: <9406030502.AA06307@cfa.harvard.edu>
From: dan%cfaps1.DECNET@cfa.harvard.edu (D.W.E. Green/SAO/617-495-7440)
To: "dhlevy@lpl.arizona.edu"%CFA.DECNET@cfa.harvard.edu
Subject: Re: some more thoughts
Status: R

That bit about talking in public about this issue stemmed from a
letter that we got from somebody who apparently heard you lecture
at the Hayden Planetarium recently (Brian will perhaps mention
this to you, as the letter went to him). Also, you say that
people have asked you privately about this "new policy" [of
single names, I presume?], but this "new policy" is not known to
anybody outside of the IAU committees and you and the Shoemakers,
unless you have leaked news yourself. You do seem to be saying
one thing to us, but then seem to be doing things that run
contrary to what you are saying. Brian and I are most happy for
your recent successes and improvements financially, but this
naming-for-nondiscovery bit seems to have gotten to your head,
and it needs to be put into proper perspective. You should not
have allowed the Nature Company, Meade, or Time magazine
associate you with 21 comets -- only eight -- as far as
discoveries go. You were part of a team, sure, with the
Shoemakers, but you were NOT a co-discoverer of those 13
"Shoemaker-Levy" comets; you WERE a co-discoverer of comets
Levy-Rudenko and Takamizawa-Levy. If I had been working with
Gene and Carolyn instead of you, I'd have been honored to have
had one "Comet Shoemaker-Green" (especially if it were periodic),
though I could hardly have expected that honor, and I wouldn't
have allowed my name to go on more than one comet that I didn't
actually discover myself (if even that one); I wouldn't have felt
comfortable bucking the tradition of naming for discoverers only
-- in effect, making a mockery of that tradition! This won't
affect our friendship, David; I don't get bogged down in petty
politics or other silly emotions. But I do feel the urge to
offer my advice from a vantage point that may be helpful to you,
as a true friend.

I look forward to seeing you in July. Do you have dates
yet? Kelly Beatty called today to say that the proofs are done
for our Focal Points.
At last!
Regards, Dan

mail> r
mail> d
Message 4:
From brian%cfaps1.DECNET@cfa.harvard.edu Fri Jun 3 06:58:41 1994
Received: from cfa.harvard.edu by lpl.arizona.edu
(4.1/hindmost-MX-1.4)
id AA15635; Fri, 3 Jun 94 06:58:39 MST

Return-Path: <brian%cfaps1.DECNET@cfa.harvard.edu>
Received: from CFAPS1.DECnet MAIL11D_V3 by cfa.harvard.edu; Fri,
3 Jun 94 09:56:21 -0400
Date: Fri, 3 Jun 94 09:56:21 -0400
Message-Id: <9406031356.AA20376@cfa.harvard.edu>
From: brian%cfaps1.DECNET@cfa.harvard.edu
To: lpl.arizona.edu::dhlevy%cfa.DECNET@cfa.harvard.edu
Cc: BRIAN@cfa.harvard.edu
Subject: To cheer you up
Status: R

Dear David,
I just received a message from Japan to say that Tombaugh's variable TV Crv was up to mag 13.5 an hour or two ago.
Regards
Brian

mail> r
Dear David,
Yes, let's indeed help each other through the crash and everything! There are almost 700 observations of the 1993e components ready for the June MPCs, and because of the perturbations checking them is much more timeconsumiungthan for other objects. Nakano just sent a nice set of orbits using these observations (through June 1), and I'll plan to use them on the June MPCs (and therefore defer any more 1993e observations that come in until July). He said he was really worn out over it. And he had to spend a fair bit of time today with the new Japanese Nova Oph 1994--the National Observatory in Tokyo continuing to be delinquent about such matters (and now it has two people there to attend to them! Meanwhile Nakano also has to pay his own e-mail costs...)
No, you're not a terrible person!
Regards
Brian

1
Message 1:
From dan%cfaps1.DECNET@cfa.harvard.edu Fri Jun 3 15:38:47 1994
Received: from cfa.harvard.edu by lpl.arizona.edu
(4.1/hindmost-MX-1.4)
id AA23464; Fri, 3 Jun 94 15:38:46 MST
Return-Path: <dan%cfaps1.DECNET@cfa.harvard.edu>
Received: from CFAPS1.DECnet MAIL11D_V3 by cfa.harvard.edu; Fri,
3 Jun 94 18:34:48 -0400

Date: Fri, 3 Jun 94 18:34:48 -0400
Message-Id: <9406032234.AA01767@cfa.harvard.edu>
From: dan%cfaps1.DECNET@cfa.harvard.edu (D.W.E. Green/SAO/617-495-7440)
To: "dhlevy@lpl.arizona.edu"%CFA.DECNET@cfa.harvard.edu
Subject: Re: some more thoughts
Status: R

In my opinion, there are 13 too many S-L comets; the policy ("tradition" as you put it) does not go that far back -- really only 10 years and then because of the Shoemakers and Glo (prior to that it was very spotty). The real "tradition" is to only put names on comets for people that actually discovered them --- NOT to put on the names of people who helped the discoverers (whether they took plates, cleaned their bedroom, cooked their meals, computed orbits for the new comets, followed up the new comets so they didn't get lost, or whatever). You should be much more humble about all this, it seems to me, and you can go around telling everybody that you have 21 named comets if you want, but it brings your reputation down in many circles to do so.

From: dhlevy@lpl.arizona.edu (David H. Levy)
Message-Id: <9406032232.AA23411@lpl.arizona.edu>
To: dan%cfaps1.DECNET@cfa.harvard.edu
Subject: Re: some more thoughts
Cc: dhlevy
Status: R

Dan, for chrisssake, you can believe whatever you want. But a lot of people read the circular and they ask, for example Tony Beresford and Bradfield all the way from Australia. And I have to say something. SO I say that you've decided there are too many S-L comets. I am very proud of my role in the discovery of all these comets,. We feel that S-L and S-H constitute team names. We have an equal level of particippation in these comet discoveries. The tradition goes way back, to Slaughter-Burnham, Burnham-Slaughter, Churyumov-Solodovnikov, etc. etc. etc. Helin-Lawrence et al. If you want to change your policy, that's fine, but don't blame me for saying that I have 21 named comets.

mail> r
To: dan%cfaps1.DECNET@cfa.harvard.edu
Subject: Re: some more thoughts

Hi Dan,

okay. Slaughter-Burnham goes back to the 60s. I try to be humble. I am very humble person. I am sorry that you think I am so terrible. On a brighter note, my book that talks so well of you and Brian has completely sold out of iots first printing and doing very well in the second!

Bye
David

Message 1:
From brian%cfaps1.DECNET@cfa.harvard.edu Fri Jun 3 19:32:23 1994
Received: from cfa.harvard.edu by lpl.arizona.edu
(4.1/hindmost-MX-1.4)
id AA00444; Fri, 3 Jun 94 19:32:21 MST
Return-Path: <brian%cfaps1.DECNET@cfa.harvard.edu>
Received: from CFAPS1.DECnet MAIL11D_V3 by cfa.harvard.edu; Fri, 3 Jun 94 22:11:10 -0400
Date: Fri, 3 Jun 94 22:11:09 -0400
Message-Id: <9406040211.AA03680@cfa.harvard.edu>
From: brian%cfaps1.DECNET@cfa.harvard.edu
To: lpl.arizona.edu::dhlevy%cfa.DECNET@cfa.harvard.edu
Cc: BRIAN@cfa.harvard.edu
Subject: RE- Better news
Status: R

Dear David,

Congratulations on the sell-out of The Book! That is indeed great news. Thanks for your congratulatory note to us on IAIC 6000. Though you may not have found that particular issue too exciting, the significant point to me was that one of the co-authors of the second item is Josh Grindlay, who as current President of IAU Commission 6 oversees the operation of the CBAT.

I see that you and Dan are still having a disagreement, mainly about the way you count comets that bear your name. I think you know that I have always been consistent in my expressions of congratulations and praise to you for all the things that are clearly your own work. Above all, this means your visual comet discoveries. It also means your extensive writing, of books and articles.

I also appreciate your important role in the Shoemaker program. But as a team member helping Carolyn's discoveries to be made you are in a different situation in comparison with your individual exploits. You know that I have always made this distinction, regardless of the presence of your name on all 21 comets. I maintain that it is an important distinction, too sophisticated for members of the public and press to understand. So no matter how careful you are in your actual statements, misinterpretation by the uninitiated is inevitable.

By the way, I particularly congratulate you for the great article you and Kelly wrote for the July S & T. I have no quibble with it. And I was pleased to be mentioned in the July S & T myself almost as much as you were! Since you were not the author, I can certainly tell you that there was a mistake in what it said about me and the transneptunians. I considered that a = 39 AU seems to give the best fit only for 1993 SC, not for the other three objects discovered last September. That may seem a small error, but I think it is significant, and it has a lot to bear on the outcome. It makes most of the rest of what I did SUPPOSITION, which some people will inevitably interpret as REALITY. It needs to be proven--or disproven, I really don't care which--with observations, which people will be less likely to make if they think that what I did was REALITY, rather than SUPPOSITION.

So, in addition to being magnanimous, it is important to consider that, for most of the population in a given circumstance, perception equals reality. But that is not good enough.

Regards
Brian

Message 3:
From dan%cfaps1.DECNET@cfa.harvard.edu Fri Jun 3 21:28:48 1994
Received: from cfa.harvard.edu by lpl.arizona.edu (4.1/hindmost-MX-1.4)
id AA00718; Fri, 3 Jun 94 21:28:47 MST
Return-Path: <dan%cfaps1.DECNET@cfa.harvard.edu>
Received: from CFAPS1.DECnet MAIL11D_V3 by cfa.harvard.edu; Sat, 4 Jun 94 00:25:41 -0400
Date: Sat, 4 Jun 94 00:25:40 -0400
Message-Id: <9406040425.AA04556@cfa.harvard.edu>
From: dan%cfaps1.DECNET@cfa.harvard.edu (D.W.E. Green/SAO/617-495-7440)
To: "dhlevy@lpl.arizona.edu"%CFA.DECNET@cfa.harvard.edu

Subject: RE: comets
Status: R

I don't think that you're terrible, David. I'm just cautioning you, and I've said as much repeatedly. Yes, I know that it goes back to P/S-W 1 as far as team naming, but I said that it was spotty prior to about 7 or 8 years ago (VERY spotty and inconsistent). Let's not have any bad feelings over this, please.

I'm very happy to hear about your book. That's great news! How many copies were in the first printing? How many in the second?

Best wishes, Dan

1
Message 1:
From brian%cfaps1.DECNET@cfa.harvard.edu Sat Jun 4 05:35:17 1994
Received: from cfa.harvard.edu by lpl.arizona.edu (4.1/hindmost-MX-1.4)
id AA03257; Sat, 4 Jun 94 05:35:15 MST
Return-Path: <brian%cfaps1.DECNET@cfa.harvard.edu>
Received: from CFAPS1.DECnet MAIL11D_V3 by cfa.harvard.edu; Sat, 4 Jun 94 08:29:31 -0400
Date: Sat, 4 Jun 94 08:29:30 -0400
Message-Id: <9406041229.AA17167@cfa.harvard.edu>
From: brian%cfaps1.DECNET@cfa.harvard.edu
To: lpl.arizona.edu::dhlevy%cfa.DECNET@cfa.harvard.edu
Cc: BRIAN@cfa.harvard.edu
Subject: RE- Re: RE- Better news
Status: R

Dear David,

Indeed, yes, it was never my intention that we should not be friends.

It is just that, in my position(s), I have to consider doing what is right for the "common good", and I'm sure you understand this.

It is just unfortunate that in all of this it seemed that you were singled out as the only victim. A lot of things have not been done "right" in the past, and it is therefore necessary to establish a system for the future that is both consistent and fair--as opposed to one that is only consistent, as some of my colleagues seem to be attempting.

Regards
Brian

Message 1:
From gshoemaker%astrog.span@noao.edu Fri May 20 15:34:50 1994
Return-Path: <gshoemaker%astrog.span@noao.edu>
Received: from noao.edu by lpl.arizona.edu (4.1/hindmost-MX-1.4)
id AA[illegible]; Fri, 20 May 94 15:34:49 MST
Received: from vela.tuc.noao.edu by noao.edu (4.1/SAG-Noao.G93)
id AA15459; Fri, 20 May 94 15:35:03 MST; for dhlevy@lpl.arizona.edu
Received: from astrog.span by noao.span with VMSmail ;
Fri, 20 May 94 15:34:12 MST
Date: Fri, 20 May 94 15:34:12 MST
From: gshoemaker%astrog.span@noao.edu
Message-Id: <940520153412.20a00ab4@noao.edu>
Subject: Re-1994k and names
To: dhlevy@lpl.arizona.edu
X-St-Vmsmail-To: NOAO::"dhlevy@lpl.arizona.edu"
Status: R

David,

I had a long phone conversation with Brian expressing all our conerns (and feelings and prejudices) after receiving this message below. He strongly feels that if the tradition of naming comets for the discoverer is to be kept

(and he feels it is certainly important that it should be for visual comet seekers), then the method for designating comets based on who sees it first and who works with it the most must probably be changed. He is looking for a way out of the proposal of doing away with names for comets altogether. He understands fully that ours is an interdependent group effort, but says that there are others too. The system of naming designed as this was when all discoveries were made visually, mostly by amateurs, is now running into difficulties. In so many words, he feels the change must start now within all group efforts. We discussed our future effort without coming to a good conclusion. Either you scan half and I scan half or we alternate names--something of the sort. Brian hopes you will try to understand the overall situation.

Sorry I couldn't persuade him. Our success together may have been our undoing when it comes to names. I suggest that if people ask you about "our change of policy", you blame it on IAU Commission 20. Just tell them that Gene and I still consider you a discoverer too. Incidentally, the way the circular came out Gene is also cut out of being a discoverer (now he has 29 to my 32).

Where are you for your birthday? I told Brian he could give you a comet!

From: CFAPS1::BRIAN 20-MAY-1994 14:11:43.75
To: ASTROG::GSHOEMAKER
CC: BRIAN
Subj: RE- 1994k

Dear Carolyn,

There has been quite a lot of thought in IAU Commission 20 recently about changes that might be made in the way solar-system bodies are designated and named. While the designation system for minor planets is very serviceable, it is clear that that for comets is not (e.g., do we really need Roman numeral designations when the letter designation system is adequate, why do we record routine comet recoveries when many periodic comets are visible all around their orbits, can we find a better system for dealing with components of split comets, etc., etc.). As for the names, you are surely aware of the feeling of many astronomers that many minor-planet names are downright "silly". The tradition of naming comets for their discoverers is long-standing, but the appearance of so many Shoemaker-Levy comets has become downright confusing.

Nobody is begrudging you your role in discovering comets. Everybody knows of your truly remarkable record of at least 32 photographic discoveries.

We are also well aware that a team effort is involved--and that David Levy is an important member of that team. But there are--as you have pointed out--other members of the team, like Tim Spahr in the present case. It is also very misleading, we feel, when TIME speaks of David "discovering eight comets and co-discovering 13 others". David is extraordinarily skillful at finding comets visually, and the eight that he has puts him third in the world among living visual discoverers. THAT is an achievement! (Actually, the TIME statement isn't even correct, for he shared some of those eight visual discoveries with others.)

So with regard to both groups of Palomar photographic comet-discovery programs, it seems to us that we should be sure to acknowledge the actual discoverer--and in really appropriate cases also others very closely involved in making the discoveries possible. As more and more team efforts come along, of course, we are going to stray further and further from the original intent of acknowledging those rugged individualits who have made (generally) visual discoveries of comets since the time of

Messier.

In the case of 1994k, you found the comet after you had returned to Flagstaff. David and Tim had gone their separate ways, you measured the films and reported the positions. That is why we decided that this should simply

be "Comet Shoemaker". We should probably have done the same with 1994d, which you found under similar circumstances; there was the difference that the recovery observations were also made by your team, but it did not seem that there was any more reason to credit David over Hank Holt--except that David had earlier taken such an interest in the comet and tried (but failed) to recover it himself in Tucson. So when should there be a comet "Shoemaker-X"? We tend to think the answer to this should be: "Rarely!" A prerequisite would seem to be that you actually find the comet while still at Palomar. "X" might then conceivably be one other person who is deemed to make a significant contribution to the discovery, e.g., by measuring all the positions on Mme Guillotine. If 1994 JF1 had been a comet, for example, one would probably have wanted to define "X" as Tim Spahr.

We think that something like this is going to be necessary in order that the IAU will be inclined not to do away completely with the present comet-naming system. In making the above proposal we are just trying to offer something that is a reasonable compromise to what what has become a decidedly awkward situation.

Regards
Brian

mail> 1
Message 1:
From dhlevy@lpl.arizona.edu Sat May 21 00:12:28 1994
Return-Path: <dhlevy@lpl.arizona.edu>
Received: from dante (dante.LPL.Arizona.EDU) by lpl.arizona.edu (4.1/hindmost-MX-1.4)
id AA05009; Sat, 21 May 94 00:12:10 MST
Date: Sat, 21 May 94 00:12:10 MST
From: dhlevy@lpl.arizona.edu (David H. Levy)
Message-Id: <9405210712.AA05009@lpl.arizona.edu>
To: brian%cfaps1.DECNET@harvard.harvard.edu
Subject: TIME exposure
Cc: dhlevy
Status: R

Hi Brian,

I rather gathered you were unhappy with parts of the TIME article. ME too. I knew as soon as I read it that you were portrayed unfairly. You know, before the piece came out I said to Gene that I was worried that it hadn't been fact-checked with us. He said that newsmagazines never do. Well, it shows. In my case, they had me discovering comets with my 8-inch Schmidt at home.

I hope you will find the Smithsonian piece in June issue more to your liking. In any case, I know it will not say inaccurate things about you and Swift-Turtle. That really was unfair to you, I thought. Maybe we can hope that the account of your role in S-T will live a lot longer, and be read by more of the interested people who count, that I wrote in Quest for Comets-- maybe that version will last longer than TIME's.

Whenever people ask, I say that I have found 8 comets visually, and that I share 13 with the Shoemaker-Levy team. Those are the words I use. The total of comets named for me is thus 21. I appreciate your reasoning that you said to Carolyn. Would it be inappropriate to tell you, though, as a close friend, that I am hurt?

All the best
David

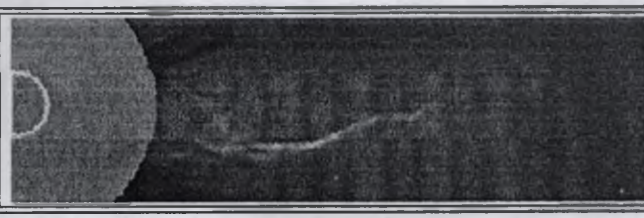
mail> d
mail> q
dante%

CN3j

Sungrazer comet program

December 17, 2001

LASCO



Home LASCO/EIT Real-Time Movies Detailed Documentation

Real Time Movie FAQ

1. Why is there a 16 hour gap in the "real-time" movie ?

SOHO is not in contact with the earth 24 hours a day. The Deep Space Network is a world wide network of antennas used to communicate with all deep space probes including SOHO. It is very busy supporting all of these missions. The Deep Space Network schedule varies from day to day and a spacecraft emergency for another spacecraft can affect the schedule. We are lucky to get a few hours a day of contact time. During the time when SOHO is out of contact the data are stored on a tape recorder (actually a solid state or RAM recorder). When the ground station establishes contact with SOHO, the solid state recorder containing the stored data is dumped and real time data starts. The hours of recorded data takes time to process so the 16 hour gap gets filled in over a few hours after contact and the tape recorder is dumped.

When we are in contact the movie images get updated within minutes of the image being received. But remember that LASCO has a "1 hour" telemetry buffer (this actually varies according to the telemetry rate for a given day) so it may be an hour or more before an image taken aboard SOHO even starts being sent to the ground. All in all the daily gap varies from day to day and may extend up to 20 hours or more.

2. OK, I understand the data gap but why is the latest frame running 3 hours behind real-time ?

This has almost the same answer as question 1. When we get archived data we start processing it even if there is real time data coming down. We get back to the realtime data as soon as we can. The forecasters really would like to know if something important has happened while out of contact. They get more warning time if we process the data in time order.

Our MPG movies are updated on a roughly 3 hour basis and the JAVA movies on a 20 minute basis.

3. Why aren't there any LASCO data for the dates aaaa to bbbb ?

SOHO uses its thrusters every few months to maintain its orbit and pointing. The flight operations team has to prepare very carefully for these operations and it is not lightly rescheduled since the orbit and thruster calculations would need to be redone. During that time LASCO and other SOHO instruments close their doors to prevent exhaust from the thrusters reaching their optics. We do calibration images (dark images , calibration lamp images or calibration opal) or no image taking at all when our doors are closed. Thruster firings (somtimes noted as momentum management) are noted in the daily status reports and typically will take several days as the flight operations team analyzes the ranging data and does other measurements to make sure everything is okay.

EIT does not close its door for thruster firing and usually continues taking images at a higher than normal cadence since LASCO is idle.

Opening and closing doors for momentum management is done by many of the SOHO instruments and in a strict sequence. We have to wait our turn to reopen our doors.

4. Why aren't there any EIT data for the dates aaaa to bbbb ?

EIT does periodic CCD bakeouts to improve the CCD performance every few months. During this time it does not take images because warm CCDs don't have the high performance needed. The bakeouts typically last a day or two. Bakeouts are noted in the daily status reports.

Over time the EIT instrument gets an image "burned in" to the CCD. Bright areas such as the latitude belt where active regions are common burn in faster. These areas will show as bright areas even though there is no real solar feature present. Rotating SOHO and doing off-points from sun center are done to help understand the degradation. The bake-out reduces the effect but it is a fact of life that the EIT CCD will degrade over time due to the EUV hitting the CCD.

5. Aren't LASCO and EIT supposed to monitor the Sun all the time to forecast solar storms ?

SOHO is a research satellite and LASCO and EIT are research instruments. There is a big difference between research instruments and instruments that are designed to meet an observational requirement such as constantly monitoring the Sun. We do observe the Sun for transient events, such as CMEs most of the time. But our mission is to do scientifically useful work. From time to time we may concentrate on taking images that are useful to someone's research such as taking EIT 304 angstrom images at the expense of other images or do calibration work.

NOAA is the official agency charged by Congress to monitor the Sun and do solar forecasting. We provide real time data to NOAA to help them do forecasting. We are specifically prohibited by Congress from making forecasts. See NOAA .

6. Are we seeing the images downloaded directly from the SOHO satellite ?

No, SOHO, the satellite, is not on the Internet. NASA is working on Internet protocols for space, so perhaps someday you will be able to contact a spacecraft directly. In the meantime, telemetry from SOHO reaches the NASA Deep Space Network at one of many locations around the world (Goldstone, USA or Madrid, Spain or Australia) and is sent to Goddard Space Flight Center in Maryland, USA and then to Naval Research Lab where the telemetry data are processed into images, converted to a movie format, and then put on the WWW.

You can see the weekly DSN schedule of contacts with SOHO at the SOHO WWW site under Operations. The schedule uses day of the year and has start and end times in GMT for the contacts.

7. What is that bright spot with a line through it ?

This occurs for any object (whether a star or a planet) that is so bright that it is overexposed. The CCD detectors that we use "bleed" electrons along the columns of the CCD when the pixels cannot hold any more electrons. Chances are that the object is a planet or bright star. A look at the almanac and a star map will confirm that. We have had comets or dust particles bright enough to saturate our CCDs also. This saturation is similar to what you can sometimes see in TV cameras if they are overexposed. However the new TV CCD cameras have special circuitry that minimizes the amount of "bleeding".

Have a look at our annotated C3 image

8. Why can't I see the comet listed as being in the NW of the C3 frame ?

An important note is that East is at the left edge and West is at the right edge, North is at the top and South is at the bottom. So when the questioner has trouble finding the reported comet he or she is probably looking at the wrong side of the photo. This follows the standard astronomical conventions of east and west as defined by the background stars. Most star maps also follow this convention. Some of the comets are very small and difficult to see in single frames. You can check the Comet section of our WWW site for some examples if you are having trouble finding the comets in our images.

9. Why do I see cosmic ray streaks persisting from frame to frame in the movies ?

Missing 32x32 pixel blocks are filled in with the corresponding block from the previous image. This was done for cosmetic reasons in the movies. It is not done in the raw data or archived data.

10. Does LASCO operate on 7/24 basis ?

The LASCO and EIT instruments aboard SOHO are generally operating on a seven days a week, 24 hours per day basis. However the ground segments (commanding, data reduction, image processing and data archives) are manned on a normal work week (9-5 M-F Eastern time) following the Federal holiday schedule and with snow and emergency days for Washington DC. That means that problems with processing (hardware, software, network, power) are not fixed until the next business day.

11. What is that radial dark area in the C3 images at about the 7 o'clock position ?

The 7 o'clock position is where the pylon that holds the occulting disk appears in the image. It has always been in the images. The C2 camera also has a pylon in the 7 o'clock position but it is less obvious than the C3 pylon due to a different optical design. The occulting disk and arm is similiar to what a person does when they want to look at something close to the sun; they hold up their hand and block the disk of the sun.

Have a look at our annotated C3 image

12. What are those dark areas that I sometimes see in the images ?

The dark areas are image processing artifacts and not a sensor problem. The images on the WWW page are processed by removing a background light model. The background light model is about 99% of the light received by the CCD and consists of instrumental stray light as well as coronal light. The amount of background light varys according to SOHO's orbit. When the model is wrong we subtract off too much light and we see a dark area. Correcting the model always lags the actual data. We are always using last month's model with today's data. So about two weeks to a month after today we will build the right model for today. The real-time images are a rough cut at the image processing and are intended for planning purposes for the next day's observations and for public outreach. The subtraction is particularly obvious during a spacecraft roll manuvuer when the spacecraft has rolled but our background light model has not rolled.

13. Why do I see a rectangular pattern on the EIT images ?

The EIT telescope uses very thin filters (about 1000 angstroms which is about 0.00004 inches) that are so weak structurally that they need to be supported on a wire mesh. During launch, the instrument was evacuated so that the vibration of the air in the instrument would not break them. The mesh causes the dark lines in the EIT images.

14. More Questions ?

Have a look at the Dr. SOHO FAQ and address a question to them. Tell them LASCO sent you!

FAQ Updated - 26 Nov 2001 - D. Wang

SEBASTIAN'S COMET HUNT

Homepage of Sebastian F. Hönig

Guide to search for SOHO comets

This is a short introduction for all those how want to start SOHO comet hunting.

1. Equipment

There are **some things you need** to start your search for comets:

- Computer with internet connection and mouse (fast connection prefered)
- Image viewer with features listed below or movie player
- High-resolution monitor, as big as possible (>15" as an absolute minimum)
- Paper and pencil for notes
- and last but not lease: **patience!**

Features the image viewer must have:

- getting coordinates in pixels (not only inches or cm)
- image looping or blending (whereas looping should be prefered)

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2. Important note:

It is important to keep calm.You mustn't have the expectation to find a comet at your first try. It may take you weeks or months till you finally catch your first discovery. However there are some examples that one found two comets within his first days (Mike Oates). Also, do not post known comets! Only the first one gets credit. Therefore **always**

check the report page before posting something!
Doug Biesecker, formerly responsible for SOHO comets, once summarized: "Please, don't guess. Don't speculate. Don't hope. Watch comets which have been confirmed before trying to report one yourself. [...]" Examples can be found below.

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3. Common terms:

LASCO	Large Angle Solar COronograph. That's the telesope that exposes the images.
C2	CCD camera that shows the solar corona within XXX solar radii (low angle camera)
C3	CCD camera that shows the solar corona within XXX solar radii (wide angle camera)
FITS	Flexible Image Transport System. Special image file format used to archivate the images
Realtime	Latest images available on the SOHO hompage
(Kreutz) sungrazer	Comet that moves in a specific direction (from anywhere on the bottom towards the sun). Most of the SOHO comets are of that type
non-Kreutz comet	Comet that has a different motion (might be seen everywhere). This type of comets is quite rare.
FOV	Field of view. The area covered by C2 or C3 CCD
X/ X-comet	object that might be real but is not confirmed due to violation of the four image limit.

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4. First step:

First you have to download some images. They should be consecutive ones with no image missing. Usually C3 images come in twice per hour at xx:18 UT and xx:42 UT while C2s are available three times per hour at xx:06 UT, xx:30 UT and xx:54 UT. Sometimes one of those imges is not downloadable. This usually happens when the SOHO Team does some calibration work (dark frames or flat fields or polarized images) which is not interesting for us. Common gaps appear around 01:00 UT, 07:00 UT, 13:00 UT and 21:00 UT. It may, however, occur that there are quite big gaps between two images because of delays in receiving data from the spacecraft.
Images are available in different resolutions on the SOHO website:

Images	useful resolutions
C2 .gif	512 x 512 pixel 1024 x 1024 pixel
C3 .gif	512 x 512 pixel 1024 x 1024 pixel
Movies	useful resolutions
*.mpg	512 x 512 pixel 1024 x 1024 pixel
*.avi	512 x 512 pixel 1024 x 1024 pixel
Java	512 x 512 pixel 1024 x 1024 pixel

I personally prefer single images since the movies are too large (~ 35 MByte) to download. I also encourage the use of 1024 x 1024 resolution images as they are more detailed and so faint objects are easier visible. For more advanced comet hunters 512x512 is also acceptable.

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5. Second step:

After having received the images, you have to work with your image viewing software. There are two common ways to search through the images:

1. Looping: That's the most popular way. Simply create an animated .gif from your images. It's useful to loop 3 or 4 images as it is possible that there are objects which seem to be comets in two images but vanish in a third and fourth. It needs a bit of practise to handle the looped images and find possible comets within them. If you don't have the possibility to create animations try to open different windows and loop them by hand. It's not perfect but it may do.

2. ***Blending:*** This alternative way of searching for SOHO comets is not that common. You take three or four images and combine them with the "blend 50%" option. So you get one image where stars can be identified as dots closely together in horizontal direction, wheras comets should have another direction. It may helpful to give different colours to the images to get a typical colour series for moving objects and an untypical one for noise. However this method may fail if searching for faint comets as they may vanish when combining.

Note: The more you process your images the more noise will mimic as an apparently real object. Therfore don't process your images any further. You won't extract more information from the .gif images by over-contrasting them.

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6. Third step:

If you think you have found a possible comet there's a simple way of checking if it is real and worth to report:

1. Self-criticizing: Look at the object. To be considered as a real object it has to fullfill the following minimum criteria:

Minimum criteria
1. Object has to be visible in at least four consecutive images.
2. Object must be constant in brightness and shape or change in a predictable way.
3. Object must have a reliable orbit (not too fast)
4. Consistent positions (no jumping or strange acceleration/decceleration)

If the object doesn't fullfill all of the points **DO NOT** submit your observations since the object is most likely not real. There are often single image cosmic ray hits which appear only in one image and are reported as comets by unexperienced observers. Planets and sometimes stars might look like comets but with a little bit of knowledge such fail reports can be avoided. You can see examples of planets, stars, spacecraft debris or cosmic ray hits on the report form page. It has to be noted that from experience **all SOHO comets, ordinary Kreutz sungrazers as well as other comets, do change their C3 positions by less then 15 pixels from one image to another** (for **C2 the change is less than about 20 pixels**). Always check if your object fits this "empiric law". An additional thing that newbies always should be aware of is the fact that more than 95% of all SOHO comets do not show up like one might expect a comet to look like, i.e. no tails. Tailed objects are most likely cosmic ray hits.

2. ***Checking for known objects:*** If the object is within the minimum criteria you have to look whether it has been already reported or whether it is some other known object passing through the LASCO FOV (e.g. a transient planet, known comet or gasous nebula within the milkyway. To check the former two you can use this site.).

Already mentioned but important enough to say it again: Please do not report if an object has already been reported! Only the first one gets credit! You can find the known objects on the comet discoverers' site. To check for these you have to look for recent "Potential comet" posts. Real objects are often confirmed quite quick by "Confirming comet of" reports or red posts by Mr. Sungrazer. To check whether your object is one of those simply extrapolate the positions to your date and time with respect to your coordinate system. At the beginning this may take some minutes but after some practise you will see it without time consuming calculations.

3. Reporting: You still think it is an unknown comet? Well, might be. Now you have to report your observation. The report must be put in the official report form on the sungrazer homepage.
Your reports must include some data:

- LASCO camera: C2 or C3
- Date
- resolution: 512x512 or 1024x1024 and origin of your coordinates (usually upper left corner or lower left corner)
- Image and coordinates: time of each image and the position of the object
- Your name

Some of the required data can be inserted by chosing the corresponding downscroll options, the rest should be written "by hand". Do not forget to choose your name at the end of the report form. As a new user you are supposed to select "New user" and fill in an additional form after having reported your object. This form is supposed to contain your name and email address. After Mr. Sungrazer receives it you will be added to the list of names and a note about the new user will appear on the report page. Never forget to press the "submit" button after your report appears in the lower window. Further help on reporting can be found the the report form page.

4. Waiting for confirmation: That's the hardest time if you are not sure about your report. But you can use it constructively! Just download further images (previous or following) and recheck. If you can't find it anymore just retract your report. It's better to retract the report than letting other people do confirmation work for something that doesn't exist.
If it is a real object you will get confirmation soon - either by one of the other observers or by SOHO Team member KB alias Mr Sungrazer who is responsible for the comets. The confirmation (or rejection) will be posted on the website where you posted your report.

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7. Examples:

New: zip-Package with already known Kreutz comets to work on and train (10Mb!!).

Here are some examples for the different comet hunting possibilities:

			
Color blending:	***Blending:***	***Looping:***	***Faint comet:***
Find SOHO-301 (easy)	Search for SOHO-294 (easy)	Look for the non-Kreutz comet SOHO-298 (medium)	Do you find this faint comet? (difficult)

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8. Some helping hints:

You feel well prepared for comet hunting? Well, there's one thing you are still missing: experience! That's perhaps the most important tool. How can you get this? Just try to locate any comet - faint or bright - which is reported. Doing this you will get an idea of **how and where comets appear** and **how fast or slow they move**. Mike Oates has produced a plot where you can see where Kreutz comets appear in C2 each month. Additional plots exists for comets of the Meyer, Marsden and Kracht group are available from Rainer Kracht.
Some other helping websites are presented on the link section

Good luck!

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Images are provided by the SOHO LASCO Team. Many thanks for this opportunity!

Contact: Sebastian@sungrazer.org

Mike's SOHO Comet Hunt

144 Comets Discovered to Date

This has changed my astronomy completely, until January 29 2000 I had no idea that anyone could download images from a web site and make discoveries such as finding comets. The thrill of finding one is immense, in some cases the comets I have found may not have been seen at all either because they were faint, or they were found on archive images taken one to four years previously.

Most of my discoveries have been made by examining archive SOHO LASCO C2 images. In order to view these images, which are only available in the unprocessed FITS format, I had to do all the image processing myself. The program I used for this is MaxIm DL 2 by Diffraction Limited, a perfect program for the job. To view the processed images I then used a program called ACDSee 32 which allows you to view one image after another without any flickering.

I am a member of the Manchester Astronomical Society, the Society for Popular Astronomy (SPA), the BAA and the RAS

- List of Comet Discoveries
- Sungrazing Comets
- Non-Sungrazing Comets
- SOHO, Sungrazers and Related Comet Web Pages
- LASCO C2 Comet Paths A guide to show where the comets have appeared in LASCO C2 images
- Archive News Items
- Comets and Cometary Fragmentation: Their Possible Effect on Life in Planetary Systems A pdf file (1.25Mb)

News

15 Mar 2005

Well it's been a while, over a year in fact, but I discovered one more comet (a Kreutz Comet) on March 7 2005. This is my 144th discovery. Rainer Kracht has also recently discovered 5 more comets and that brings us both joint top in the comet discoverers. Here is the announcement of the discovery by Karl Battams:

> Mar 15 2005 18:54:13
> Confirmations, at last!
> Soho# Date/Time of Post Discoverer Tel Group Images of...
> ===
> 914 Mar 07,05 07:52:46 M.Oates C2 Kreutz Mar06,05
> 915 Mar 10,05 08:25:37 R.Kracht C3,C2 Marsden Mar10-11,05
> 916 Mar 11,05 20:45:05 H.Su C3 Kreutz Mar11-12,05
> 917 Mar 13,05 15:37:58 B.Zhou C3,C2 Kreutz Mar13-14,05
> 918 Mar 14,05 11:22:54 X.Leprette C3,C2 Kreutz Mar14,05
> 919 Mar 15,05 08:29:23 T.Hoffman C3,C2 Kreutz Mar15,05
> 920 Mar 13,05 09:08:07 R.Kracht C3 Kreutz Aug08,97
> 921 Mar 13,05 09:20:05 R.Kracht C3 Kreutz Aug08-09,97
> 922 Mar 14,05 14:58:23 R.Kracht C3 Kreutz Sep19,97
> 923 Archive claim email R.Kracht C3 Non-grp Jan21,97
> 924 Mar 15,05 12:52:16 B.Zhou C2 Kreutz Mar14-15,05
> --
> Well considering it's March, that's an awful lot of comets we've had lately! Mike Oates' Kreutz was deemed real by Brian (see latest MPEC). I am assuming here that Xavier's C3 claim is the same as Tony's C2. Note Rainer's archive non-group claim. I have 11 or 12 positions for the object -- I'm certain it's real but I guess there's always the chance it is a "known" comet. I'm sending the astrometry for it tomorrow.
> --
> So, unless I'm mistaken, this puts Rainer and Mike on joint top-spot for the number of comet discoveries -- they both have 144! Very impressive!

The delay for the confirmation was because the comet in C2 was faint with only just 5 images. The last word was with Brian Marsden if it was to be counted, thankfully it is. You may wonder why the long gaps between my discoveries? Well I basically took three years off from comet hunting to take a Masters Degree (Part time) it was a big commitment, one that needed more of my time. Comet hunting is VERY time consuming, so it had to go.. I can now say that I have graduated with an MSc. in 'Environmental Management and Technology' from UMIST (Manchester, UK), something I am very pleased with, especially at the age of 47!

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26 Feb 2004

It is with great honor, that I can announce that Sebastian F. Hönig, a fellow SOHO comet hunter with many comets to his name, also the visual discoverer of C/2002 O4 (Hönig) and discoverer of about 477 Asteroids has had one of his first numbered minor planets named after me: (58548) Mikeoates. I cannot thank Sebastian enough for this.

Citation as it appeared in Minor Planet Circular MPC 50466:

```
Mikeoates 68948                          Director of an electroplating company

(68948) Mikeoates
   Discovered 2002 Aug. 8 by S. F. Hönig on NEAT images taken at Palomar.
   Through 2003 Michael Oates (b. 1957) has been the most successful SOHO
   comet hunter. Using his personal computer and fast Internet connections to
   scan through the SOHO LASCO image archive, he is credited with 138
   near-sun comet discoveries.
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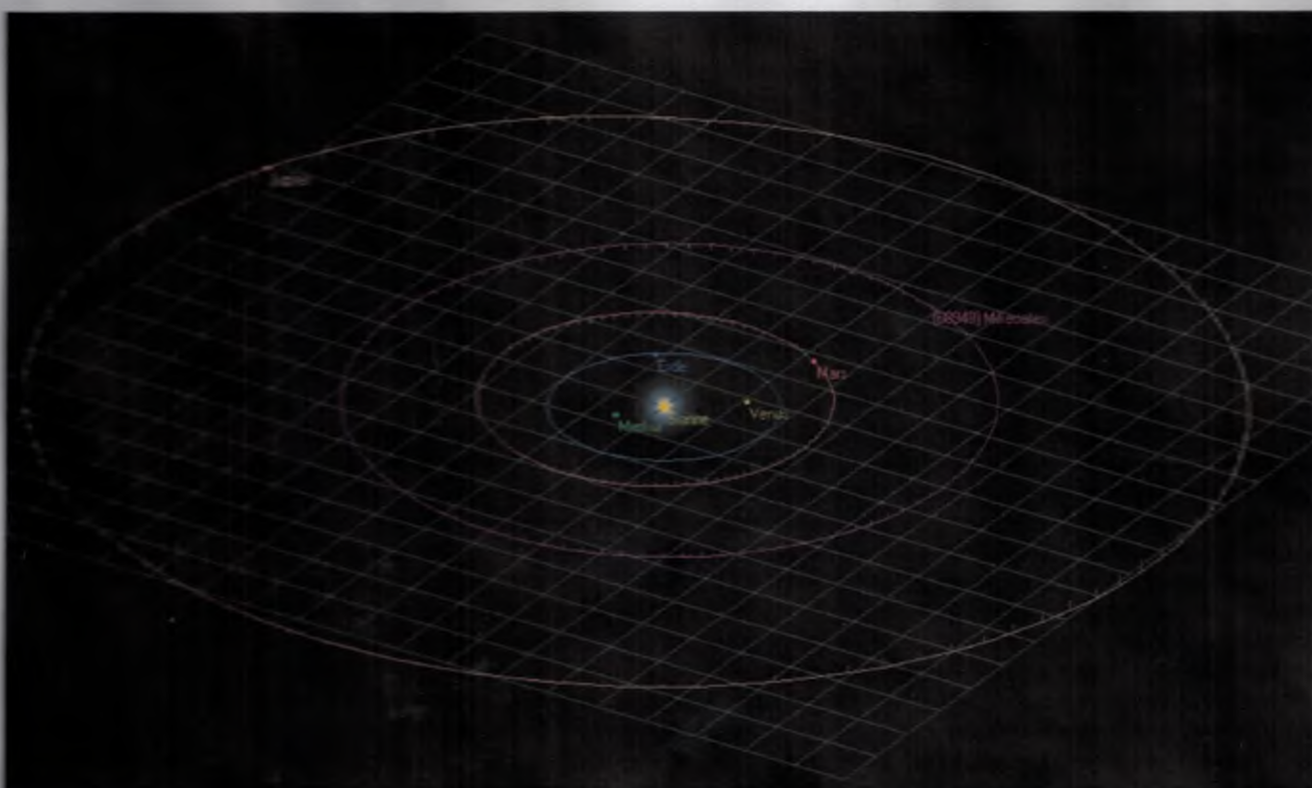
Orbital Elements

(68948) Mikeoates

```
Epoch 2002 Dec. 27.0 TT = JDT 2452635.5        MPC
 M 142.34075        (2000.0)       P         Q
 n 0.22102888    Peri. 239.23485  +0.1734288  +0.9847484
 a 2.7823280     Node 40.69946    -0.8861635  +0.1036205
 e 0.0207080     Incl. 1.21546    -0.4364167  +0.0581228
 P 4.67          H 15.8           G 0.15      U 1
 From 40 observations at 5 oppositions, 1993-2002, mean residual 0".39.
```

Discovery date : 2002 08 08
 Discovery site : Palomar
 Discoverer(s) : Hoenig, S. F.

Minor Planet (68948) Mikeoates belongs to the Main Belt Ib, with a size of ~5 km.



Orbit of (68948) Mikeoates

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29 Dec 2003

After a gap of 9 months, I have just reported my 143rd comet. Reported with only 2 images seen, however, the path, appearance and motion were consistent with a Kreutz comet at this time of year. Two previous Kreutz comets had just passed through this area the day before. I can safely say that, even with so many discoveries, finding this latest one is just as exciting and rewarding as the first comets I found. I am also very happy to welcome Karl Battams who is the person on the SOHO team who now responsible for measuring and reporting the SOHO comets to CBAT.

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15 Jun 2003

I think an update is needed...

I am still looking for comets, and I am still finding them, but I don't have the time needed to be first to report them. Today Rainer Kracht reported his 100th SOHO comet, well done Rainer. So it looks like my record of 142 comets is now in serious risk of being beaten!

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19 Mar 2003

Reported a Kreutz group comet in realtime C3 images today. The comet can be seen right at the edge of the field, so there is a chance that this may be a bright one.

Report positions:

```
 (0,0 in BOTTOM LEFT corner in 1024x1024 images)
  Image                    Col Row
  20030319_1618_c3.gif 87  222
  20030319_1642_c3.gif 90  227
  20030319_1718_c3.gif 95  230
  20030319_1742_c3.gif 98  232
  20030319_1842_c3.gif 106 238
```

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21 Jan 2003

On the 19th January I had been busy with my assignment for a course that I am taking. At the end of the afternoon I checked for new images from SOHO as there has not been any that day or the day before since early morning. The images were there, I had no idea how long they had been available and downloaded all the C2 and C3 images for that period. I inspected C2 images, nothing there, then looked at the C3 images, and there, on images from the 18th was a faint comet. I then checked the reports page expecting it to have been reported, but hadn't. Very quickly I made a report and I was first, but in my haste I had posted the wrong position, I had transposed some figures and had to make a correction. This is SOHO-582.

I am very pleased with this find, as earlier that day I had emailed Sebastian and said that it did not look as though I would reach 150 comets, a target I had said I would like to get to. There are more people looking for comets in the SOHO images and many of these are looking at the realtime B/W images as they are made available, which requires a great deal of time spent at the computer. Time do not have these days!

It is now approaching 3 years since I started to look for comets on the SOHO images. I would like to express my thanks to the SOHO team for making the images available in almost realtime, especially Doug Biesecker and Derek Hammer for there work in confirming and measuring the positions for reporting to CBAT. I would also like to thank very much all other SOHO comet hunters for their support and emails, and for making this so much more enjoyable. And finally, this would not have happened if it was not for Jon Shanklin who gave a short talk on how he discovered a SOHO comet 3 years ago. 141 comets in 3 years, not bad eh!

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18 Dec 2002

On the 11th Dec I reported a comet in C2 images from the previous days images. The report time was Dec 11 2002 12:26:26. However one second earlier, yes ONE Second! Xavier Leprette had posted a report for the same comet. This is the closest two reports have ever been except one for Sebastian and Xavier who posted a report at the same second, this was SOHO-517 on the 17 Sept 2002. Today the 18th, Derek has decided to give Xavier and myself joint credit for the discovery, partly as it was so close, but also due to the fact that I had also included other information such as when the comet was and listed all the images. Had I sent in a short post such as "comet in C2, positions next post" I would not have been given credit. This is my 140th confirmed comet and is SOHO-573.

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24 Oct 2002

Over two years ago on 28 June 2000 I reported a possible Kreutz comet found in C2 images to Doug Biesecker, but alas it did not have enough images for confirmation, so it was assigned to a list of possible comets unoficially called X/Comets. These are most likely to be comets but they do not meet the minimum specification of 4 good images.

Then on 19 October 2002 Rainer Kracht reports a number of images of a comet in C3 images and he reports that it maybe the same comet I reported over two years previously. Today Derek Hammer has confirmed that this is indeed a Kreutz comet and must have been over looked somehow. This is SOHO-531.

Was this the only one to be overlooked? I don't know, but I intend to search the C3 images for all the other X/Comets just in case. Many thanks to Rainer for his report.

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12 Oct 2002

The comet I report on the 8th has been confirmed as SOHO 528.C/2002 T3 see: 2002-T75 It was visible in both C3 and then C2.

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8 Oct 2002

Not too long since my last Kreutz comet find in LASCO C3 and I have found another today, again in C3 images, this one is brighter. The comet has a hint of a tail, and most of the images I have so far are 512x512 B&W so I have yet to see a good animation of it. Seen in images from 16:18 to 21:18 so far

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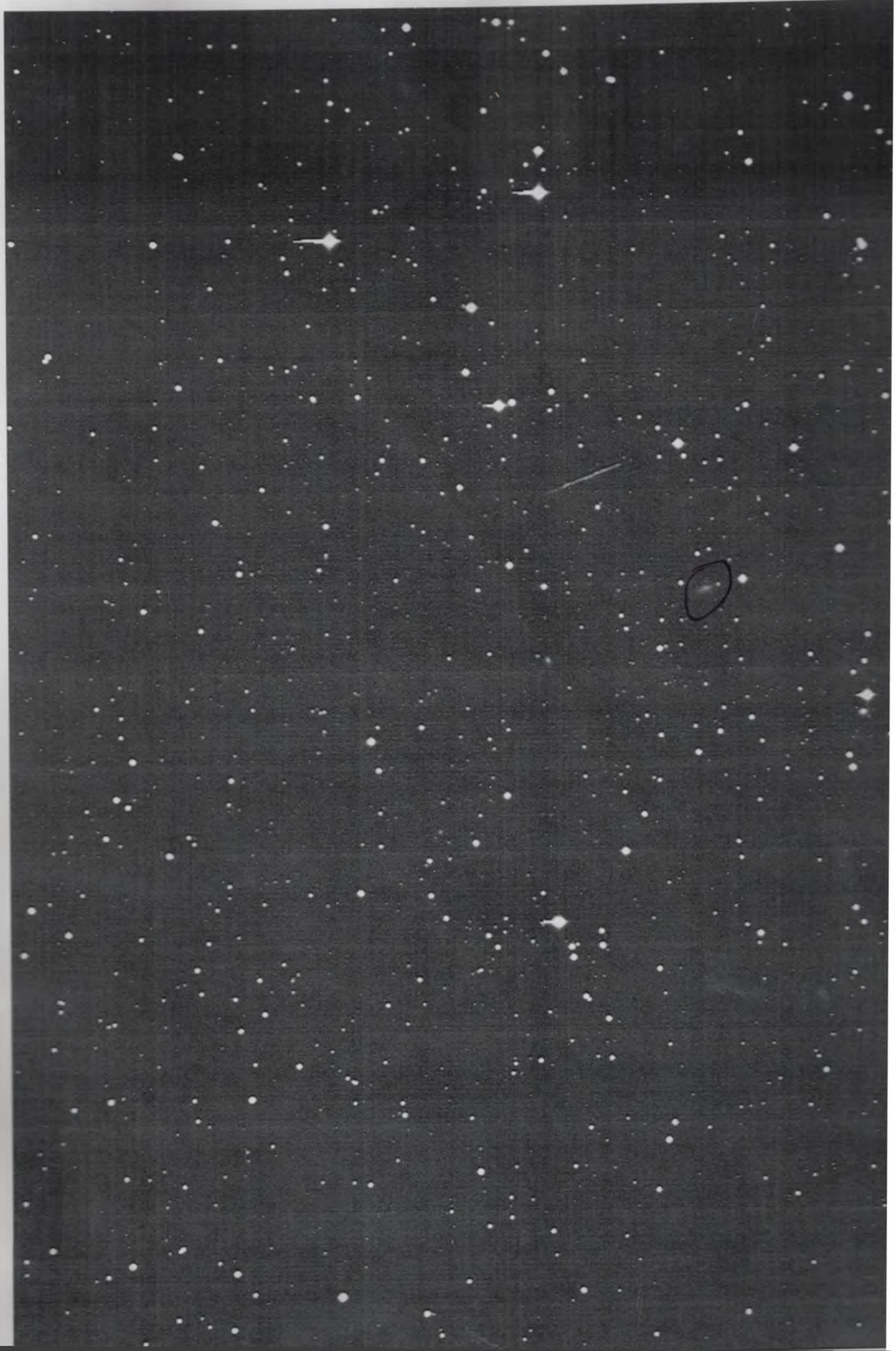
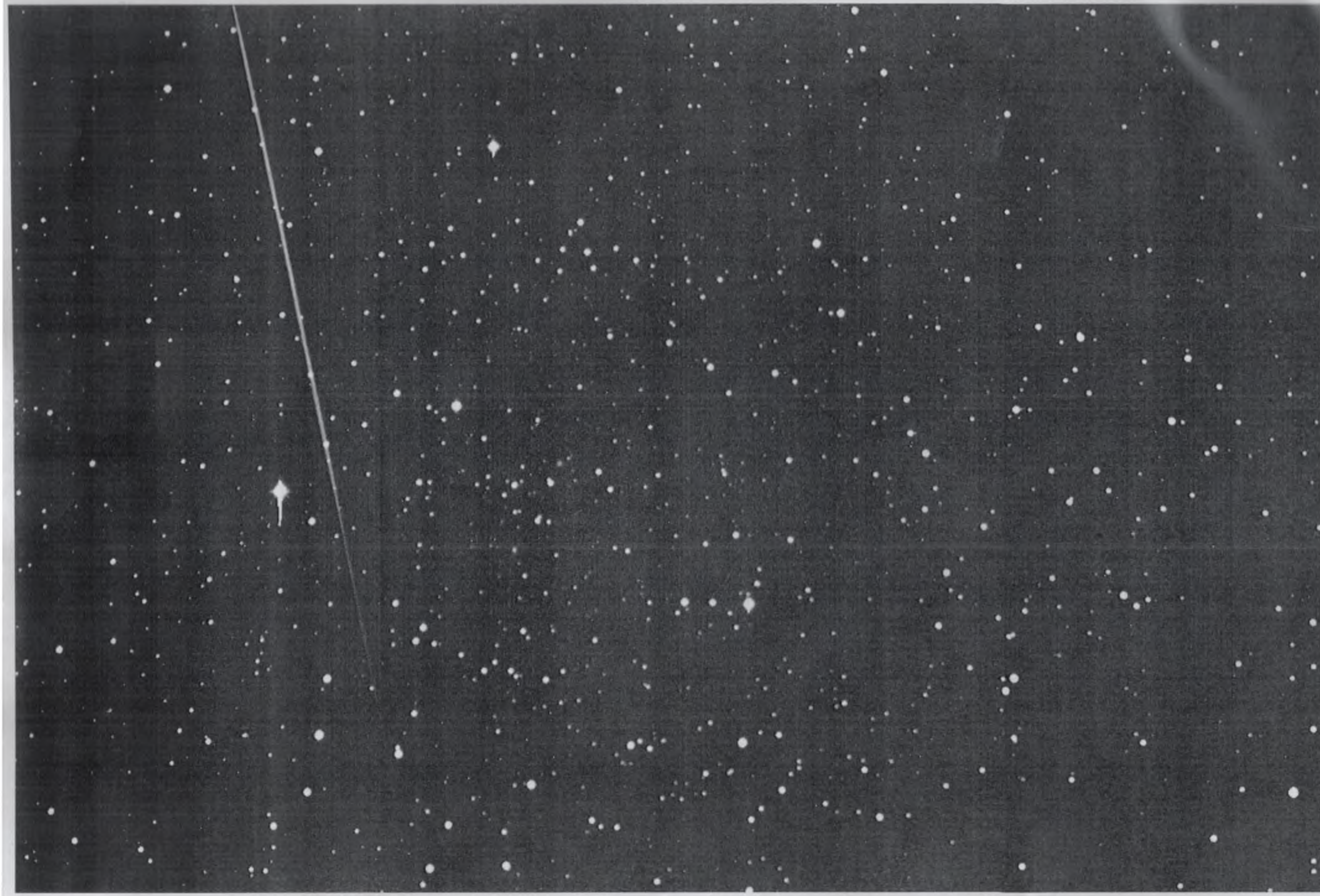
23 Sept 2002

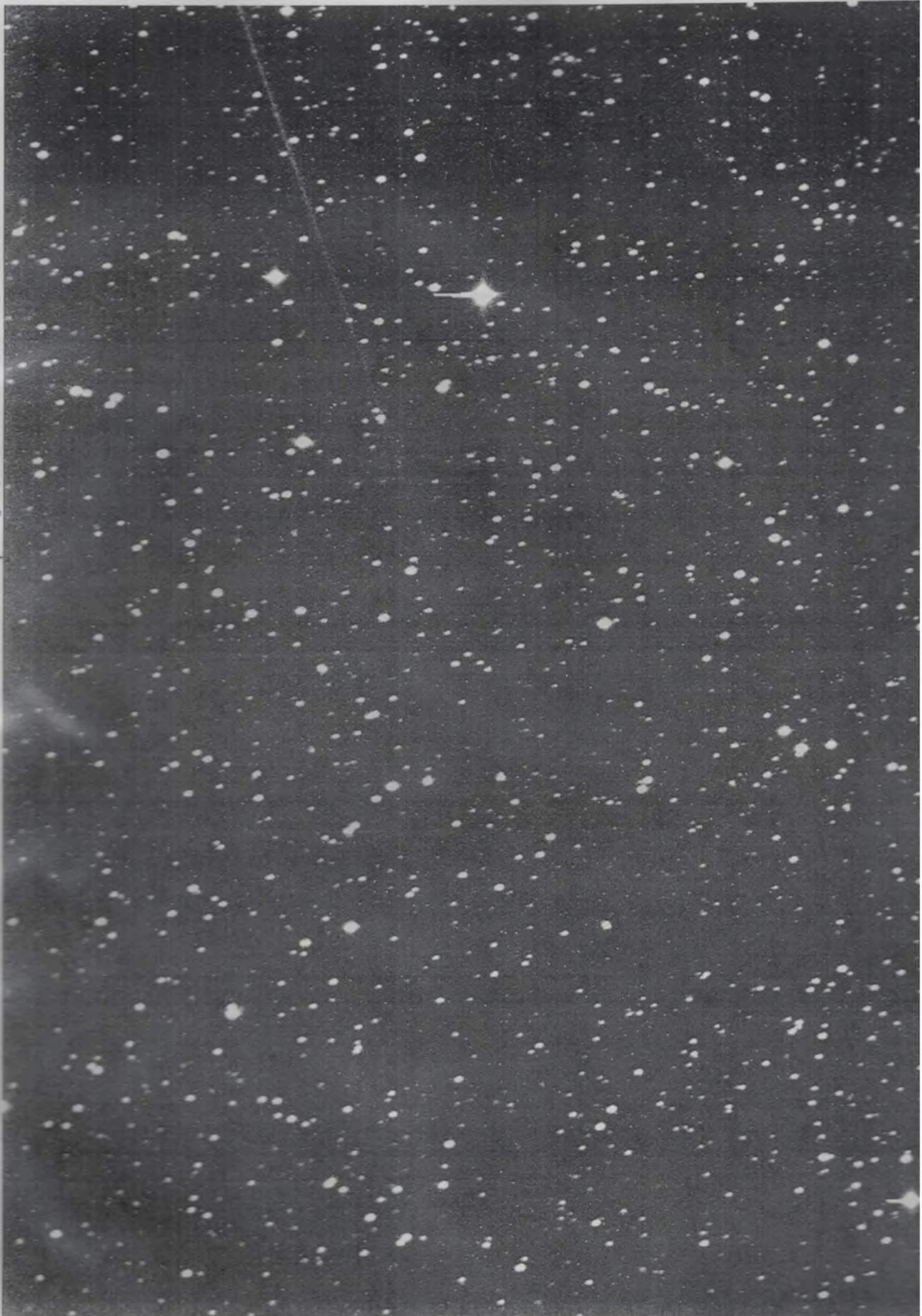
Quick note to say that the discovery of the Kreutz comet in C3 images has been confirmed. This is SOHO-521.



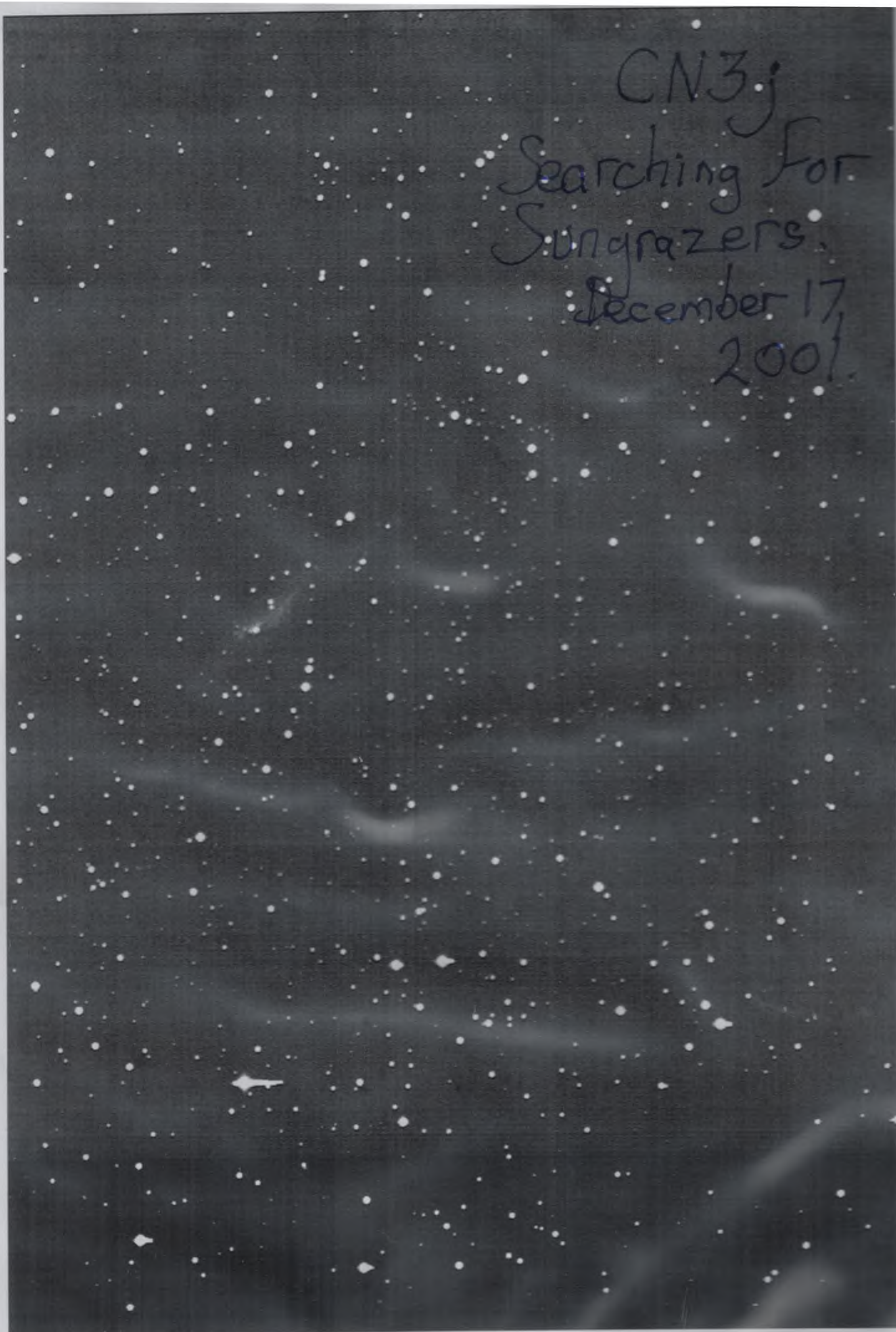


CN3; 2011 10 31 meteoric meteor

CN35 Possible Meteor 20121016

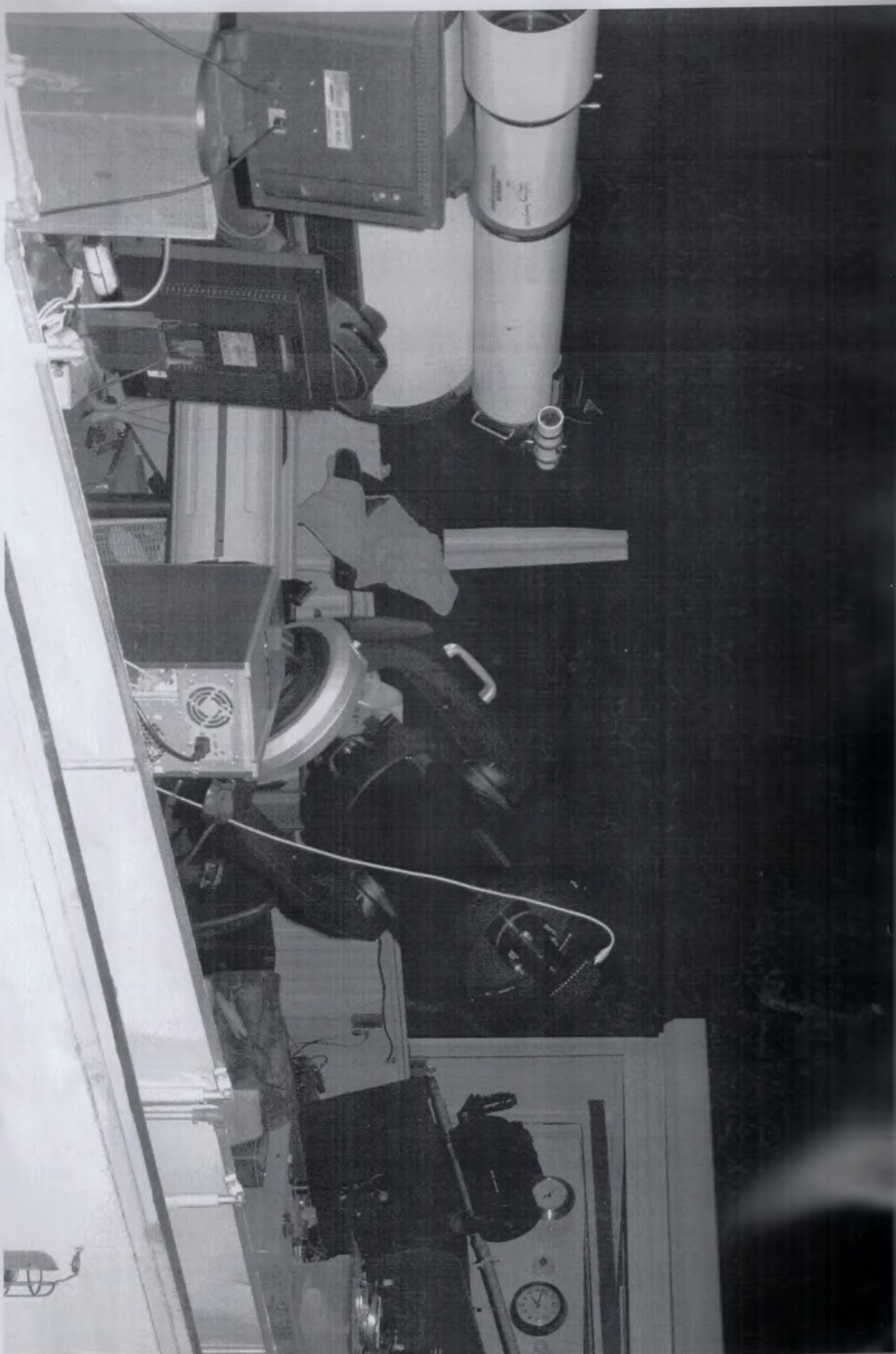


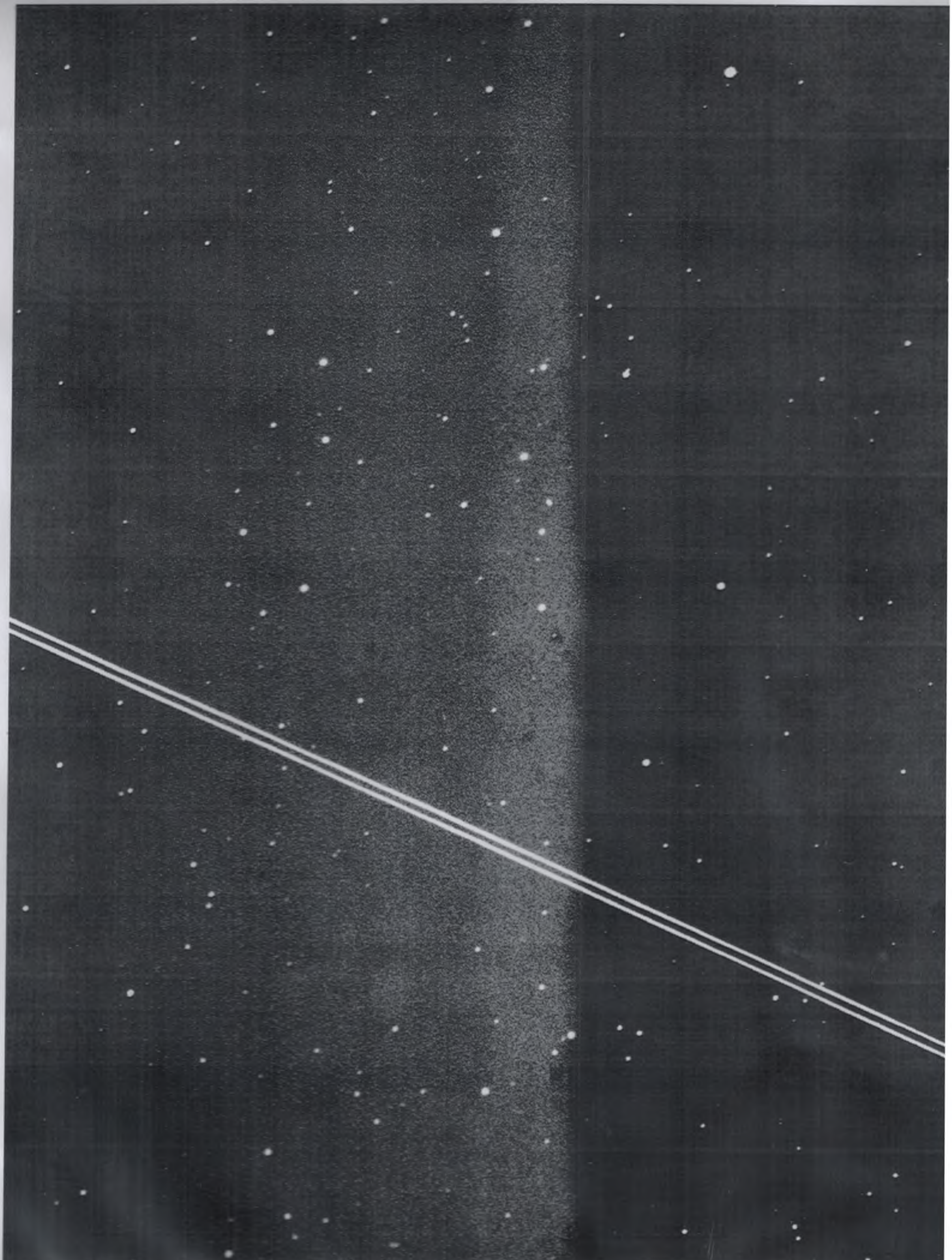
CN35 Possible Meteor 20121016


CN3:
Searching for Sungrazers.
December 17, 2001.

CN3h-11
Digital Comet Hunting with POTUS.

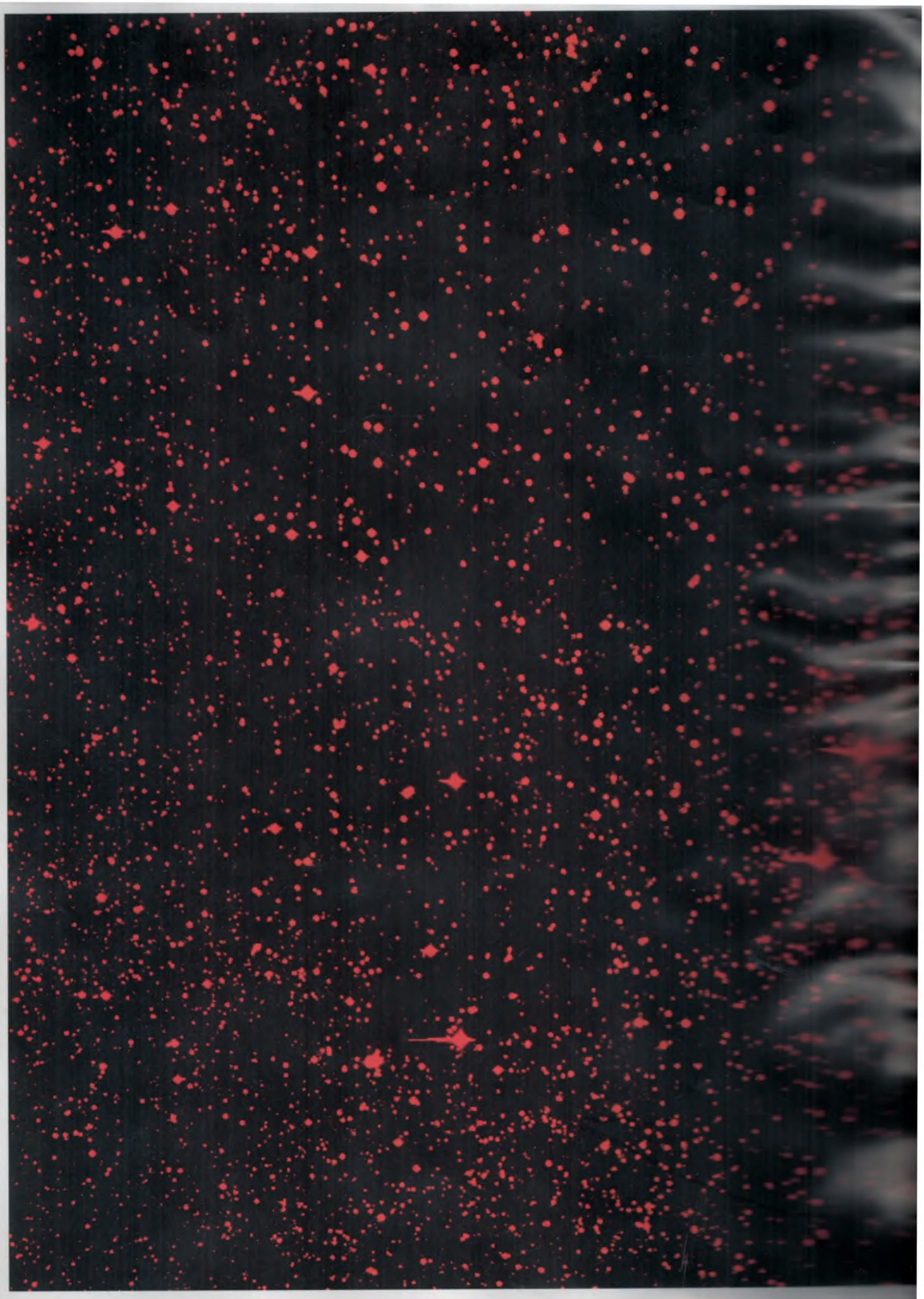
Begun early in 2010
Using POTUS, the telescope that Dean Koenig set up at the White House, as a part of what might have been the first star party held with the President of the United States.

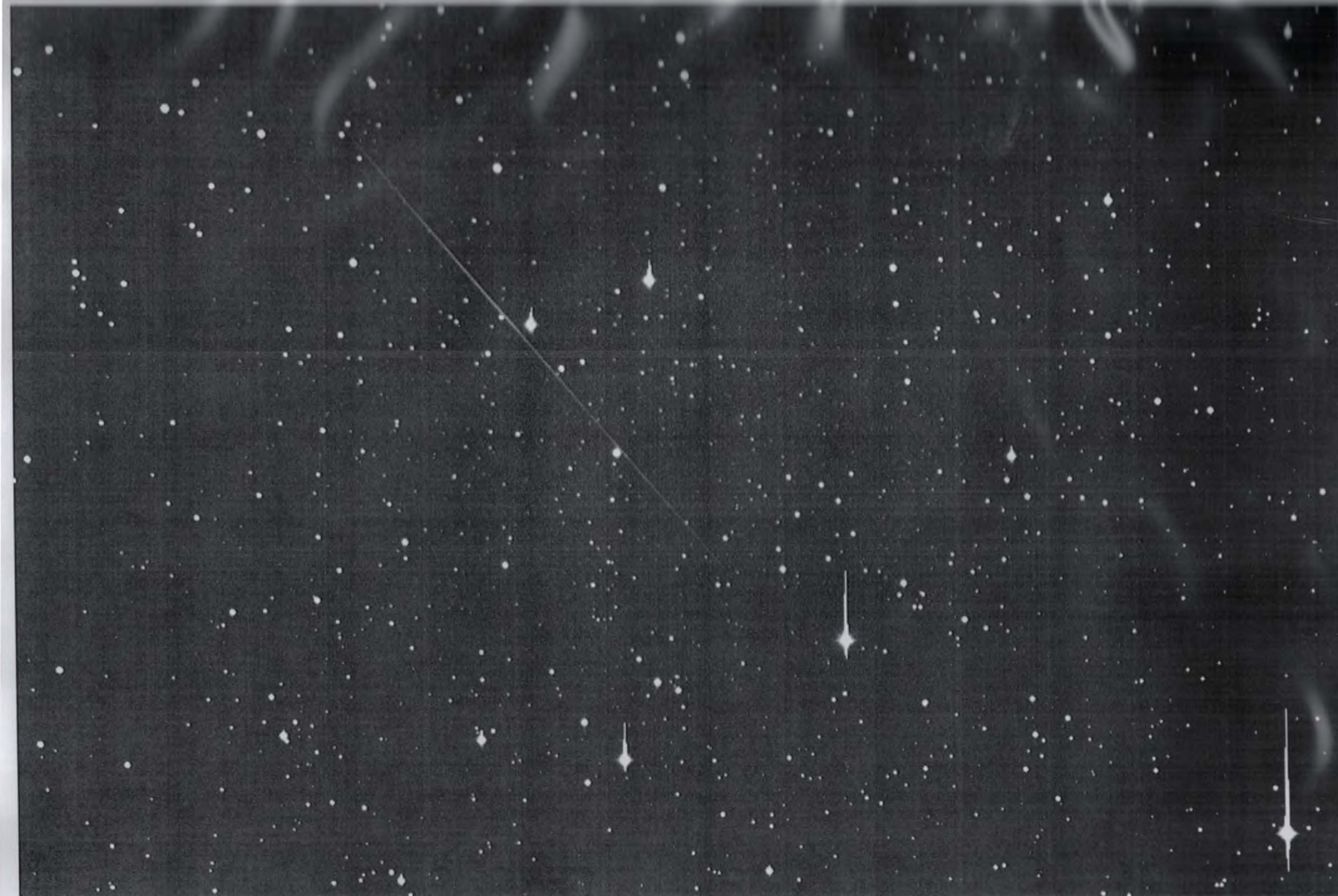




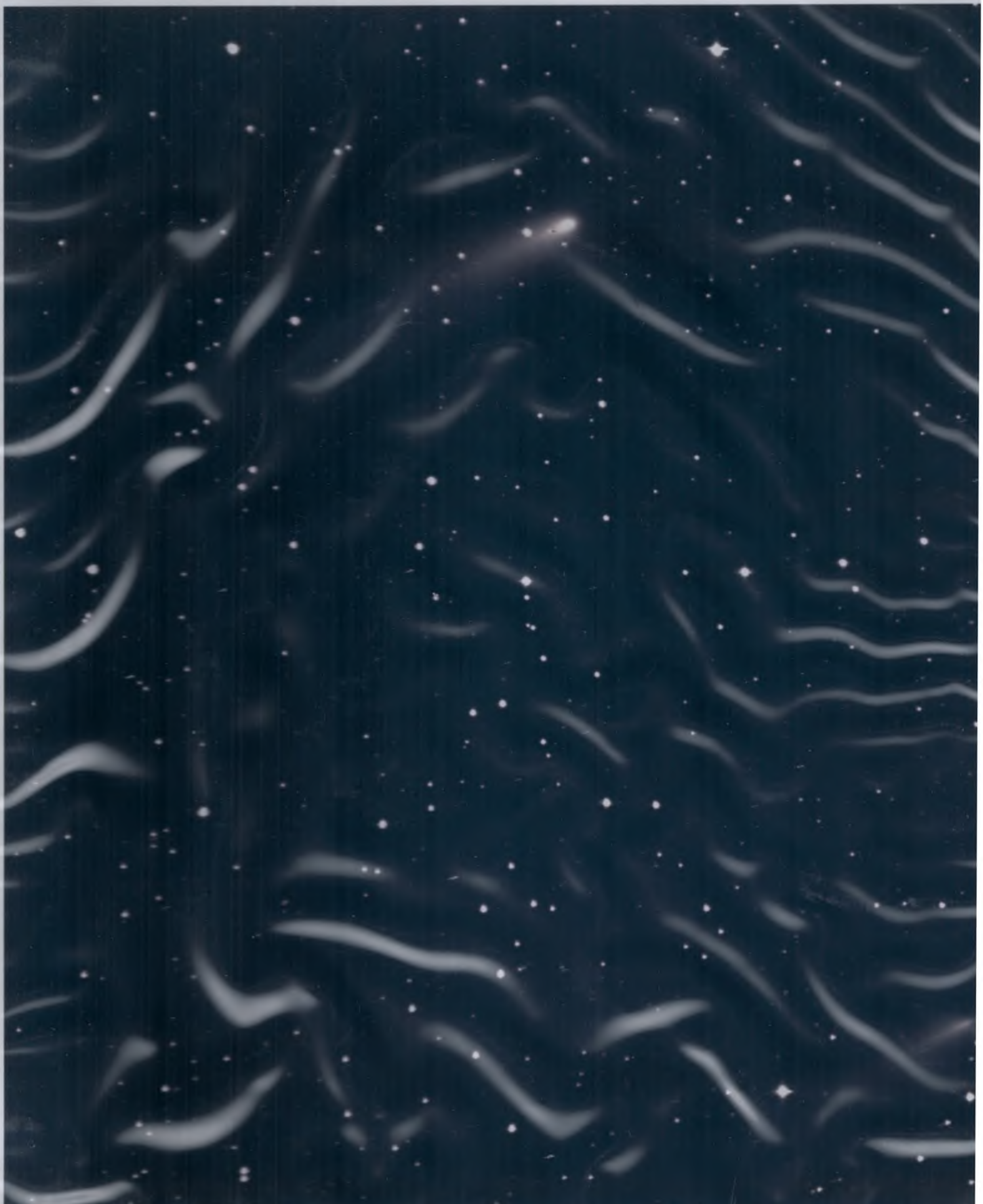
CN3k11
CN1
Comet
Hunting
Clyde's
Way
with
Clyde.

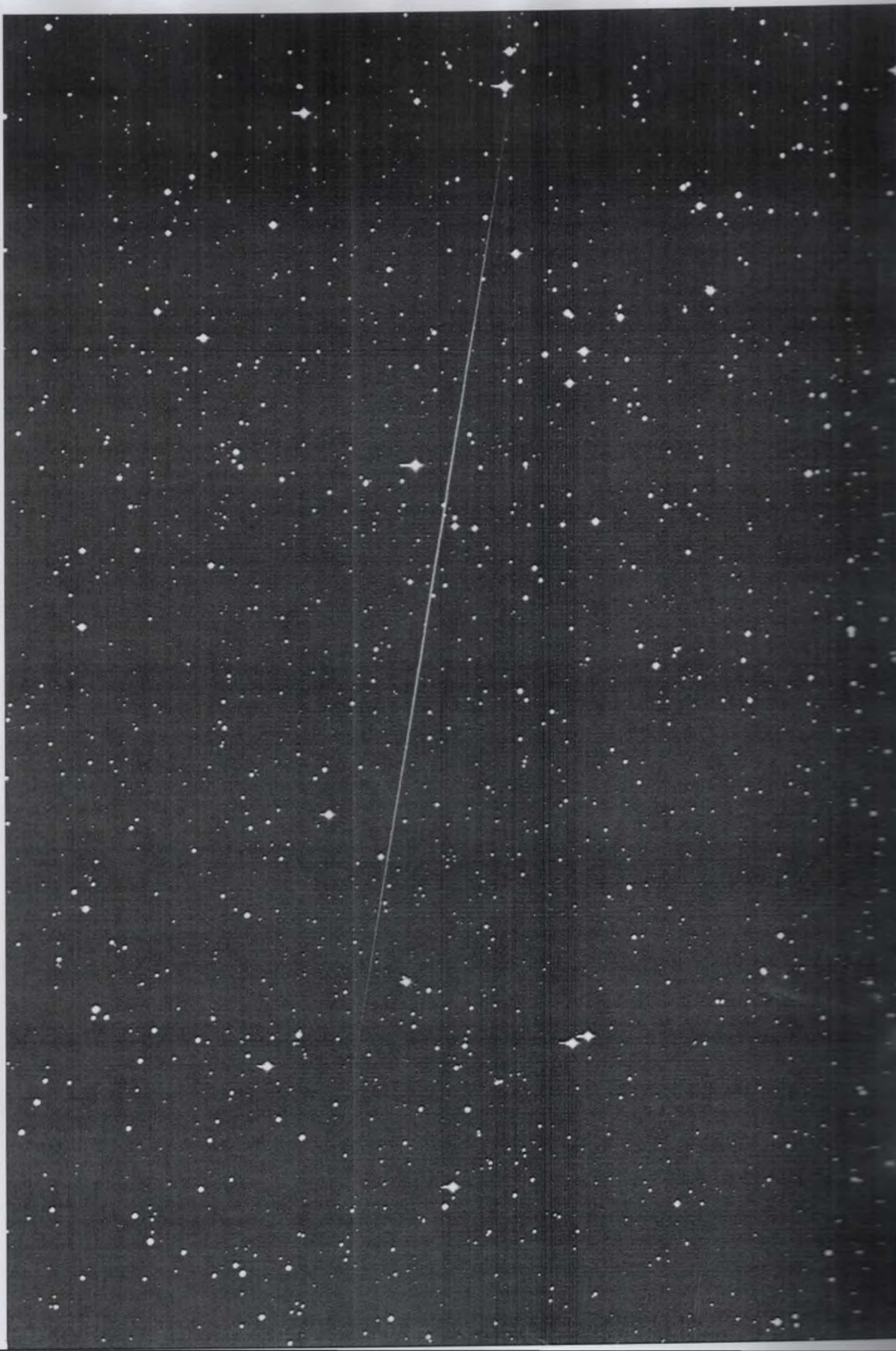
A AR
2012
Sunrise.

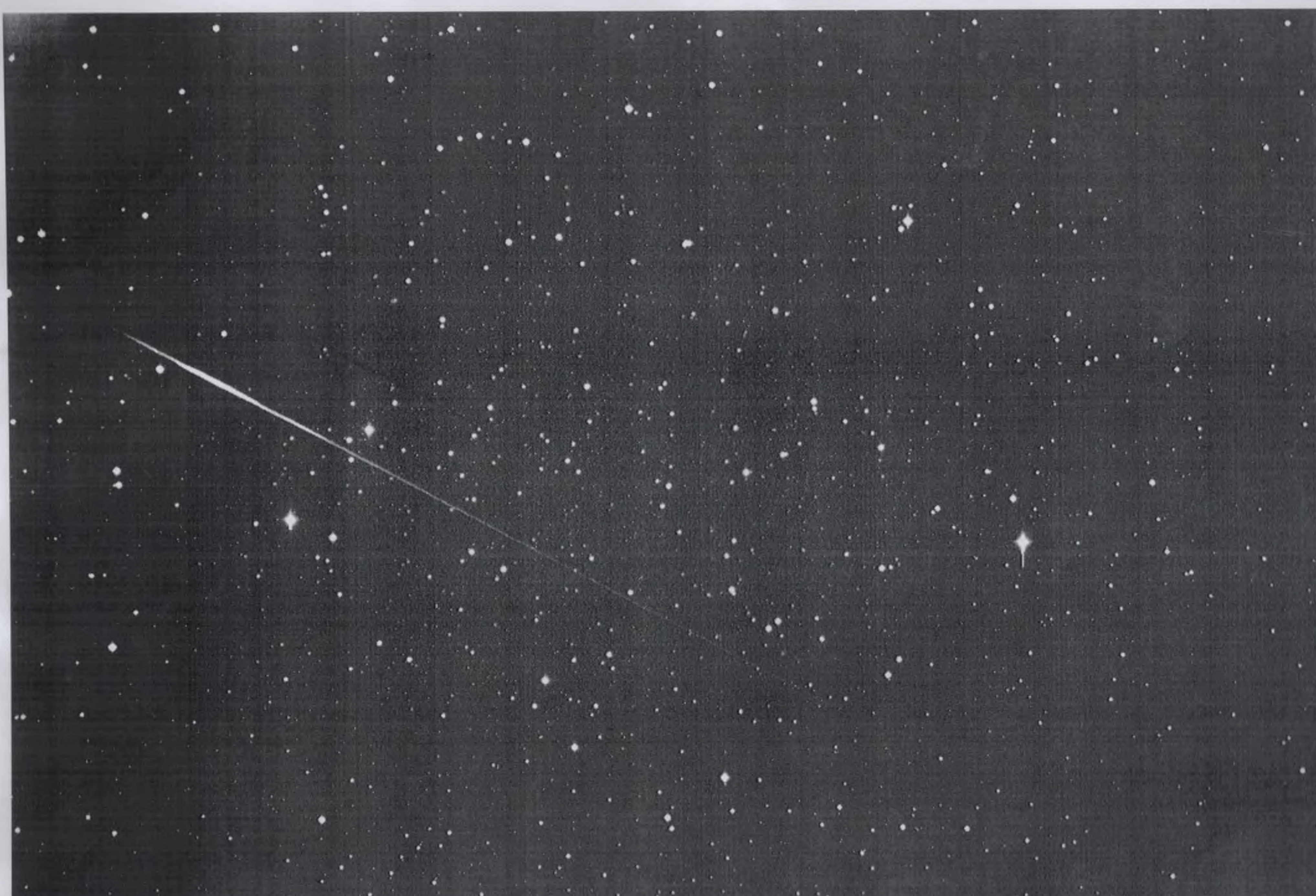




CN3k|| CN| - 2012-01-06 Late Quadrantid? Meteoric meteor

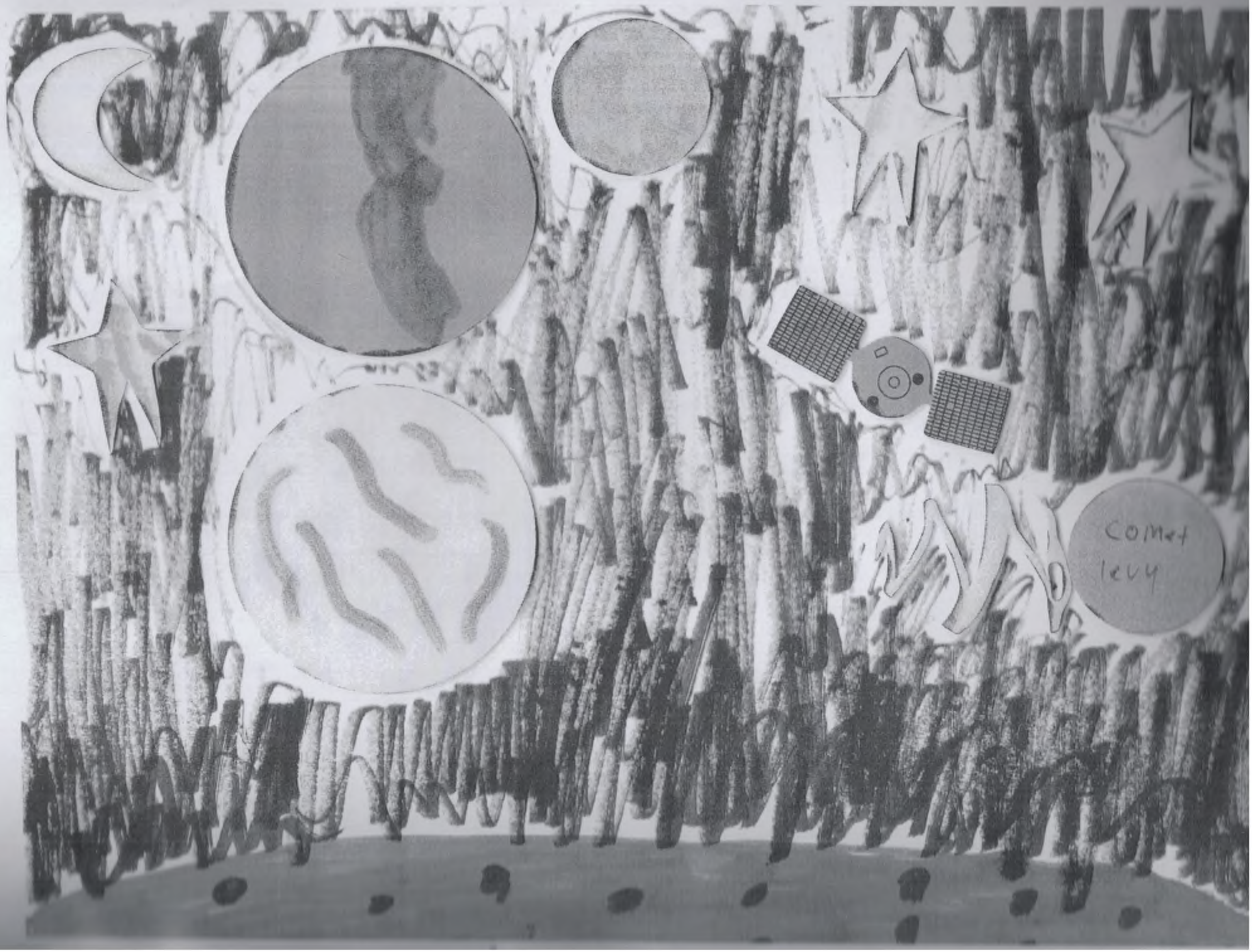






CN3k11-CN1 Meteoric Meteor 2011 07 02

CN3611 2011 11 05 probable meteoric meteor


Comet
levy

CN3R11-CN1 2012 June 29 Probable Meteoric Meteor.

NGC 4395 December 4/7 2013 CN3R11 CLYDE

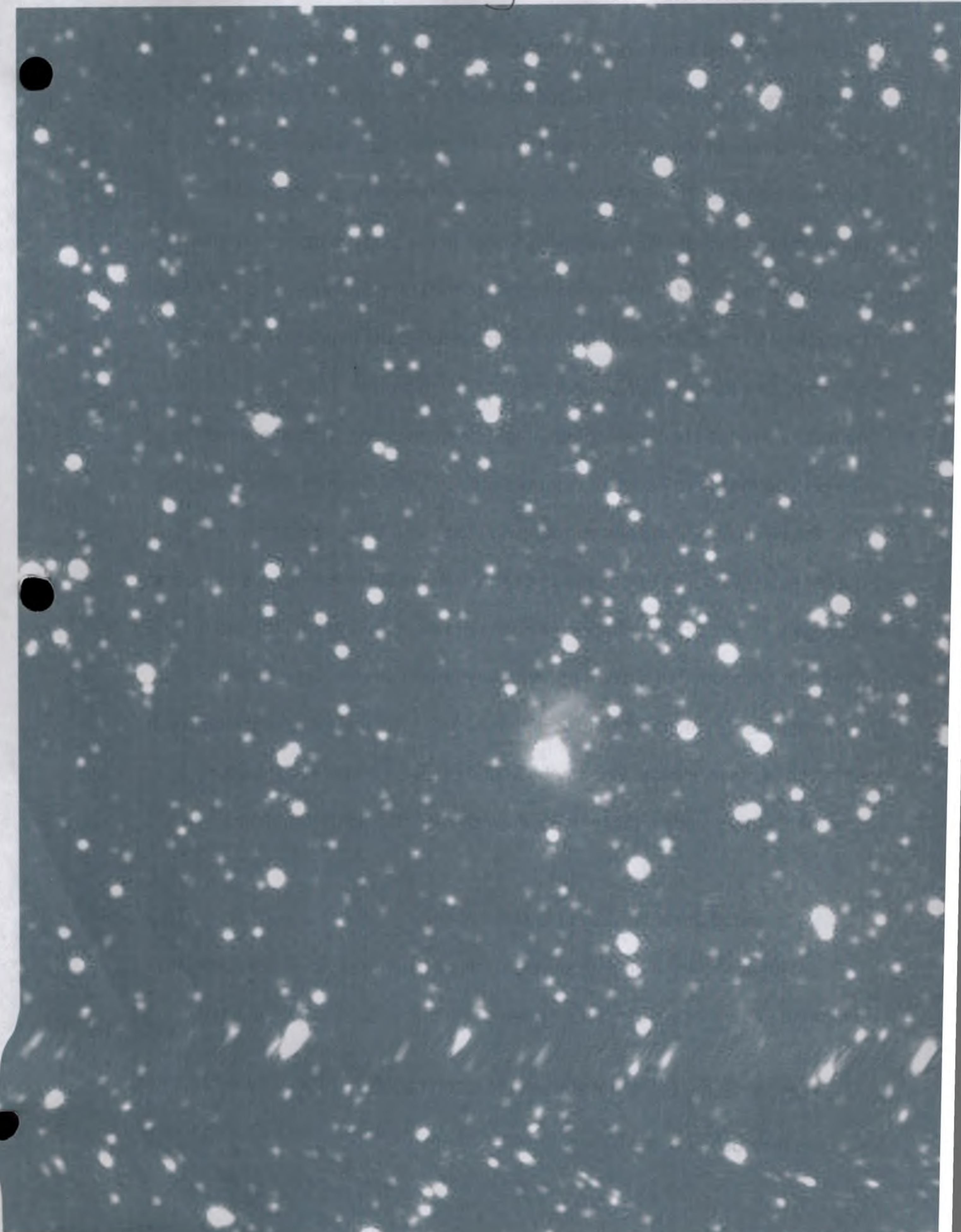
Meteor Oct 2013 Chudo?

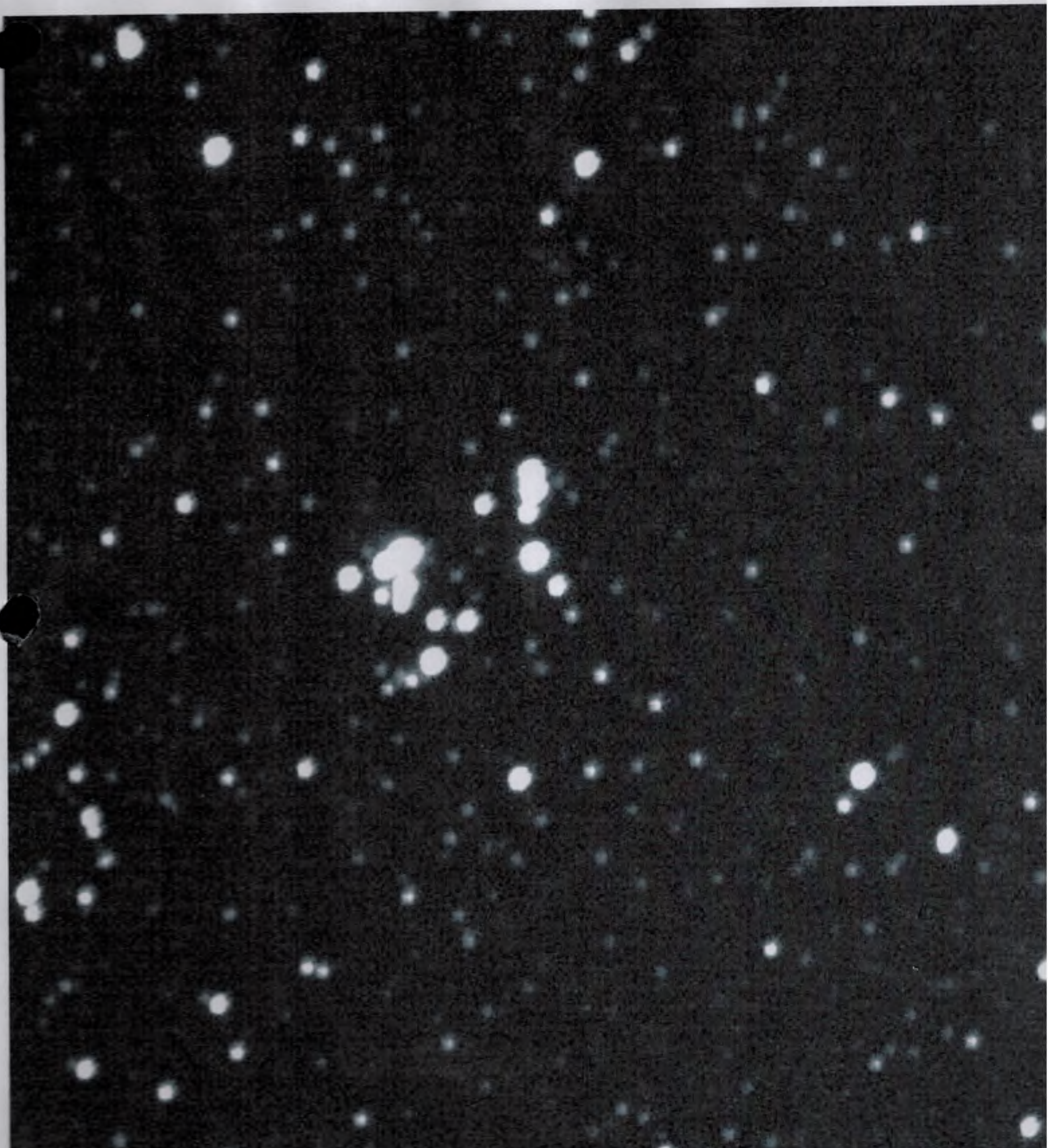
CN3k11

Comet Hunting with Clyde

December 17, 2002

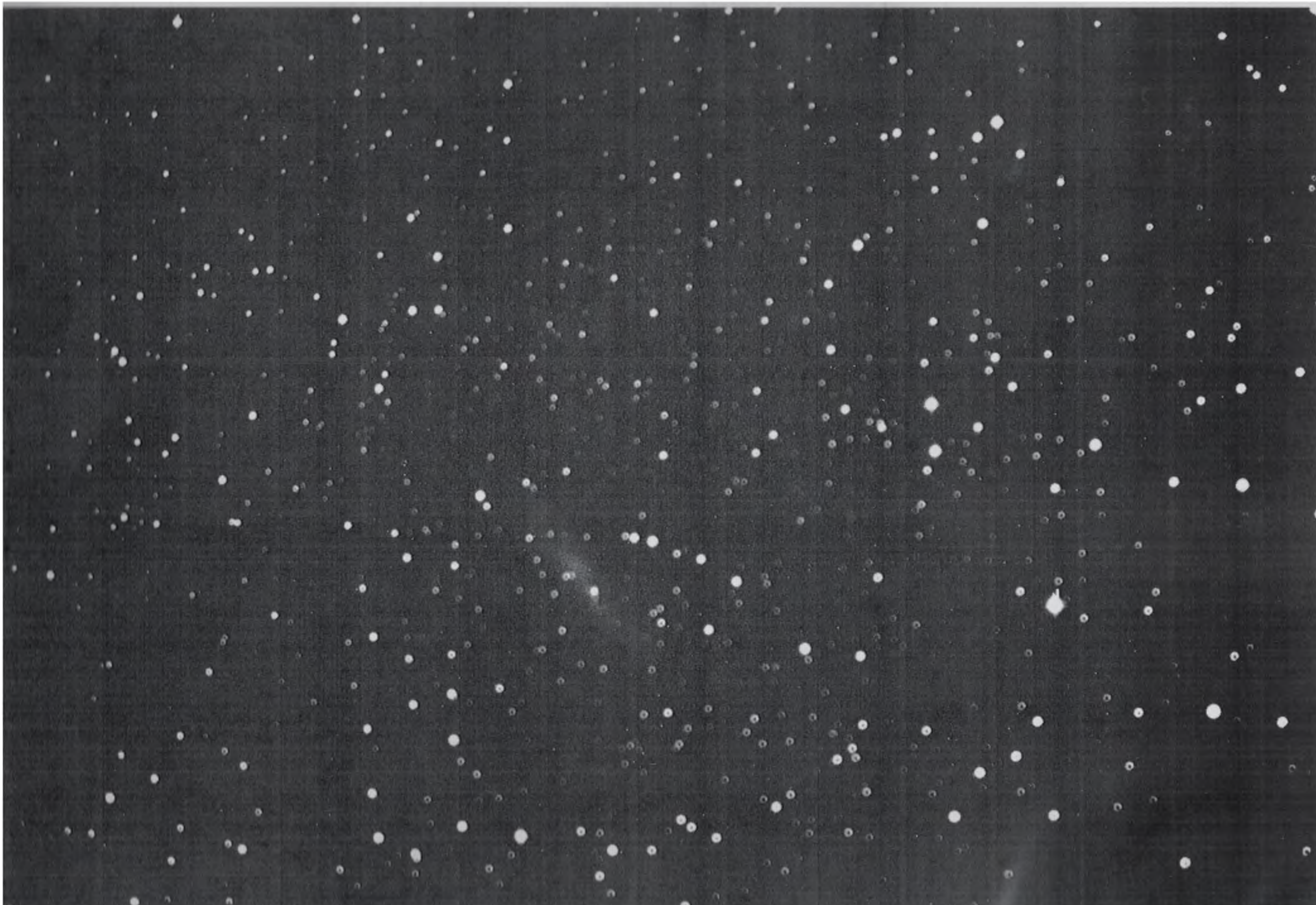
Levy 387 Nov 19 2005





Levy 390 NGC 2169

June 2015 Summer of 2015



conputandi is not quite in Bede's class, either in the computistical or the polemical arts, but Bede, after all, had the advantage of coming later.

Rijksuniversiteit Groningen JOHN NORTH

BIOGRAPHY OF CLYDE TOMBAUGH

Clyde Tombaugh: Discoverer of Planet Pluto. David H. Levy (The University of Arizona Press, Tucson, 1991). Pp. xx + 211. $35.

The discovery of Pluto was one of the outstanding astronomical events of the twentieth century. Clyde Tombaugh, the first to recognize Pluto's image on a photographic plate, is the subject of this biography.

In the third paragraph of the author's preface, Levy writes that this book "is not intended to be a scientific biography or a scholarly work of astronomical history". And indeed it is not. This book appears to me to be the work of a well-meaning amateur biographer uncritically reporting interviews with an astronomer who feels that his work has not been adequately recognized. This book gave your reviewer the impression that somehow both Tombaugh and Levy equate success with fame. Further, it gives a false impression of the way reading it more ignorant than when he began.

For example, when it became clear, in 1930 just before the discovery of Pluto was to be announced, that Lowell Observatory would be deluged with reporters, V. M. Slipher "protectively" admonished Tombaugh to be careful about what he said to the press. Levy then speculates, page 68, "Was it possible that one of Slipher's ways of protecting Tombaugh was to deny him full credit for the discovery?" Your reviewer sees no realistic basis for this speculation; rather, he finds this remark, and many other similar attempts at mind-reading, ungracious, misleading and without foundation. Indeed, Tombaugh should not be given full credit for the discovery of Pluto. The discovery was a team effort; many people besides Tombaugh deserve credit: Percival Lowell not only for his mathematical prediction, but perhaps more for his supreme and enduring confidence in his results, a confidence shared by A. Lawrence Lowell who donated the 13-inch refractor with which Pluto was found, by V. M. Slipher who set up the program, by C. O. Lampland, and by many others. To be sure, Tombaugh's part was laborious, tedious and crucial, but the fact that Tombaugh's was the last and certainly the most spectacular link in the chain of discovery should not be the basis for claiming his was the only link in the chain.

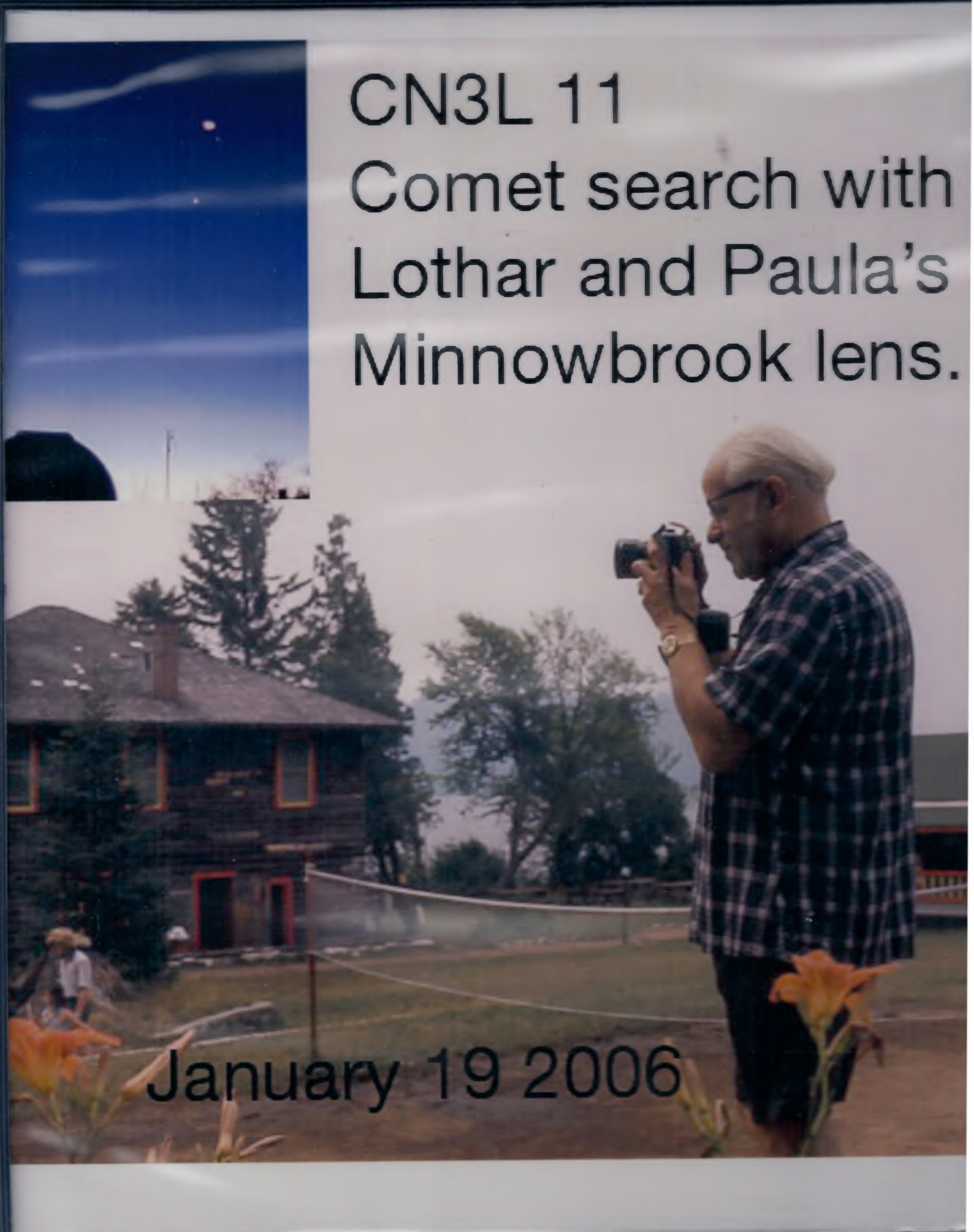
A few pages before this, on page 63, Levy states that "it was the observational search, not the mathematical one, that led directly to Pluto's discovery". This is true, but it is not the whole truth. To me, it is equivalent to a claim that it was Galle's and d'Arrest's observation of Neptune, not LeVerrier's calculations, that led directly to Neptune's discovery. Whether Lowell's prediction was founded on celestial mechanics or voodoo mechanics, his prediction of the evidence for this speculation. (Milton Humason, Hubble's collaborator, did not have a doctorate.) If this story is intended to suggest to the reader that somehow Tombaugh should be given credit for the discovery of the now well-known "voids and concentrations" in the distribution of galaxies, then it is misleading. Priority in astronomical discovery is normally established by publication, not by conversation. As far as I know, Tombaugh's counts of galaxies are not yet published.

A biography of a scientist should list, or at least mention, major honours that scientist has received. In this book I saw no mention of the award to Tombaugh of the 1931 Hannah Jackson (Gwilt) Gift and Medal by the Royal Astronomical Society.

As appropriate for the readers of this *Journal*, your reviewer has concentrated on the parts of Levy's biography that relate to Tombaugh's astronomical work at the Lowell Observatory. In addition, much of this book is devoted to Tombaugh's childhood, his work on the family farm, his search for additional trans-Neptunian objects, his searches for a second natural satellite of the Earth, work at White Sands just after the Second World War, and his career at New Mexico State University. Tombaugh entered professional astronomy the hard way, backwards: it was after his spectacular achievement in finding Pluto that he went to college to study astronomy. This is very much to Tombaugh's credit.

Clyde Tombaugh is a self-made, innovative, energetic and contagiously enthusiastic astronomer; this biography does not do him justice.

University of Southern California — GIBSON REAVES


CN3L 11
Comet search with
Lothar and Paula's
Minnowbrook lens.
January 19 2006

CN3L11

Comet hunting with Lothar and Paula's Minnowbrook lens

January 19, 2006

New Horizons AND CN3211 launches January 19 2006.

Subject: Re: liscences
To: David Levy <david@jarnac.org>
From: tg@glinos.net (Tom Glinos)

>I've decided to heed your advice and reinstall Windows XP. Could you
>please send me the following keys?

Sure.

>1) Windows XP

TJ9B6Y9WVM7XK86WT3YD3XHWT

Maxim 4.5
3kSSS-JJG3-
Tkzb-VX89-
zK2g

>2) ACP 4.0

set clock to sep 2004 Install ACP 4.0

Name: Tom Glinos
Email: tg@cquest.utoronto.ca
Upgrades Expire: 13-Jan-05
Serial Number: LK-uxir-a#fE-aRZP-rZ&X-Z/tg

reboot and install 4.1.1

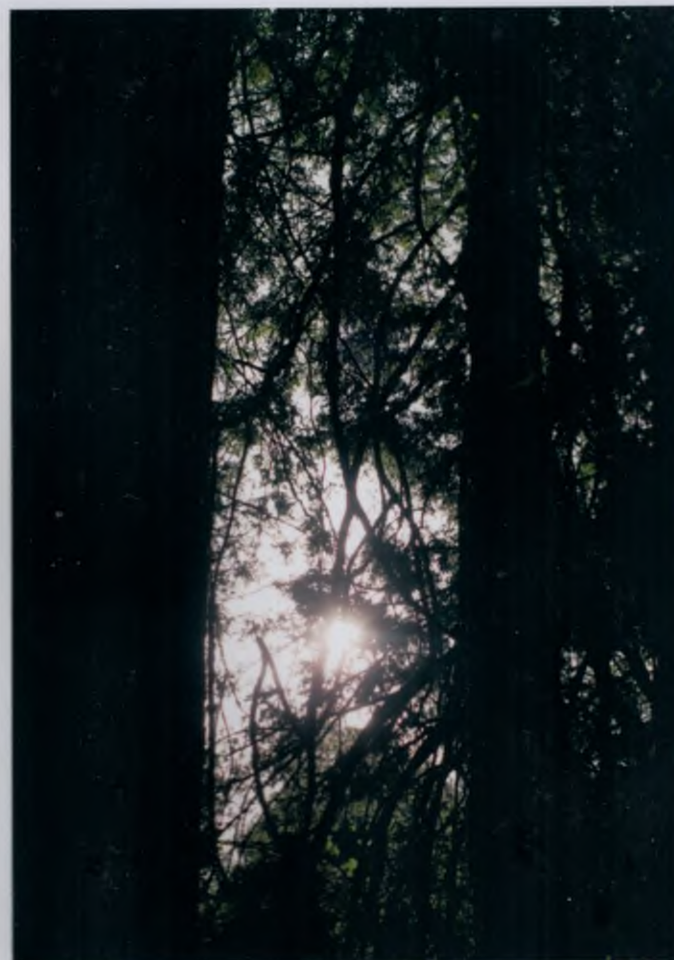
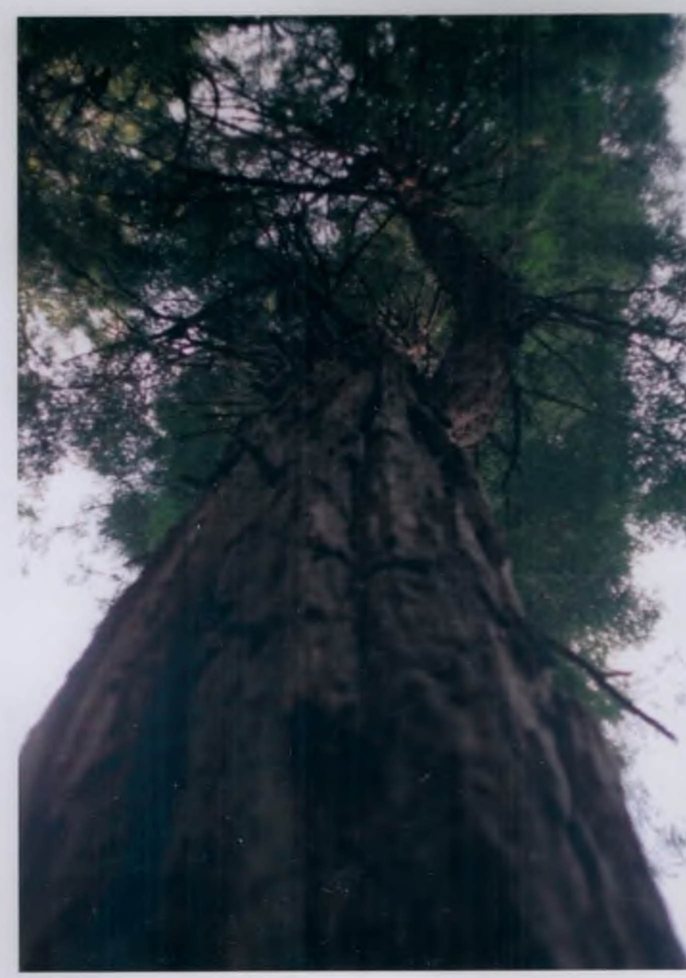
Name: Tom Glinos
Email: tg@cquest.utoronto.ca
Upgrades Expire: 21-Jan-06
Serial Number: 8X-Ugmd-mPSC-@ghX-VHCt-95xA

>3) Maxim DL 4 and 4.50,

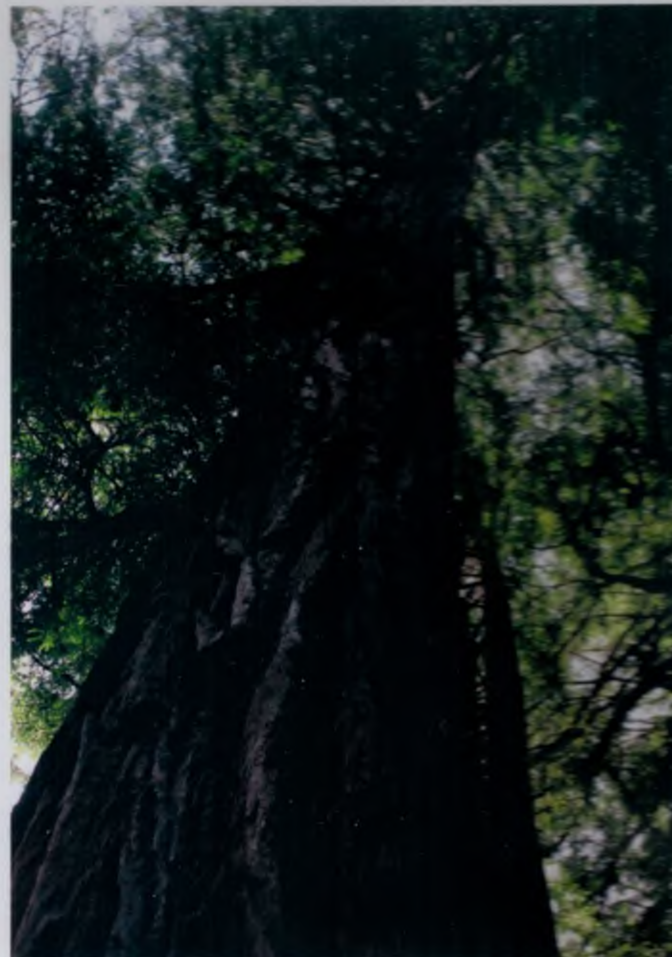
Might I suggest the following for Maxim. I'm doing this from memory so it might be wrong.

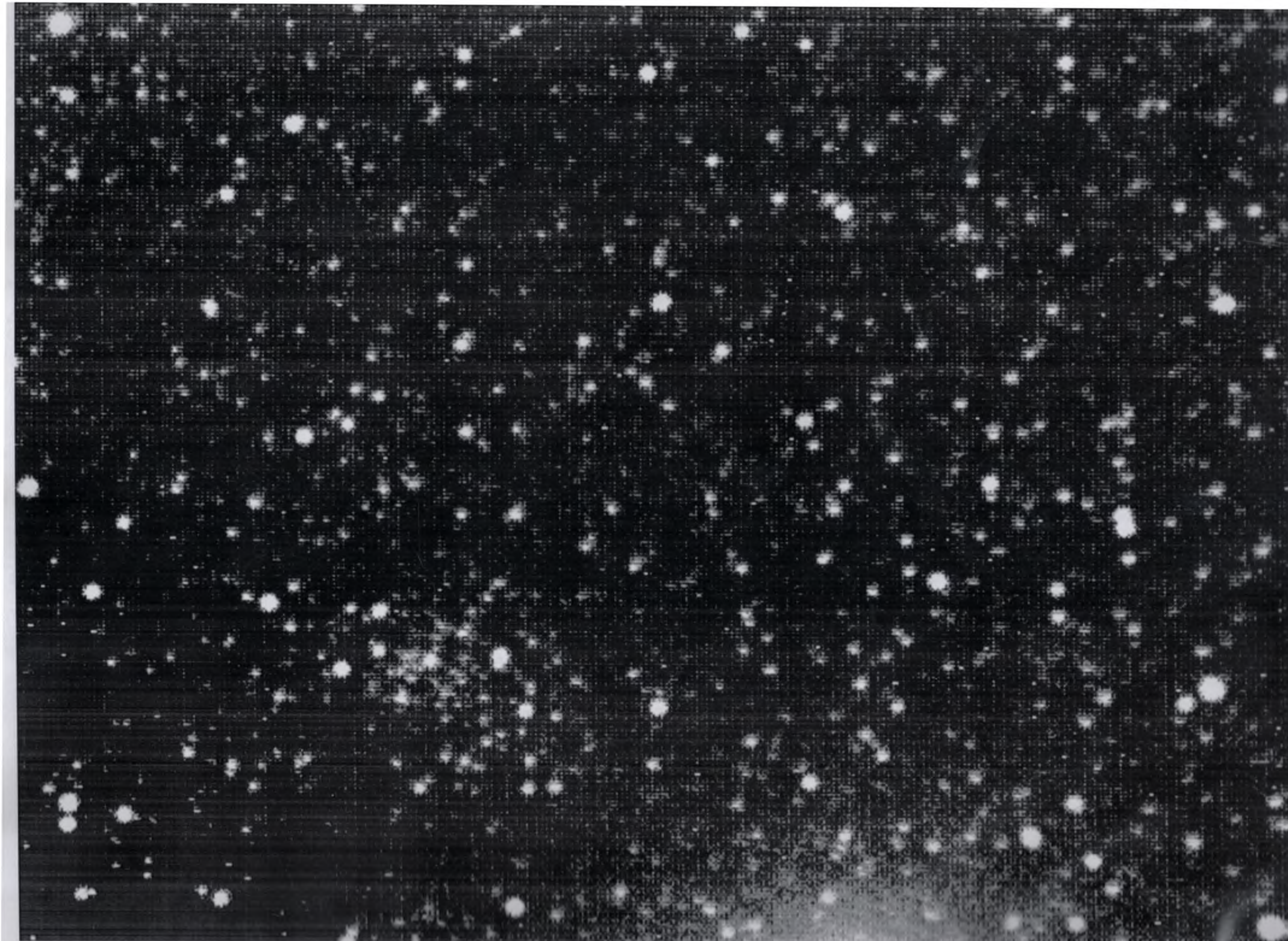
(i) Set the clock back to 2004.
(ii) Install 4.0 BUT DO NOT RUN IT!
(iii) Install 4.51 on top and run
(iv) Install the 4.51 license key when asked

This MIGHT be the license info for 4.0
Name : Tom Glinos
EMail : tg@utstat.toronto.edu
Upgrades Expire : 2005/06/03
Serial Number : 5$if+-JU&r-bnWe-vH3$-nRA8Q

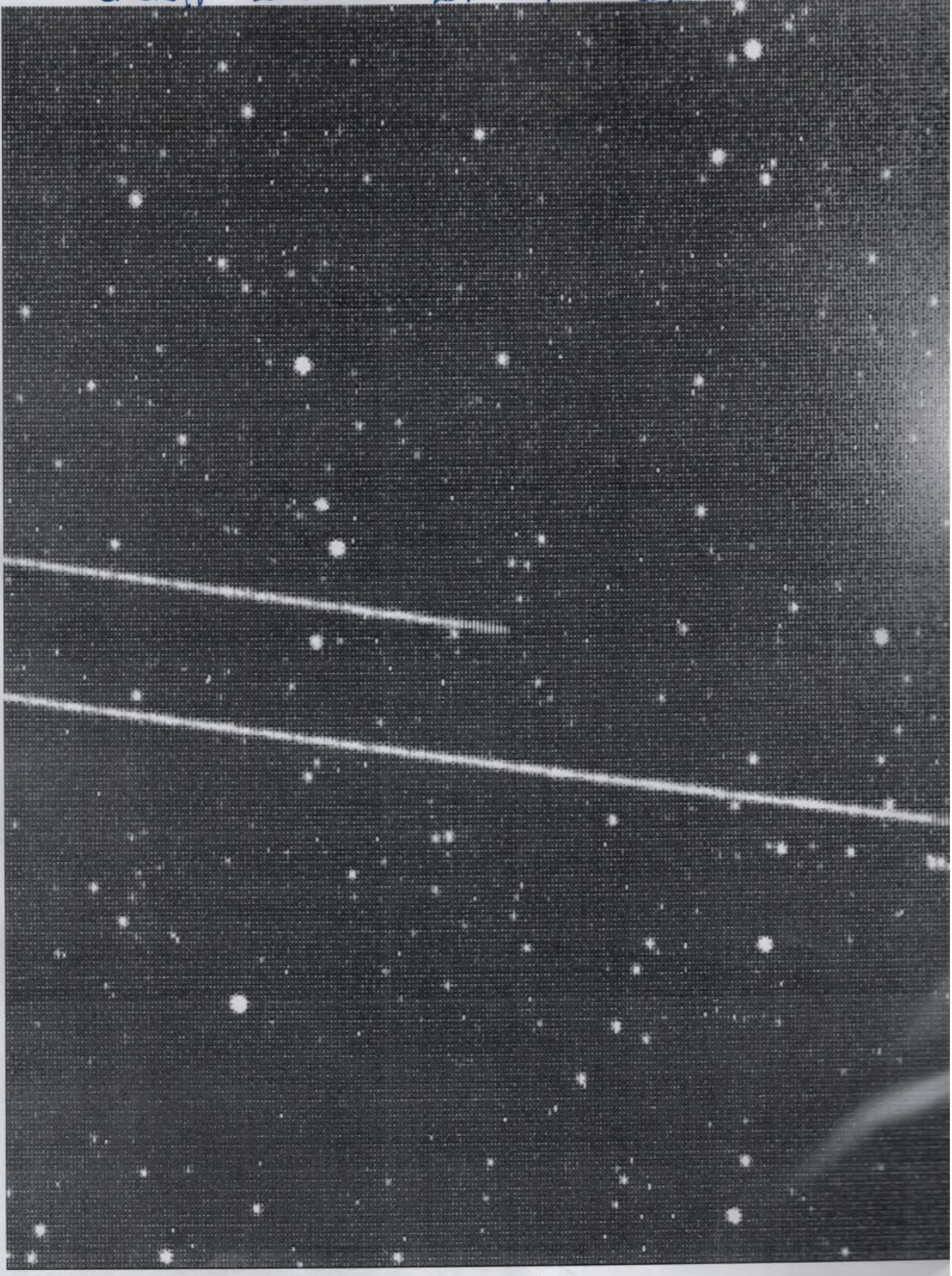




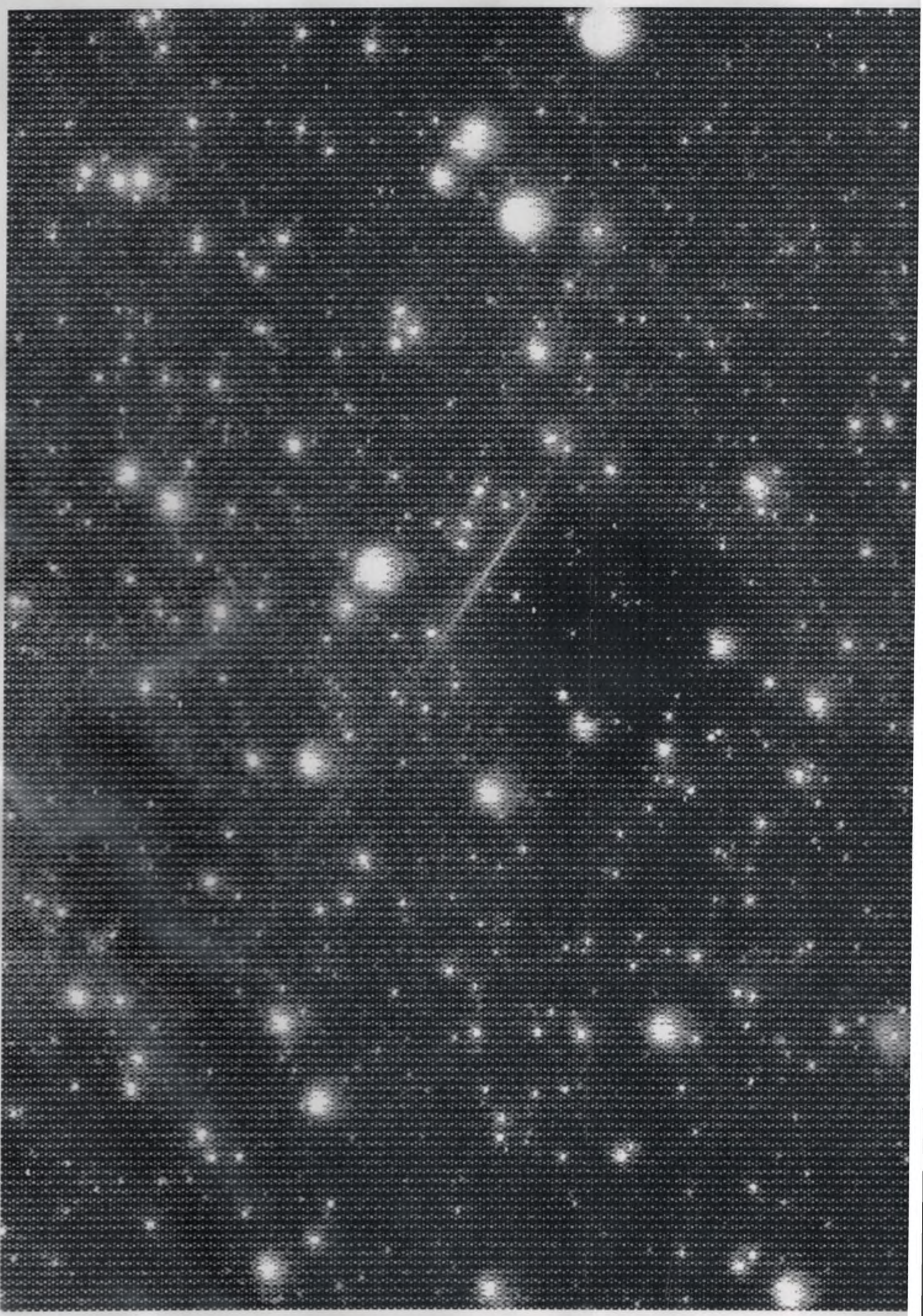




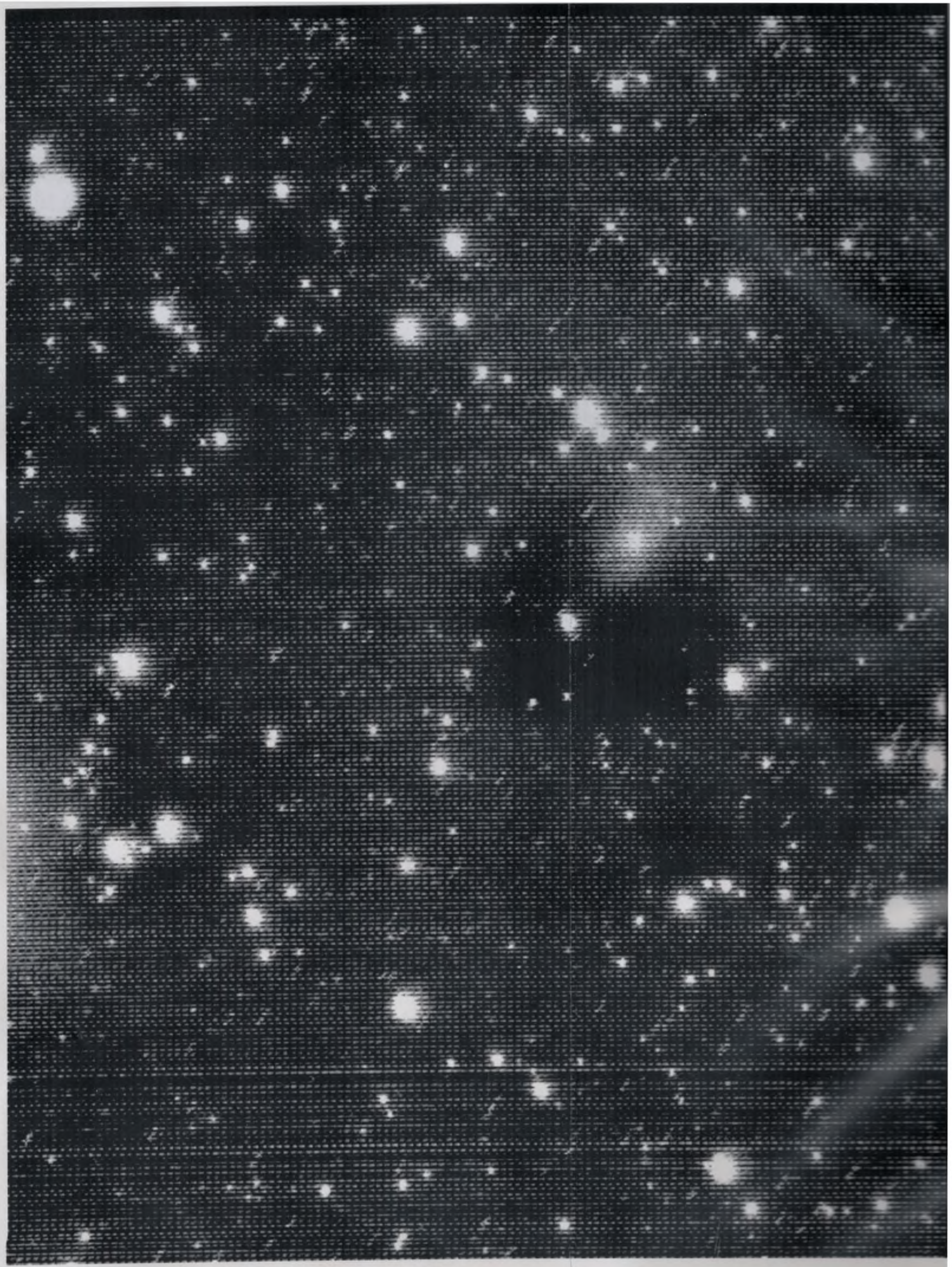



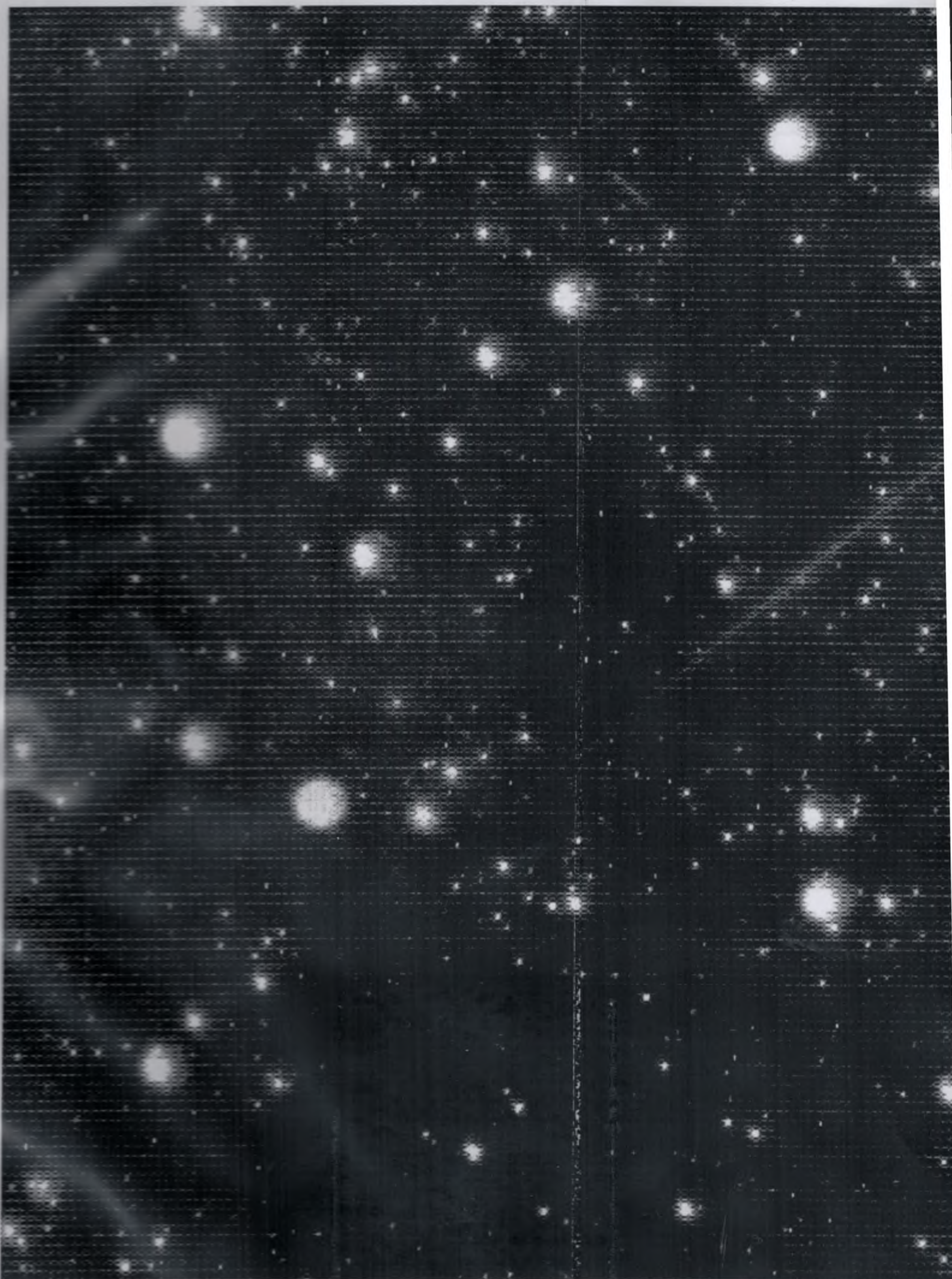
CN3L 11 Dec 1 2011 Lothar & Paula Satellites.





CN3211 Lothar & Paula's Minnowbrook lens. Early Lyrid. 2013 04 14. V2090





CN3 40M

Comet hunting with Flaire

December 17, 2005

Flaire Stars.

December 17
2005

or UV Ceti stars/
intrinsically faint, cool red main sequence stars that undergo intense outbursts from localized are[illegible] of the surface.
Result: increase in brightness of [illegible] or more mags in several seconds followed by decrease in ~ 10-20 minutes.

UV Cet
AD Leo
EV Lac
WX UMa
V371 Ori
YZ B.CMi

To: observe@jamac.org
From: Janine Rogers <jrogers@mta.ca>
Subject:

Hi David,

Personally, I am doing very well: it is finally summer here, and I have been horseback riding and gardening as much as I can, given my various deadlines. The puppy is still a challenge, but it is actually good that she's getting me up early, since I work best in the morning!

Thanks for the revised preface, and the "shout-out" in it (as the kids say!). I just gave it a quick read here in my office, and I will send you more fulsome comments soon, but I think it is generally looking really good. I like the way you bring the reader in with a specific event, and I think the analysis of your own methodology is off to a great start. Your strongest points include your justification for choosing the period in question because of the unusual number of astronomical events, and your point that science now has information about the cosmos that was not available before, thanks to new technologies. Those two points alone, I think, provide a a clear justification for the project from the scientific standpoint, which links to the reasons we then need to examine the literature that discusses the astronomy. Your last paragraph on page 4 about the significance of studying Shakespeare's references to astronomical events is especially eloquent.

The *compilatio* section is also looking good, but there is a slight hitch (albeit a creative one, perhaps)! On page 6 of your preface you've written it as *complicatio*, as in "to complicate, complicate," whereas *compilatio* means "to compile." The two words are related, of course; both both describe a process of merging together diverse information systems. The term *compilation* has a specific medieval context (one that drifted into Renaissance culture) within manuscript or book-making methods. It means essentially an act of collection of diverse sources, and then reassembling them into new contexts and new juxtapositions within new bindings. Things that are placed side by side in new manuscript, even if they originally had nothing to do with each other, may reflect new meanings on one and other when read in close proximity. Medieval compilers realized this – that texts can be reinterpreted according to new reading contexts -- and they therefore saw a great deal of creative activity and ethical imperative imperative in producing these new meanings. The twelfth century, when *compilatio* activities reached their peak, also saw a change in reading philosophy as a result of these manuscript construction processes that contained multiple sources. MB Parkes, who wrote the seminal article on this idea, describes it beautifully when he wrote that in these new circumstances, "to think became a craft."

I think this section of your preface could be expanded to include both a meditation on the the idea of compilatio and the happy accident of the "complication" idea. You might structure it thusly:

-- explain that your first book on astronomy and lit was primarily structured by collecting collecting literary references to astronomical events.

--that in my conference paper for the British Society of Literature and Science (2007) I compared this assembly process to *compilatio.*

--define/discuss *compilatio* as a creative act of interpretation (M.B. Parkes's article could could help you with this, as could the Introduction to John Dagenais's book *The Ethics of reading in a Manuscript Culture: Glossing the Libro de Buen Amor)*.

--note that your method of structuring the diss. according to astronomical events also parallels compilatio activities, in that it is not a merely passive collection of historical facts (or, as as you put it, mere annotation), but an active and creative re-compiling of an historical series of experiences that were part of the everyday culture of the writers, and their readers. Furthermore, your methods of collection and compilation reconstruct the early modern psychology of learning, which merged both medieval styles of collection and categorization with with the new Baconian/ humanist interests in observation and experiment. In reconstructing these methods and experiences we come closer to understanding the true psychological –and therefore interpretative and artistic – impact of the texts. (Elizabeth Spiller's book on *Science, reading, and Renaissance literature : the art of making knowledge, 1580-1670*, may help here).

– segue to your "Freudian slip" re: complication: while compiling means to put together, together, to collect, it slides easily into the similar sounding word *complicare* (L.) to fold/twist together . . which you could then bring to you broader point re: "folding" the disciplines of science and literature together (an idea which I love, by the way, and which I will think on much more for my own research!)

I hope this helps: all of these points are to be taken as suggestions only: you may find lots of other ways to present the information, that was just off the top of my head.
I am going to keep working on the article form of the conference paper; who know, maybe you you'll be able to cite it as a "forthcoming" article by the time you submit. When is your submission deadline, by the way?

I'll take this home and I'll keep thinking about it. I'll give you more feed back soon!
Janine

P.S. I have attached a PDF copy of Parkes' article: it is a bit technical, but I think you can ignore the techical details of MS making and just look at his interpretation of the cultural significance of these activities.

Other portential sources?
Time, space, and motion in the age of Shakespeare / Angus Fletcher.
The age of Milton and the scientific revolution / Angelica Duran.

I haven't read them: just saw them when I looked up Spiller!
J

Concepts.pdf

P/2006 T1

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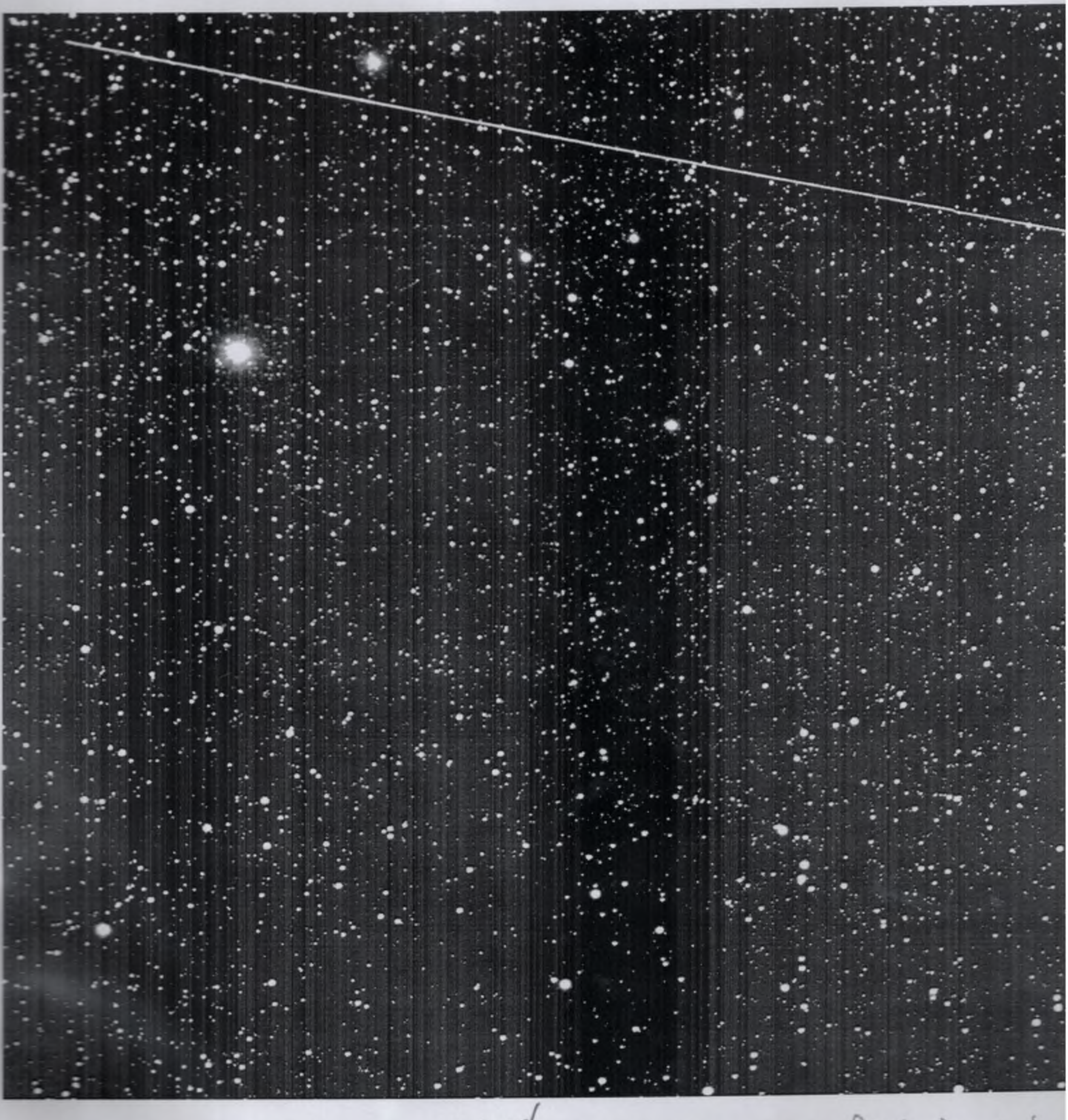
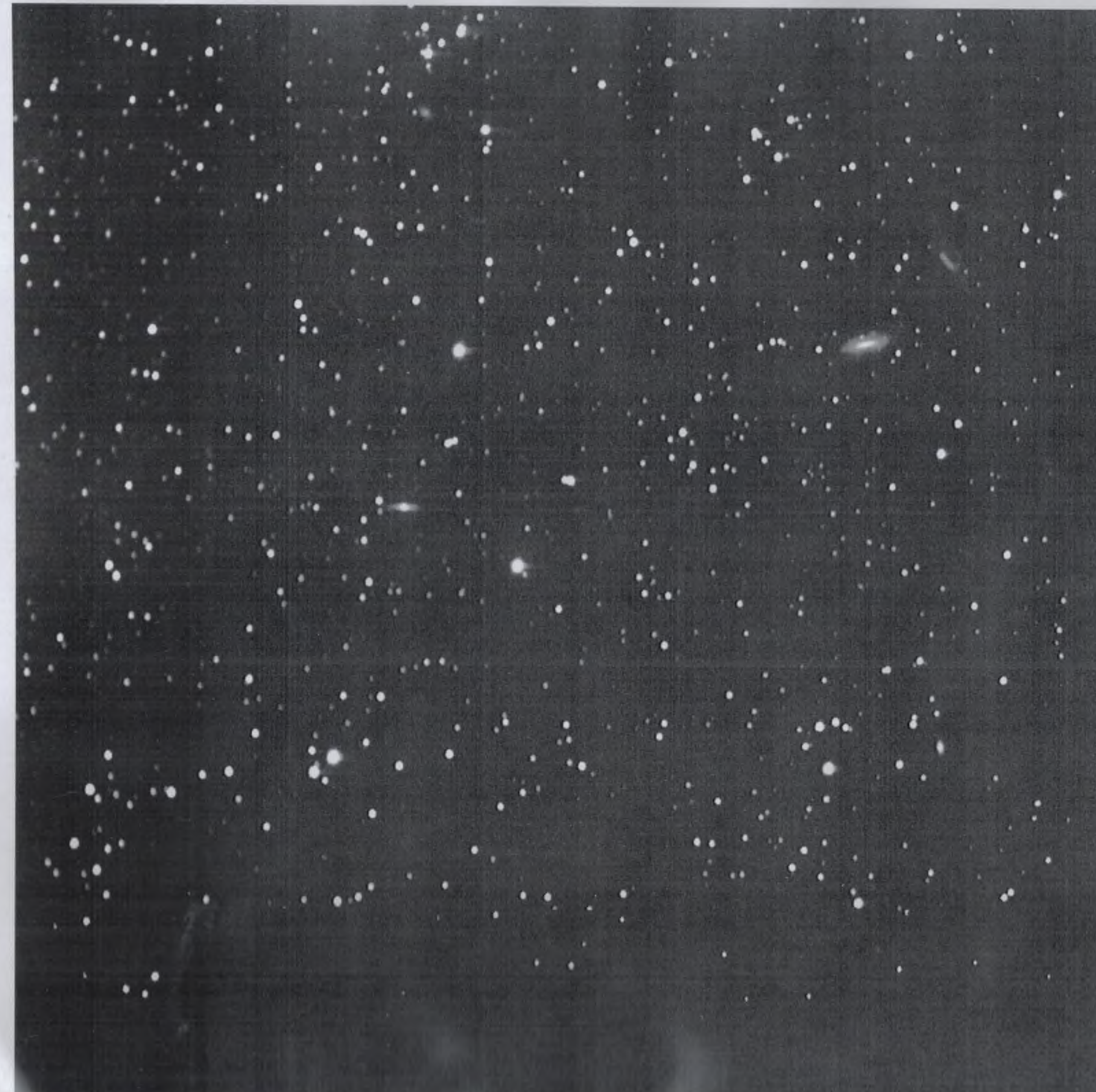


CN 3^{40}_{m} April 14/15, 2011 Satellite in view

Flaire!



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CN3m
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Horsehead
Nebula
at edge

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CN3440 m
Meteoric meteor
2011 07 26

CN3 40m meteoric meteor
2011 12 07

CN3
40m
May 1
2012

2 satellites
on 2 images
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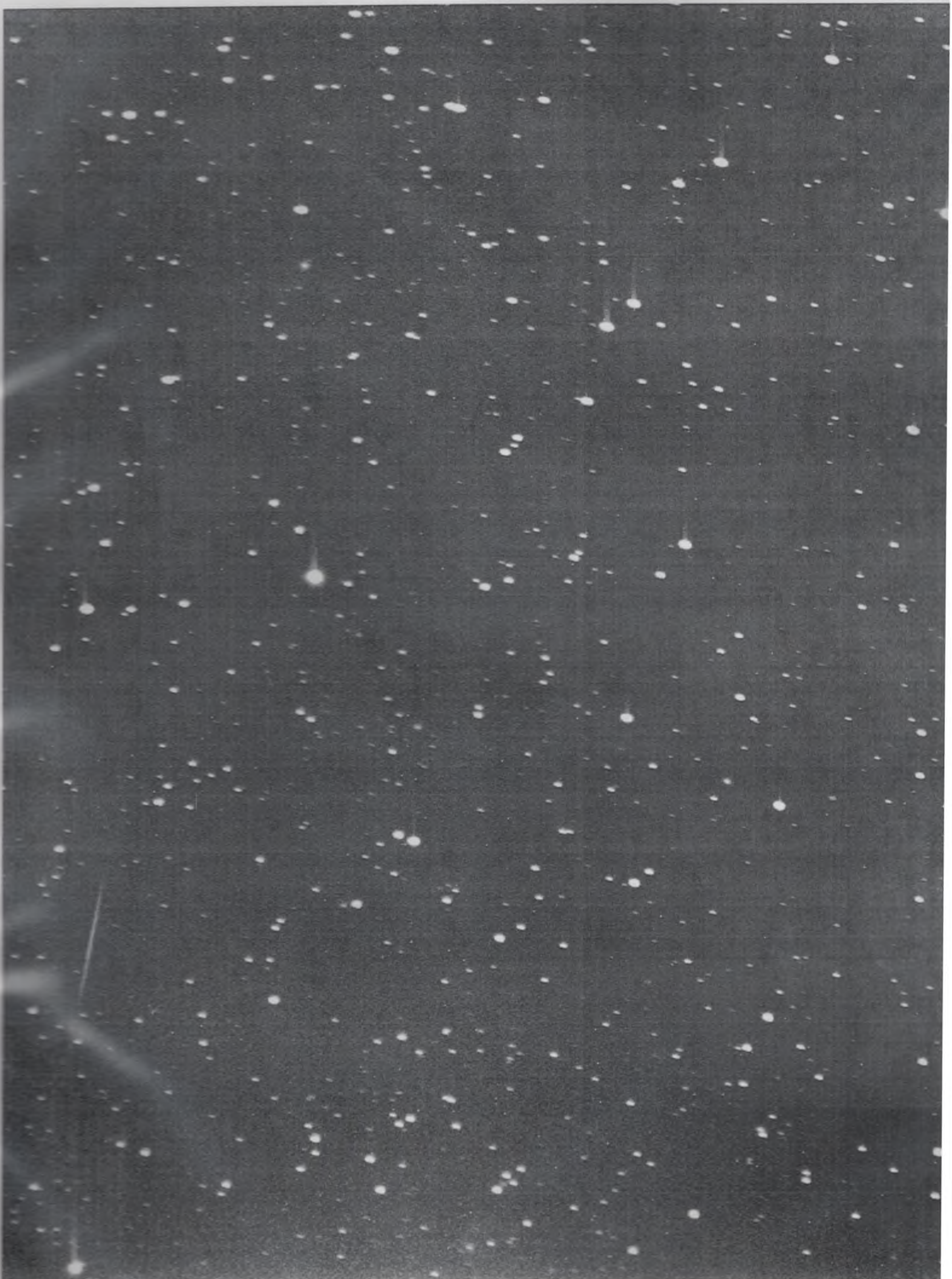
←



dN3 42m Flaire 2013 01 10 meteoric meteor. PR?

CN 340m Flaire 2013 01 10. meteoric meteor. PROBABLE.

Flaire meteoric meteor 2013 07 14

Subject: U Washington: Stardust Nears End of Epic Journey
From: "Dr. Stephen Maran, AAS Press Officer" <pressofc@aas.org>
To: pressofc@aas.org

THE FOLLOWING RELEASE WAS RECEIVED FROM THE UNIVERSITY OF WASHINGTON,
IN SEATTLE, AND IS FORWARDED FOR YOUR INFORMATION. (FORWARDING DOES NOT IMPLY ENDORSEMENT BY THE AMERICAN ASTRONOMICAL SOCIETY.) Steve Maran, American Astronomical Society maran@aas.org 1-202-328-2010 x116

PIO Contact:
Vince Stricherz
(206) 543-2580
vinces@u.washington.edu

(NOTE: researcher contact information at end)

For Immediate Release
Jan. 3, 2006

STARDUST NEARS END OF EPIC JOURNEY;
RESEARCHERS AWAIT ITS TREASURE

Donald Brownlee's heart skipped a beat six years ago when the launch of the Stardust spacecraft didn't happen as planned. The University of Washington astronomy professor has experienced many other tense times since the historic mission blasted off a day late, and its return to Earth on Jan. 15 will be just one more white-knuckle moment.

Just before 3 a.m. MST, the spacecraft will jettison its return capsule, which will plunge into Earth's atmosphere at nearly 29,000 miles per hour, the greatest return speed ever recorded. A few moments later, after the capsule slows to just faster than the speed of sound, a parachute will apply the brakes and Stardust will settle to the ground on the Air Force's Utah Testing and Training Range southwest of Salt Lake City.

"There's a lot at stake. You just hope everything works, and I am confident it will work," said Brownlee, the mission's principal investigator, or lead scientist.

The return capsule contains tiny bits of dust captured two years ago as it spewed from a comet called Wild 2. The tennis-racquet-shaped collector used a remarkably light and porous material called aerogel to capture the particles, each much smaller than a grain of sand and traveling six times the speed of a bullet fired from a rifle. Earlier, the reverse side of the collector snared interstellar dust grains flowing into the solar system from other stars in our galaxy. In all, the capsule contains tens of thousands of comet grains and about 100 bits of interstellar dust.

"It's really quite an epic thing. I think it tends to get overlooked because it's just a little mission, and there aren't any people on board," origins. The Wild 2 samples are cryogenically preserved solar system building blocks, kept close to their original state because they have existed mostly at the outer edge of the solar system.

"Virtually all the atoms in our bodies were in little grains like the ones we're bringing back from the comet, before the earth and sun were formed," Brownlee said. "Those grains carry elements like carbon, nitrogen and silicon from one place to another within our galaxy, and they helped form the sun, the planets and their moons."

Stardust's photographs of Wild 2 also are cause for further study. Brownlee still marvels at the rugged surface the pictures disclosed, a surface very different from the smoother cores of the other three comets - Tempel 1, Borrelly and Halley - that have been photographed up close.

"For unknown reasons, the surface of Wild 2 looks quite different - spectacularly different - from asteroids, moons, planets and even from other comets," he said.

###

For more information, contact Brownlee at (206) 543-8575, by cell phone at (818) 726-5563 or by e-mail at brownlee@astro.washington.edu

NOTE: High-resolution images are available through this news release at http://www.uwnews.org

STARDUST WEB SITE - http://stardust.jpl.nasa.gov

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Stardust Milestones

**Farthest distance solar powered spacecraft has traveled from the sun, 253 million miles

**Longest distance traveled by a return mission, 2.88 billion miles

**First solid sample return mission since the Apollo program

**First sample return mission from beyond the moon

**First interstellar dust collection on Feb. 22, 2000

**Close encounter with Asteroid 5535 Annefrank on Nov. 1, 2002

**Return to Earth of microchips engraved with the names of more than 1 million people, plus the names from the Vietnam Veterans Memorial in Washington, D.C.

**Fastest re-entry speed of any return capsule, nearly 29,000 miles per hour

Brownlee said. "But the really big part of the research is just getting ready to start, when the material goes to the laboratory. The train is headed for the station and we're all waiting for it."

Stardust is part of the National Aeronautics and Space Administration's series of Discovery missions and is managed by the Jet Propulsion Laboratory in Pasadena, Calif. Besides the UW, other collaborators are Lockheed Martin Space Systems; The Boeing Co.; Germany's Max-Planck Institute for Extraterrestrial Physics; NASA's Ames Research Center; and the University of Chicago.

After the capsule touches down in the Utah desert, a canister bearing the aerogel collector grid will be removed and taken to the Johnson Space Center in Houston, where the samples will be cataloged and sent to scientists around the world. Brownlee expects them to provide key information on the formation of the solar system 4.6 billion years ago and possibly to shed light on the origins of life on Earth. Scientists are likely to study Stardust's treasure for decades to come.

Stardust was launched on Feb. 7, 1999, and set off on three giant loops around the sun. It began collecting interstellar dust in 2000 and met Wild 2 (pronounced Vilt 2) on Jan. 2, 2004, when the spacecraft weathered a hailstorm of comet particles and snapped exceptional close-up photographs of the comet's surface. During its 2.88 billion-mile voyage Stardust made one pass by Earth to get a speed boost from the planet's gravity, and later staged a dress-rehearsal for the comet encounter when it maneuvered very close to Asteroid 5535 Annefrank.

The tensest moment other than the comet encounter came in November 2000, while the spacecraft was cruising along some 130 million miles from the sun. A huge solar flare, 100,000 times more energetic than usual, engulfed Stardust and its special digital cameras that help the spacecraft know where it is by viewing the stars and making comparisons with a comprehensive star
chart stored in the onboard computer. The high-energy solar flare electrified pixels in the cameras, producing dots that the computer interpreted as stars. Suddenly the spacecraft did not know where it was and, in a preprogrammed act of self-preservation, it turned its solar panels toward the sun, losing communication with Earth.

Ground controllers finally found a faint signal and were able to contact Stardust and correct the problem. A little more than three years later the spacecraft finally met the target that scientists had been aiming for since 1974, when a close encounter with Jupiter altered Wild 2's orbit and brought it to the inner solar system. That made the mission feasible.

Scientists have collected thousands of meteorites and cosmic dust particles on Earth, Brownlee noted, but with few exceptions the origin of those materials is unknown. Now there will be samples of material from another known body in space, and those grains can be compared with all the previously collected meteorites and bits of dust to see if there are similar

Variable Star Of The Season

Autumn 2003: UV Ceti
0134-18

UV Ceti and the flare stars

Figure 1: An infrared image of Proxima Centauri, the closest star to Earth (other than the Sun) and a flare star. From the 2MASS Atlas Image Gallery. Atlas Image courtesy of 2MASS/UMass/IPAC-Caltech/NASA/NSF.

Our galaxy is filled with billions of red dwarf stars, all of which are too dim to see with the naked eye. Lying at the faint, red end of the Hertzsprung-Russell diagram, their small masses – a few tenths that of the Sun – make them much cooler and dimmer than our own Sun. In fact, few of these stars have been detected beyond a dozen or so parsecs of our solar system. However, some of these stars belong to the spectacular class of variables known as the **flare stars** or the **UV Ceti variables**. At irregular and unpredictable intervals, they can dramatically increase in brightness over a broad wavelength range from X-rays to radio waves for anywhere from a few minutes to a few hours. The fact that such small, unassuming stars can suddenly undergo incredibly energetic events make the flare stars one of the more intriguing targets for variable star observers.

A short history of flare stars

Although flare stars may have been detected as early as 1924, the earliest confirmed observations are attributed to W.J. Luyten, who discovered strongly variable spectra in two high proper-motion dwarf stars now known as V1396 Cyg and AT Mic. In particular, Luyten noted that the emission lines of hydrogen were first observed in a very bright state, but then rapidly faded. Several similar stars were found in short order: V371 Ori, WX UMa, YZ CMi, and DO Cep were all discovered in the late 1930's and early 1940's.

However, the field of flare star research really took off with the discovery of flares on Luyten 726-8, another high proper-motion binary, in September of 1948 (Joy & Humason 1949). Astronomers observing this star at Mount Wilson discovered a huge increase in brightness over a very short time. Later analysis of the spectra taken during the observation revealed a change in brightness of over *four magnitudes*, and a rise in effective temperature to well over 10,000 K. These incredible changes faded just as rapidly, with the star returning to its cool, quiescent state in less than a day. Today, the star is known as **UV Ceti**, the class prototype for the flare stars.

Since their initial detection and characterization in visible light, the UV Ceti stars have also been detected over a wide wavelength range, from X-rays to radio. The coincidence between radio and optical flaring in the UV Ceti stars was noticed as early as 1966 (Lovell & Solomon), and X-ray flares were first detected in 1975 (Heise et al.). Many multiwavelength campaigns have been conducted on various flare stars, and as a result, we now have a reasonably good physical picture of how flares work. The number of known flare stars is also increasing with time: the GCVS currently lists 1620 stars of UV Ceti (UV) or UV Ceti + Nebular (UVN) type. Recently, variable emission lines have been detected in young brown dwarf stars (Liebert 2003), raising the exciting possibility that brown dwarfs may also exhibit flaring activity.

The Characteristics and Physics of Flare stars

As a class, the known flare stars have spectral types of late M through late-K.

corresponding to temperatures between about 2500 to 4000 K. Often, they have detectable emission lines of hydrogen and calcium in their spectra, indicating chromospheric activity. They have masses between 0.1 and 0.6 times that of the Sun; some brown dwarfs may exhibit flaring activity, though the study of these stars is still very much in its infancy. Many of the known flare stars are members of young stellar associations (e.g. the Orion and Taurus star-forming regions), though some older flare stars are known. Many are also known to be binary stars, and this *may* correspond to an increased likelihood of activity. Some of the UV Ceti flare stars are also members of the *BY Draconis* class of spotted variables.

Figure 2: Schematic diagram of a solar flare. Red and blue lines represent magnetic fields, carrying solar material off the surface. Flares occur when these field lines meet and "reconnect", producing huge explosions, and heating and acceleration of solar material. Credit: NASA Marshall Space Flight Center.

Variability in the flare stars is characterized by rapid, irregular, large-amplitude increases in stellar brightness, followed by a much slower decay (from minutes to hours) back to a quiescent level. The strongest variations occur in the blue end of the optical spectrum: a flare may cause a one-magnitude change in brightness in the *V*-band, but *five* magnitudes in the *U*-band. Flares are typically accompanied by brightening of the emission line spectra of the star, particularly of the Balmer series of hydrogen, and the appearance of ionized helium lines as well. Flares have also been observed in the radio and X-ray regions of the spectrum, though they are not necessarily coincident with optical flares.

Figure 3: A large solar flare. Image Credit: NJIT/ Big Bear Solar Observatory

It is now believed that flares on the UV Ceti stars are analogous to solar flares in nearly all respects. On the Sun, flares are caused by the sudden release of magnetic energy via *magnetic reconnection* events. The solar photosphere is threaded with magnetic fields that move and change in strength over time. Solar material and the magnetic fields are coupled together, and one of the effects of this can be *sunspots*. In sunspots, the magnetic field prevents *convection* which transports heat from the interior to the surface -- when the heat transfer is blocked, material at the surface cools down. Another effect of this coupling can be a *solar flare* -- if the magnetic field can rearrange itself to a lower-energy configuration, the excess energy gets transferred to the plasma within and around the magnetic field. When this happens, the solar plasma is rapidly heated, and can even be accelerated to relativistic speeds. The super-heated plasma radiates vigorously in ultraviolet (and even X-ray) light, producing a *flare* -- a rapid spike in brightness. In addition to thermal heating, particle acceleration also results in the emission of non-thermal radiation, including gamma-rays from collision-induced nuclear reactions. As the gas cools and the energetic particles dissipate, the brightness of the flare decays with an exponential timescale.

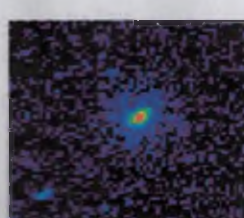

Figure 4: UV Ceti in X-rays, observed with the ROSAT High Resolution Imager

Similar things are believed to happen on flare stars, with a few important differences. One difference is that flare stars are intrinsically faint in visible light, particularly at shorter wavelengths. Thus the flare drastically raises the ultraviolet-blue continuum of the star, along with emission lines atypical of cool stars (like ionized helium). Another difference is that the absolute sizes of flares on flare stars may be a significant fraction of the size of the star itself (perhaps as much as one fifth of the circumference!) rather than being limited to a few thousand kilometers as on the Sun. These two things combine to cause very large luminosity changes in the flare stars, particularly in the blue end of the spectrum.

The flare stars are known to be bright at X-ray (Figure 4) and radio wavelengths as well. The physics of flare star radio flares are likely the same as those on the Sun: a magnetic event accelerates charged particles that interact with magnetic fields to produce cyclotron and synchrotron radiation. X-ray flares have also been observed, but the flare stars are also known to have very large *quiescent* X-ray luminosities, most likely from a large, bright corona. Their X-ray luminosities can be on the order of one percent of the total bolometric luminosity – far, far greater than would be expected for a low-mass, non-interacting star.

Observing flare stars

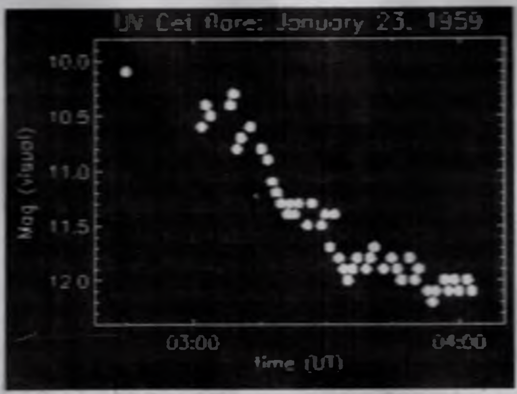

Figure 5: Flare on UV Ceti, observed by T. Cragg (CR), January 23, 1959.

The flare stars have been a part of the AAVSO observing program for nearly as long as the stars have been known. The earliest observations of UV Ceti in the AAVSO International Database date to January of 1950, less than 18 months since its discovery in late 1948. Observations commenced on several other stars in the early and mid-1950's. One of the earliest high time-resolution lightcurves of a flare was made by Thomas Cragg on November 14, 1952. Cragg caught UV Ceti in the midst of a flare (m_{vis} = 10.4), and made observations once every few minutes until the star faded to its quiescent level (m_{vis} = 12.2). He recorded another flare in UV Ceti on January 23, 1959, shown in Figure 5. Many other flares have been caught and followed by AAVSO observers since then, both in UV Ceti and in other flare stars, like EV Lac and V371 Ori. Flare stars have also been subject to collaborative efforts between the AAVSO community and professional astronomers, particularly for the purpose of multiwavelength campaigns.

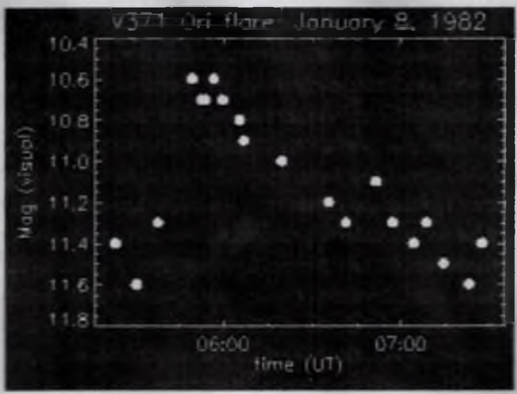

Figure 6: Flare on V371 Ori, observed by L. Cook (COO), January 8, 1982. Read about this observation here!

The morphology of a flare event you are likely to see is much like the January 7-8, 1982 flare of V371 Ori (observed by Lew Cook) shown in Figure 6. The star will brighten from its quiescent level by (up to) a few magnitudes over the space of just a few minutes. After the peak is reached the visible light fades back to quiescence over a period of tens of minutes to a few hours. Depending upon the strength of the flare and the color sensitivity of the observer, the peak brightness may be between one and several magnitudes above the quiescent level. Flare stars can undergo much smaller flares of a few tenths of a magnitude or less, though these may be difficult to measure by visual observers. Sometimes, the star may reach a plateau, superimposed with several short flares – the high point near 06:50 in Figure 6 may be an example of such a flare.

The flare stars spend relatively little time at their brightest -- perhaps a few minutes per flare -- and the occurrences of flares are unpredictable. Therefore, flares are difficult to catch. The best way to observe one is to devote one night to a single flare star, and monitor it once every few minutes, much like one would observe a short-period eclipsing binary. In the ideal (but unlikely) case, these observations would allow you to catch the quiescent pre-flare brightness level, the rapid rise of a flare, and its decay to quiescence. Unfortunately, *flares are unpredictable*, so it may be awhile before you catch a flare star in the act. Flare stars are ideally suited to CCD and (especially) photoelectric observations because of the high time-resolution needed to catch all phases of the flare, and photomultipliers have the additional benefit of being very blue-sensitive. If you are using a CCD or photomultiplier, *U, B,* or *V* filters or their equivalent are recommended, since the flare amplitudes are larger at bluer wavelengths. However, many flare events have been detected by visual observers (including the two shown above), so persistent visual observers should have no problem observing flare stars.

When submitting observations to AAVSO, it is easiest to use the following procedure:

1. Record the start time of your observations, and the magnitude of the flare star
2. Observe the star once every few minutes, and determine whether the brightness has changed. If so, record the time and magnitude. If not, observe again in five minutes.
3. If you notice a very large increase in brightness, record the time and magnitude, and try to increase the frequency at which you make observations.
4. If no change in brightness is noticed by the end of your observations, report the start and end times of your observing run, and indicate "NO FLARES" in the notes.

Good luck!

Postscript: a note on charts

Many of the flare stars were first discovered during studies of high proper motion stars, and some have proper motions of several arcseconds per year. Because of this, many of the charts for flare stars are out of date, especially those made during the 1960's and 1970's.

We are in the process of generating new charts for these objects, but until they are available, we have assembled "blinking" images from the first and second editions of the Digital Sky Survey, with the time between images ranging between seven years (V371 Ori) and 43 years (AD Leo). You can use the blinking images to help you estimate the position of the star in the current field.

The blinking images may be found here, and DSS2 images (ca. 1997) indicating the star's current position may be viewed individually through the following links: WX UMa, UV Cet, EV Lac, AD Leo, YZ CMi, and V371 Ori. All images are 30 arcminutes on a side, and the flare star is located within the square aperture in the static DSS2 images. The approximate direction of the proper motion (if any) is indicated with an arrow. We recommend that you use the blinking images and the existing AAVSO charts together -- use the blinking images as finder charts to determine the current position of the variable star, and the AAVSO chart for the sequence.

For More Information

- AAVSO charts for: UV Cet , AD Leo , EV Lac , WX UMa , V371 Ori, and YZ CMi

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- "Solar Flare Theory" at the Laboratory for Astronomy and Solar Physics, NASA Goddard Spaceflight Center

This Variable Star of the Season was prepared by Dr. Matthew Templeton, AAVSO.

- Variable Star of the Month Archive

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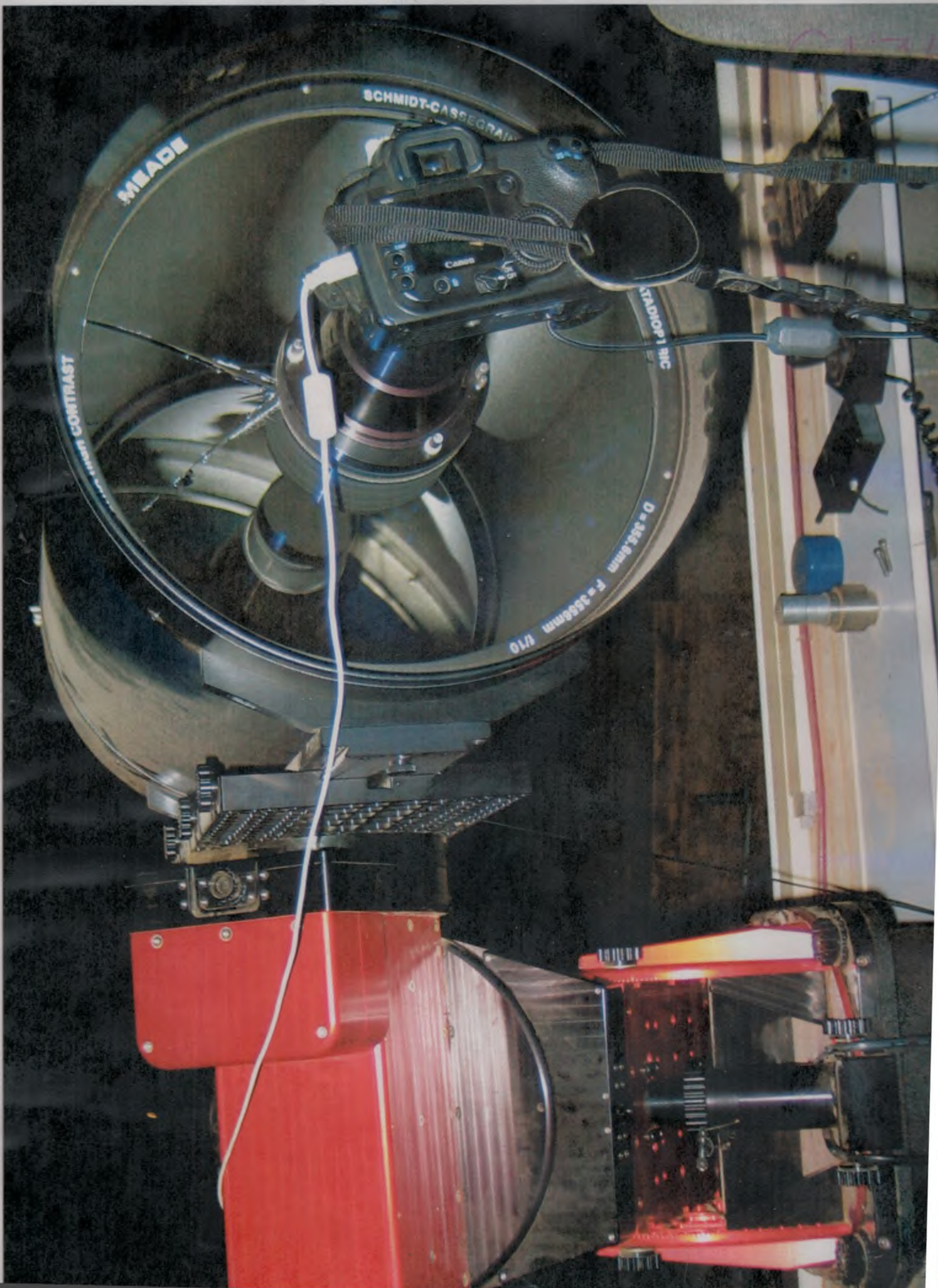
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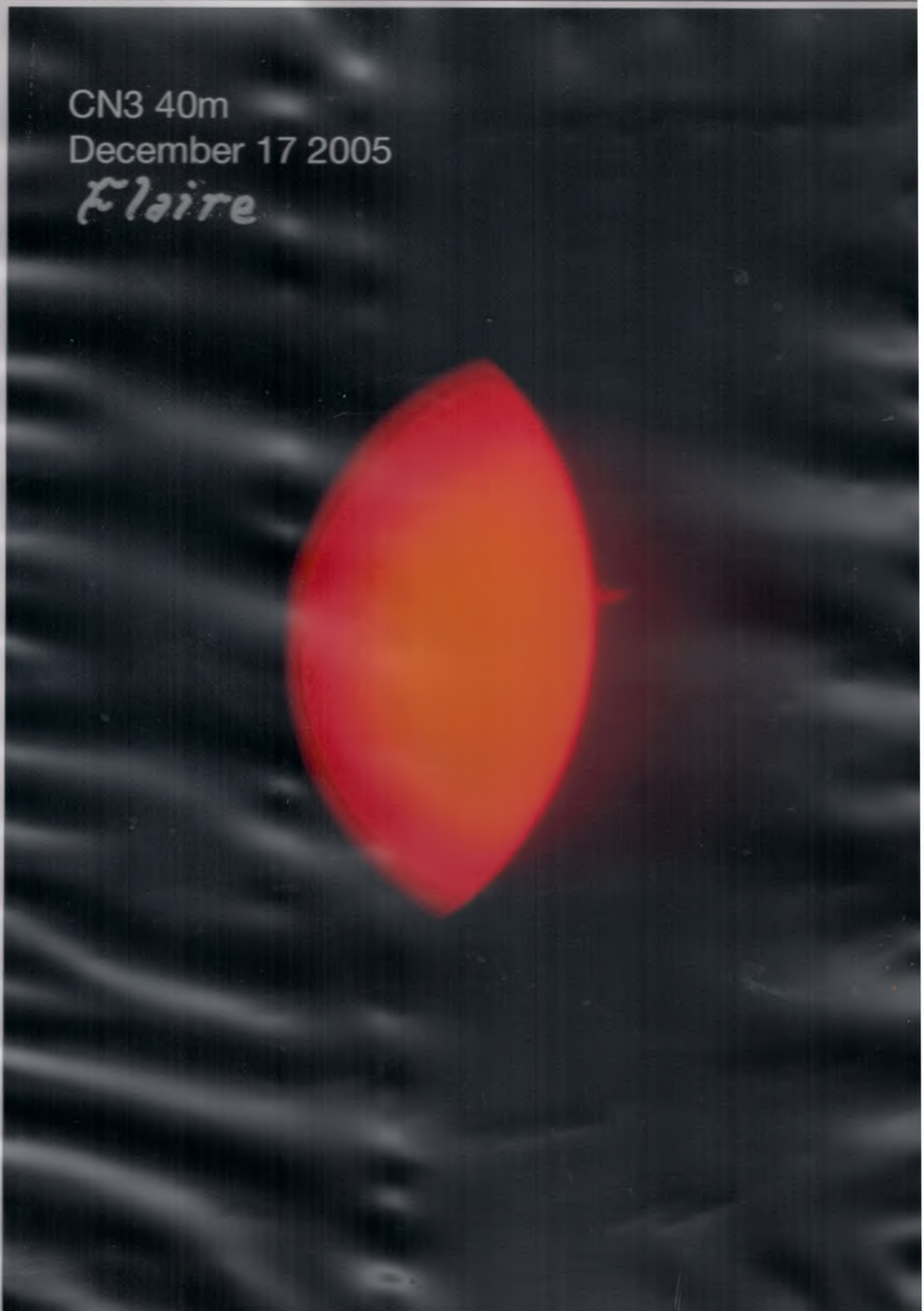
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Comet Hunting with a 250mm lens

December 17, 2005

MPChecker/CMTChecker/NEOChecker/NEOCMTChecker

Here are the results of your search(es) in the requested field(s):

The following objects, brighter than $V = 20.0$, were found in the 5.0-arcminute region around the following observation:

```
     J00GF3   C2010 03 19.48325 19 59 00.64 -17 31 51.4          15.8 R      G92

Object designation         R.A.      Decl.     V       Offsets     Motion/hr   Orbit  Further observations?
                          h  m  s    °  '  "          R.A.   Decl.  R.A.  Decl.        Comment (Elong/Decl/V at date 1)

  (336) Lacadiera       19 59 00.0 -17 31 53  14.3   0.2W   0.0S    71+    19+   40o  None needed at this time.
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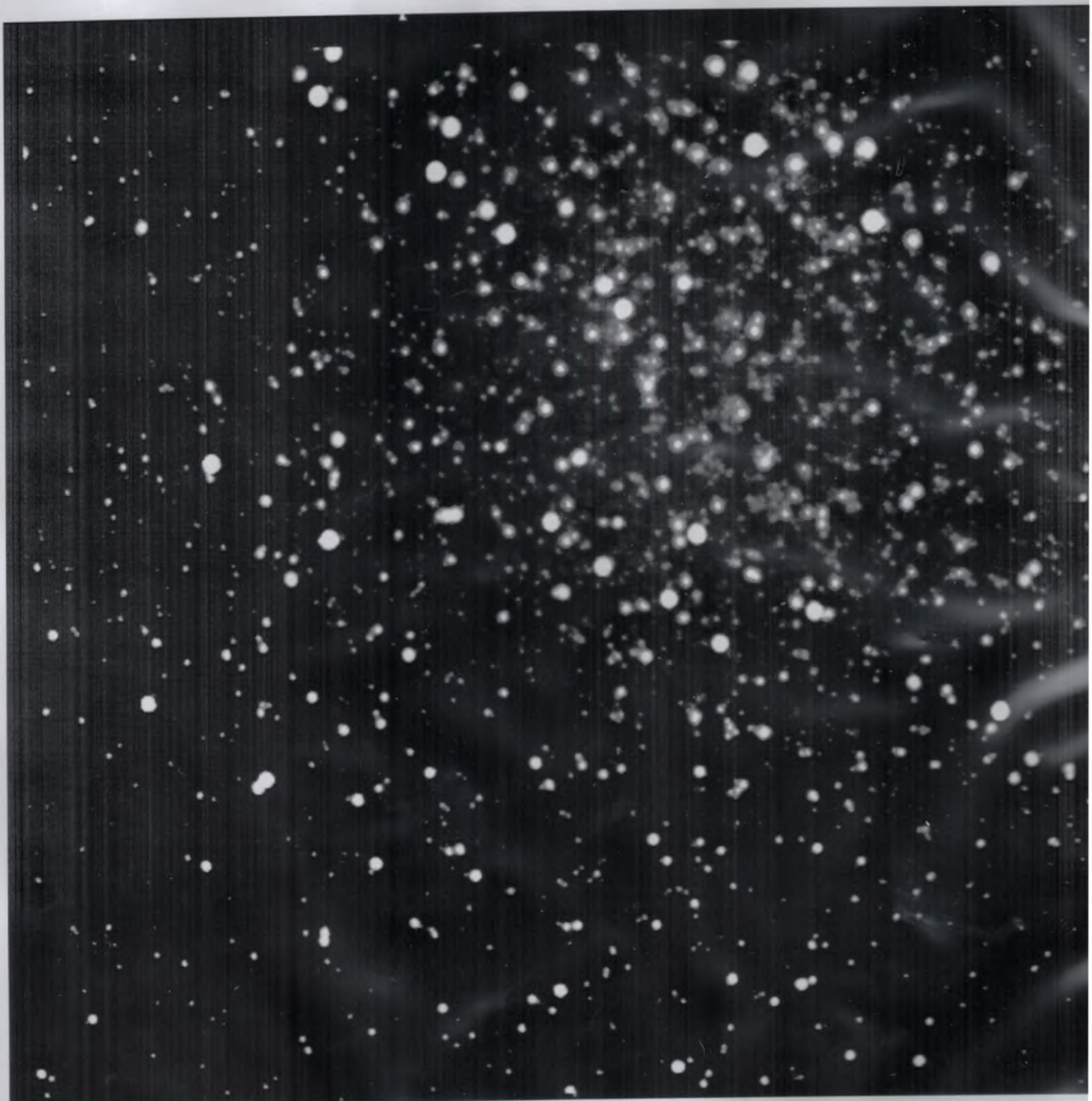
Number of objects checked = 480874

Explanatory Notes

- The positions are J2000.0 and are "quick look" positions designed for identification, not the rigorous comparison of observations with theory.
- Offsets, intended for use by supernova hunters, are given in arc-minutes as the coordinates of the parent galaxies are rarely given to arc-second precision.
- The motions are in arcseconds per stated time unit (if minutes or hours) or degrees/day.
- Right-ascension motions include the cos(Decl.) term.
- The brief orbit descriptor is either:
  - the number of oppositions (if marked with `o'),
  - the arc-length in days (if marked with `d') or
  - `V' if it is a Generalized Väisälä solution.
- Comets are listed regardless of how faint they are. No magnitude estimates are supplied for comets. The heliocentric distance, r, is displayed in the Comments column. Most comets more than 5 AU from the sun will be beyond the reach of most observers, but the information is displayed to enable identification should an outburst occur.
- If you are requesting objects other than just planets and natural satellites, a count is displayed of the number of objects that were checked. If the count is less than 300000, then the file of elements used by this service may have been truncated and this fact should be reported.

These calculations have been performed on the Tamkin Foundation Computing Network.



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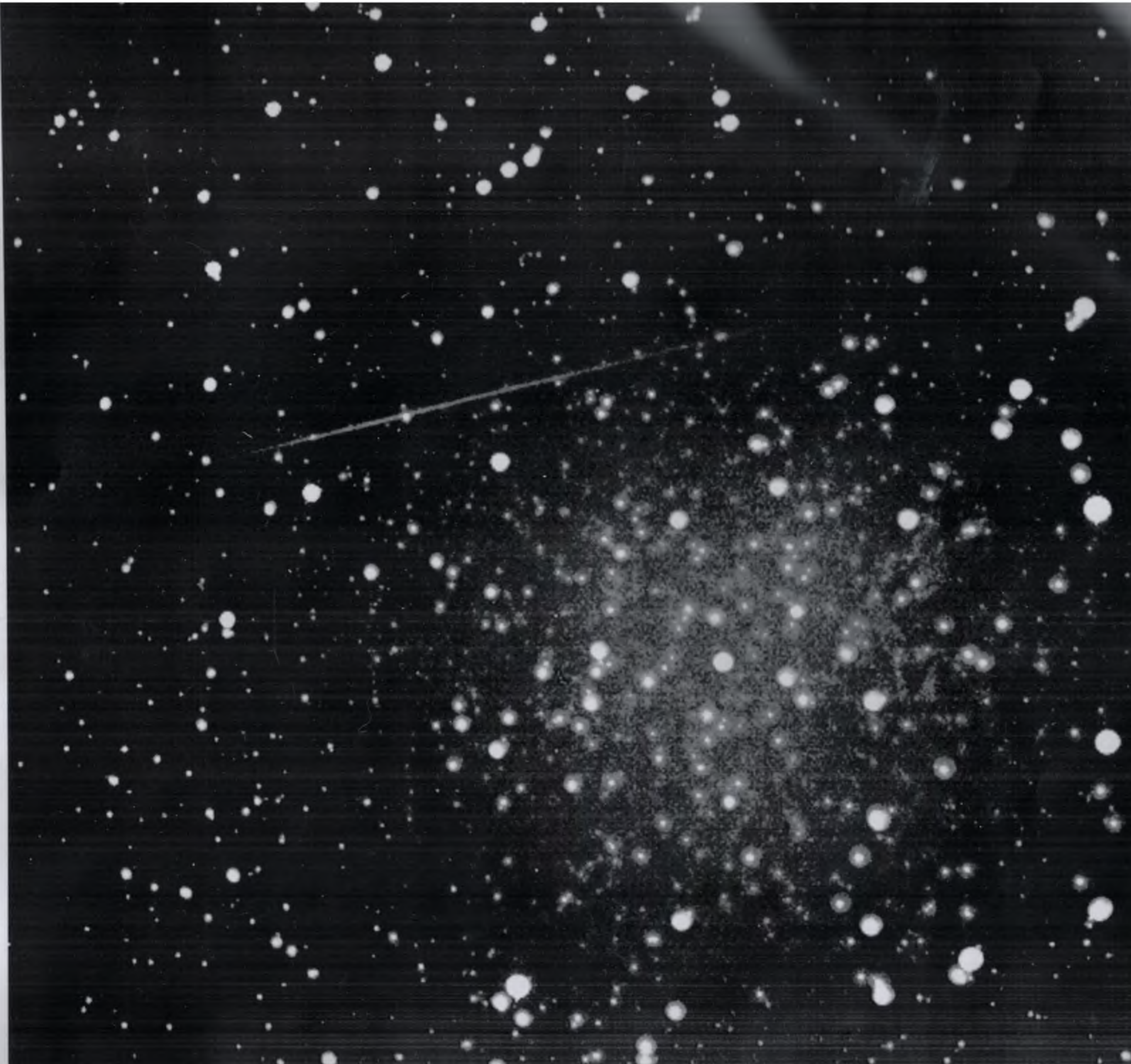

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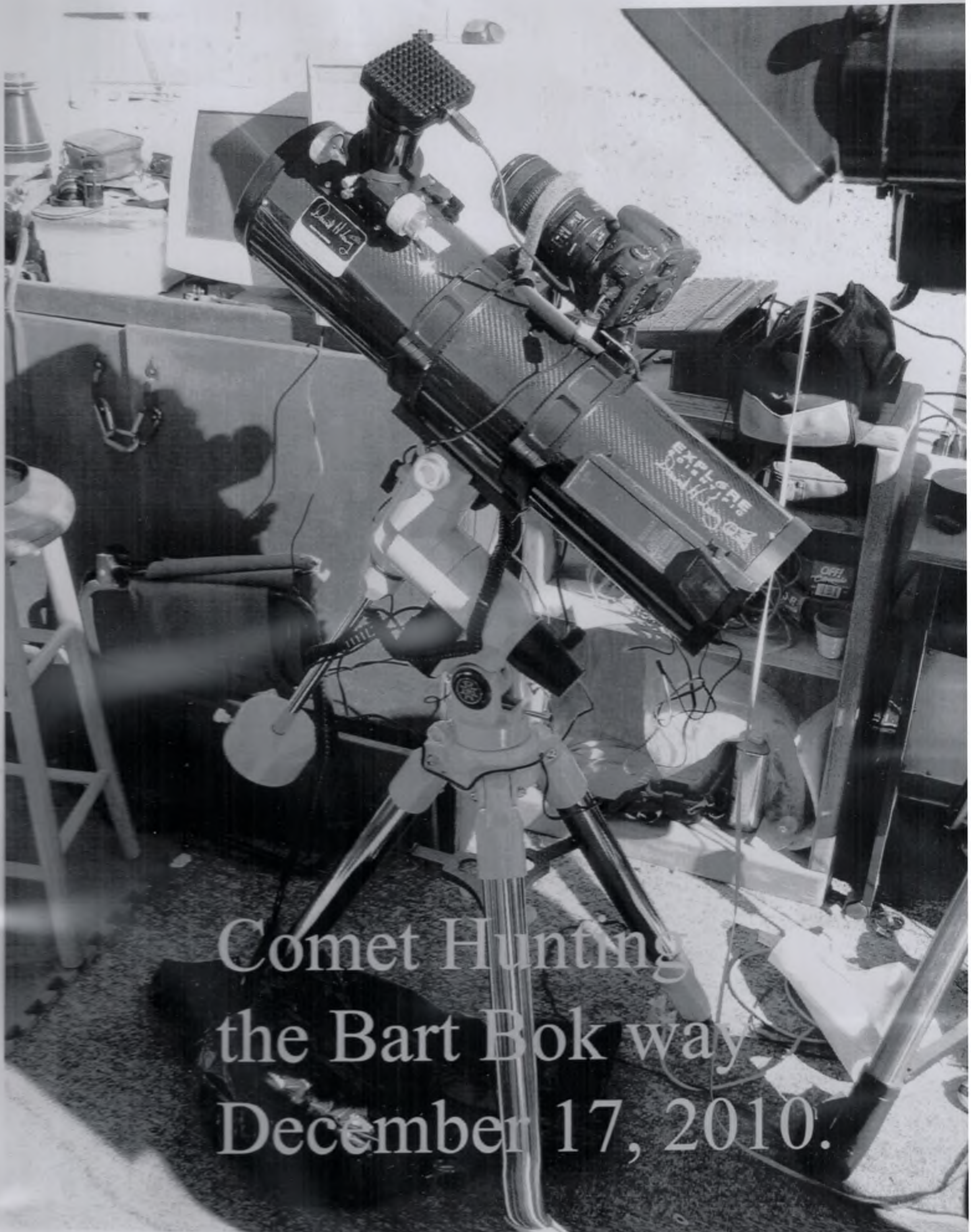
Comet hunting the Bart Bok way.


Comet Hunting
the Bart Bok way
December 17, 2010.
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XIV

Up she got, and wrote him all,
All her tale of sadness,
Blistered every word with tears,
And eased her heart of madness . . .
In the night, and nigh the dawn,
And while the moon was setting.

315 The Charge of the Light Brigade

Published *The Examiner*, 9 Dec. 1854, signed 'A.T.'; then *1855*. The Crimean charge took place 25 Oct. 1854; cp. *The Charge of the Heavy Brigade* (p. 1305). Written 2 Dec. 1854, 'in a few minutes, after reading . . . *The Times* in which occurred the phrase "some one had blundered", and this was the origin of the metre of his poem' (*Mem.* i 381). The editorial (13 Nov.) in fact spoke of 'some hideous blunder'. T. also drew on the report (14 Nov.), where – as he says – 'only 607 sabres are mentioned'. T. wrote to Forster, 6 Dec.: 'six is much better than seven hundred (as I think) metrically so keep it' (*Lincoln*).
Text: T. soon deplored his *1855* revision, which omitted ll. 5–12 ('Some one had blundered') and closed feebly. He reverted in *1856* to earlier readings. 'Not a poem on which I pique myself' (*Mem.* i 409–10); at one stage he intended to omit it from the 3rd edition of *Maud and Other Poems* (*Virginia*).
Sources: Drayton's *Ballad of Agincourt* was suggested at least as early as 1872; T. said it 'was not in my mind; my poem is dactyllic'. Chatterton's *Song to Ælla* is similar in rhythm, form, and theme, e.g., 'Down to the depth of hell / Thousands of Dacyanns went . . .'. T. may have remembered it unconsciously.

I

Half a league, half a league,
Half a league onward,
All in the valley of Death
Rode the six hundred.
'Forward, the Light Brigade!
Charge for the guns!' he said:
Into the valley of Death
Rode the six hundred.

¶315. 3. *the valley of Death*: as the soldiers called it (*The Times*).
5–8] *1856*: Into the valley of Death
Rode the six hundred,

II

'Forward, the Light Brigade!'
Was there a man dismayed?
Not though the soldier knew
Some one had blundered:
Their's not to make reply,
Their's not to reason why,
Their's but to do and die:
Into the valley of Death
Rode the six hundred.

III

Cannon to right of them,
Cannon to left of them,
Cannon in front of them
Volleyed and thundered;
Stormed at with shot and shell,
Boldly they rode and well,
Into the jaws of Death,
Into the mouth of Hell
Rode the six hundred.

IV

Flashed all their sabres bare,
Flashed as they turned in air
Sabring the gunners there,
Charging an army, while
All the world wondered:
Plunged in the battery-smoke
Right through the line they broke;

For up came an order which
Some one had blundered.
'Forward, the Light Brigade!
Take the guns,' Nolan said:
Into the valley of Death
Rode the six hundred. *1854 as separate stanza*;
'Charge,' was the captain's cry; *1855*.
9–12] *1856*; . . . / No man was there dismayed, / . . . *1854*; *not 1855*.
13–14] *Transposed 1855*.
17. *hundred*: pronounced 'hunderd' in Lincolnshire, according to T.'s friend W. F. Rawnsley.
27–32. 'Through the clouds of smoke we could see their sabres flashing' (*The Times*).
28. *as they turned*] *1856*; all at once *1854–5*.
33] *1856*; With many a desperate stroke *1854*; Fiercely the line . . . *1855*.

Cossack and Russian
Reeled from the sabre-stroke
  Shattered and sundered.
Then they rode back, but not
  Not the six hundred.

V

Cannon to right of them,
Cannon to left of them,
Cannon behind them
  Volleyed and thundered;
Stormed at with shot and shell,
While horse and hero fell,
They that had fought so well
Came through the jaws of Death,
Back from the mouth of Hell,
All that was left of them,
  Left of six hundred.

VI

When can their glory fade?
O the wild charge they made!
  All the world wondered.
Honour the charge they made!
Honour the Light Brigade,
  Noble six hundred!

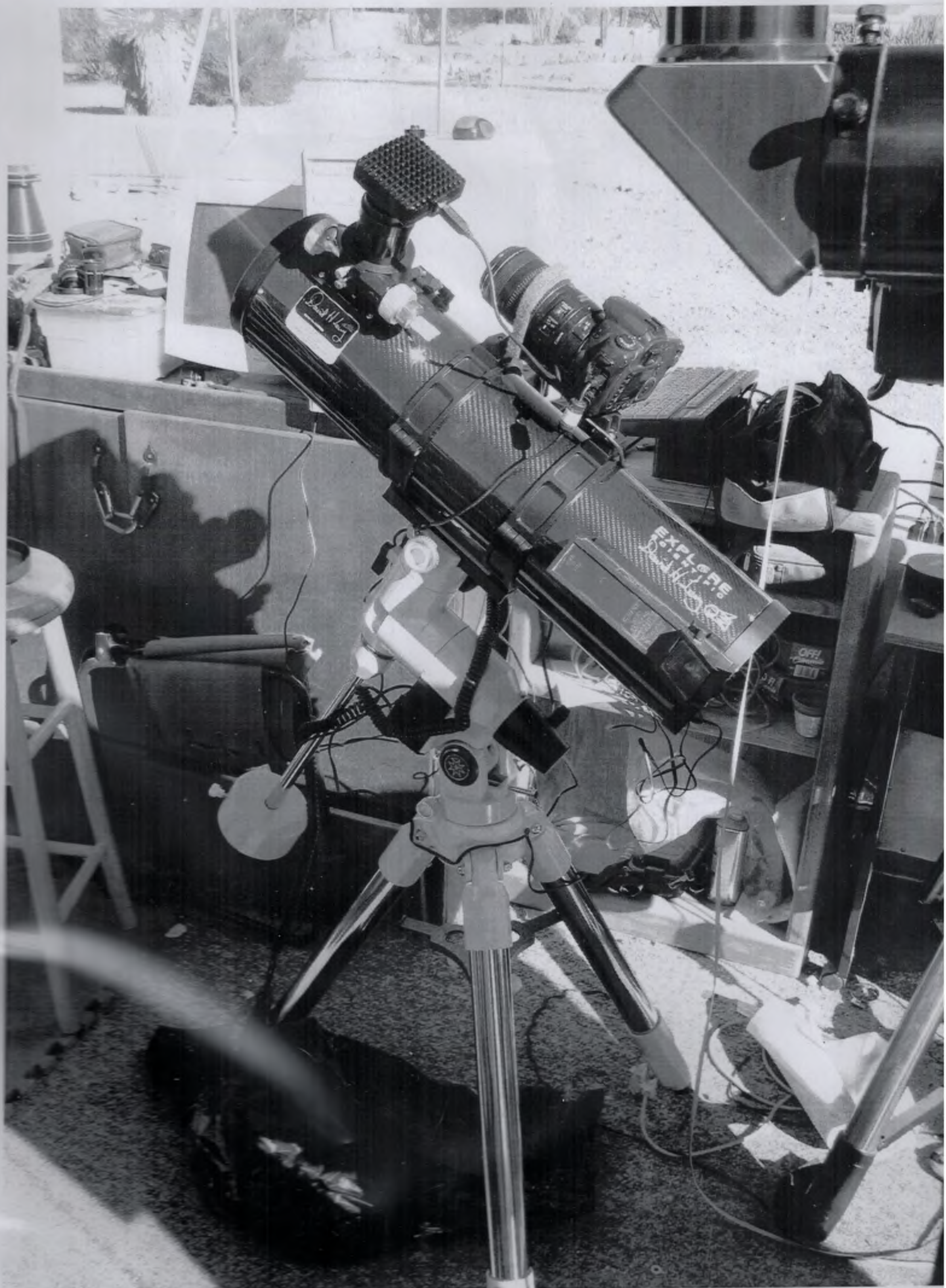
34] *1856*; The Russian line they broke; *1854*; Strong was the sabre-stroke; *1855*.
35–6] *1856*; *not 1854*;   Making an army reel
    Shaken and sundered. *1855*
44] *1854, 1856*; *not 1855*.
45. *fought*] *1854, 1856*; struck *1855*.
46. *Came*] *1854, 1856*; Rode *1855*.   *through*] *1855*; from *1854*.
46 ^ 7] Half a league back again, *1855*.
47. *Back*] *1854, 1856*; Up *1855*.
49. 'Only 195 returned' (T.).
50–55] *1854, 1856*;   Honour the brave and bold!
    Long shall the tale be told,
    Yea, when our babes are old–
    How they rode onward. *1855*

316 Maud

A MONODRAMA

Published *1855*.

Composition. T. worked on *Maud*, 'morning and evening', in 1854 (*Mem.* i 377). On 10 Jan. 1855, he had 'finished, and read out, several lyrics of *Maud*' (*Mem.* i 382); in Feb. 1855, 'he made the mad scene in *Maud* in twenty minutes' (*Mat.* ii 108). On 25 April 1855, he 'copied out *Maud* for the press', and put 'the last touch' to it on 7 July (*Mem.* i 384–5). On the trial edition see T. J. Wise, *Bibliography* i 126–31. The germ of *Maud* was the early lyric *Oh! that 'twere possible* (p. 598; now *Maud* ii 141–238), which T. had written in 1833–4 soon after the death of Arthur Hallam. There are two drafts of this in *Heath MS* and T. published an expansion in *The Tribute*, Sept. 1837 (for details, see p. 1082), apparently with reluctance. R. W. Rader (p. 6) comments: 'Tennyson finished and published his poem in 1837 against his will, cobbling up an ending for it under pressure because he wished to pacify Milnes and had no other poem to do it with. But that he continued to think of his poem as incomplete (the 1834 version ended unsatisfactorily with "And weep / My whole soul out to thee") is suggested by the existence of a fair copy, dated April, 1838, in which it has been returned to its pre-1837 form; and by the fact that he did not reprint this lovely lyric in the *1842* volumes or in any other collection before *Maud*.' In *Eversley*, T. records: 'Sir John Simeon years after begged me to weave a story round this poem, and so *Maud* came into being.' Aubrey de Vere's account in *Mem.* i 379 differs slightly: 'Its origin and composition were, as he described them, singular. He had accidentally lighted upon a poem of his own which begins, "O that 'twere possible", and which had long before been published in a selected volume got up by Lord Northampton for the aid of a sick clergyman. It had struck him, in consequence, I think, of a suggestion made by Sir John Simeon, that, to render the poem fully intelligible, a preceding one was necessary. He wrote it; the second poem too required a predecessor: and thus the whole poem was written, as it were, *backwards*.' But in H.T.'s notes (*Lincoln*) for the early version in *Mat.* the phrase 'in consequence ... Simeon' does not appear. Rader argues, persuasively, that though Simeon's remark may well have spurred T. on, it would be wrong to give it too much weight, since T. must have long thought of doing something more with *Oh! that 'twere possible*. 'Tennyson plainly intended to do something with the piece eight months before his friendship with Simeon began', since in Oct. 1853 his father-in-law, Henry Sellwood, sent by request to Emily T. a copy of the poem from *The Tribute*. See Rader, pp. 1–11. In *1913*, H.T. records: 'My father told [Simeon] that the poem had appeared years before in *The Tribute*, but that it was really intended to be part of a dramatic poem' (p. xxxix). The lyric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The Man who Sold the Milky Way

by David H. Levy

personally autographed by the author

read about one of the most exciting people in 20th century astronomy!

Controversial for his politics (he was forced to leave Harvard during the McCarthy era) Bart Bok was famous for the work he did on the Milky Way. This book gives a feeling for what it is like to be an astronomer in a time of great change in our understanding of the galaxy in which we live.

$35

77850 words.

Preface

IN THE BEGINNING, THERE WAS NO BOK. And the Milky Way was without form, and void. But darkness no longer is upon the face of the deep, for Bart J. Bok has helped explain our galaxy to us.[1]

In the fall of 1979 I was taking my friend Peter Jedicke to the airport when he gave me a piece of paper with a phone number on it. "Your mission," he commanded, "is to telephone Bart Bok and interview him for me." The thought of meeting the great astronomer was terrifying, no less so when I telephoned for an appointment. "This is Bok," he declared. "Be quick!" I arrived with a list of several questions, and asked him the first: "Twenty years ago you began your book *The Astronomer's Universe* with these five words: 'Astronomy is on the move.' How would you react to these words after two decades?"

I never got to ask another question. After an hour I had to rush outside to get an extra tape so that Bart Bok could fill that one as well with his incisive comments on the development of astrophysical research, the refinement of telescope technology, and the role of the amateur astronomer. I had pressed the right button; Bart Bok always loved to talk about astronomy's big picture. In his lifetime of commitment to the Milky Way, Bart J. Bok had seen that picture evolve.

Bok's professional experience began at the University of Leiden and as an assistant in Astronomy at Groningen in the Netherlands. At an IAU meeting he met Harlow Shapley and his career blossomed. In 1929 he became Wilson Fellow in astronomy at Harvard, and was promoted in 1933 to Assistant Professor of astronomy at Harvard. In 1946 he became Associate Director of Harvard College Observatory. By 1957 he was Professor of Astronomy at Australian National University, and Director of Mount Stromlo Observatory. In 1966, he became Head of the Department of Astronomy and Director of Steward Observatory, University of Arizona.
But this is not really Bart Bok -- not as I knew him, and certainly not why I have written this book. His research was a major part of his life, but there was much more to him than that. There is a big difference between a scientist like Bok and one who devotes his or her professional life to research and teaching without leaving the public with a feeling for the benefits of

that research. For example, at a time when astrology was considered very much an off-limits subject for reputable scientists, Bok helped persuade the scientific community to take a stand against it. The public, he felt, had the right and the responsibility to know the difference between the art and science of the universe and the charlatan practices of the astrologers.

Bart Bok was as enthusiastic about informing people about the Milky Way as he was about his own research concerning it. "Scientists have a role in public education that cannot be filled by planetarium people," he maintained. The astronomer is involved every day with his own research, and he knows its developments intimately. The public ought to be able to share in this." Bart and I discussed this point at length. He explained that astronomy educators have a role that is generalized. Their job, to alert people to appreciate the presence of a universe out there, must be augmented by the astronomer who paints the details, using all the excitement of first-hand acquaintance. In support of this, Bart Bok had an extensive public lecture program. While he was director of Australia's Mt. Stromlo Observatory, he lectured to schools and the public about astronomy-- he was in great demand. Later in Arizona, he lectured extensively to diverse groups, including prisoners. These lectures he took as seriously as his professional work.

Bart had a silly side. As mail arrived frequently addressed to "Bart J. Bok, A.A., O.A.P." the postman wanted to know what the initials stand for. "After all, you are a great astronomer, and these letters must refer to some major honor you have received."

"Yes, yes," joked Bok, "the A.A. (for Alcoholics Anonymous) means that I enjoy my sherry, and the O.A.P. means that since I've retired I am an old age pensioner with no income worth speaking of!"

*****

This book has been in preparation for a decade. At first Bart opposed the idea of a biography. But the notion intrigued him: "if I ever changed my mind," he allowed, "you would be the one I would want to write it." I prepared a proposal detailing the conditions under which the biography would be written and how the interviews would proceed.

Between October 1982 and August 1983, I interviewed Bart over fifty times. "This is your book," he told me, "and you should be as nasty as you wish." We were both aware that biographies gain by showing a person's full spectrum, not just a narrow band. Nasty, perhaps, but that side of Bok, properly told, presents a fuller picture of a enigmatic personality. The long delay since Bart's death in 1983 has allowed me to complete this project with a more detached eye. However, although I have tried to be objective in portraying Bok's adventures and ideas, I state at the outset that I developed a great admiration and respect for my subject. It is my hope that through this narrative, readers will enjoy and understand what it was like to be an astronomer in the complex time of Bart J. Bok.

1. Adapted from the introduction to D.H. Levy, "Bart Bok at 75," *Astronomy* (1982),

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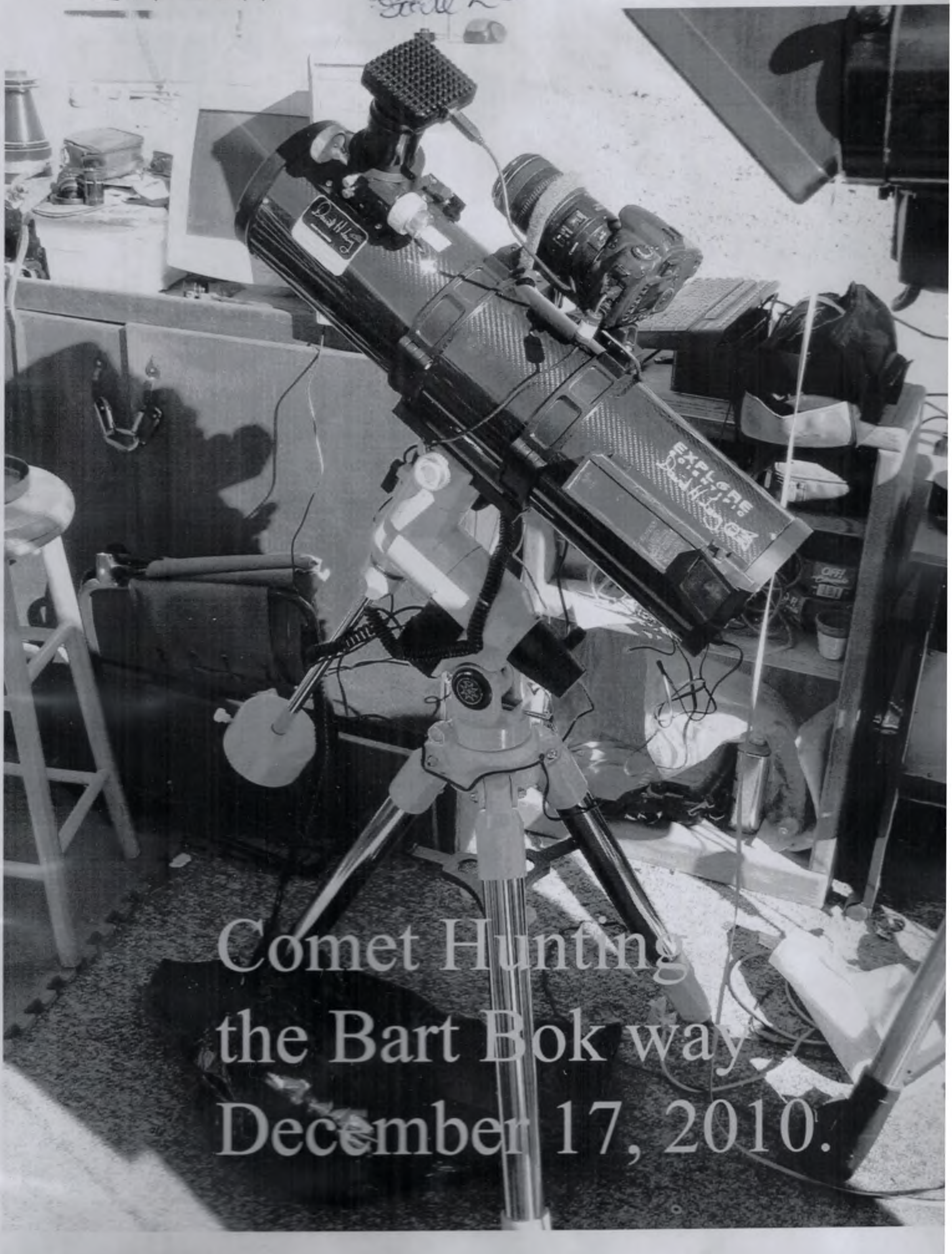

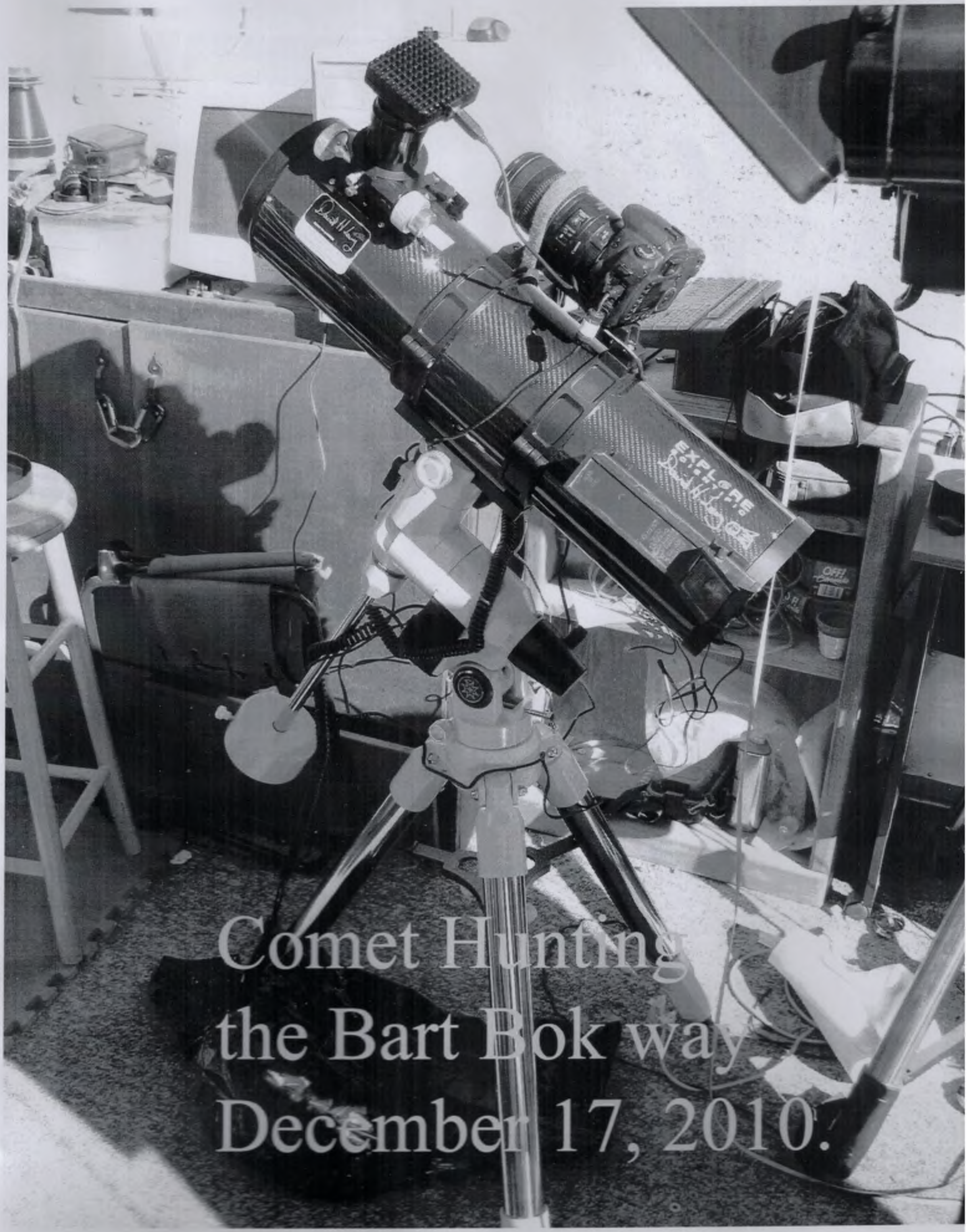
Comet Hunting
the Bart Bok way
December 17, 2010.

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Comet hunting the Bart J. Bok way—reminding us the we need to look up at the sky, just look, to make sure we're making bloody sense.

Begun on Friday, December 17, 2010.

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A meteoric meteor!.
May 2015.

Comet Hunting by the Numbers

Michael Rudenko
Amherst, Massachusetts

Discovering a comet may seem like a Herculean task only to be attempted by those of stout constitution and fanatical resolve. This most certainly was true of the trailblazers, who searched the wilderness of the night sky in pursuit of these creatures whose nature and habits were not well understood. Since the days of Messier and Pons, much has been learned about the form and manner of cometary migration. By identifying and analyzing the circumstances of comet discoveries, what is often thought of as an overwhelming and somewhat mysterious task becomes a more manageable, realistically achievable undertaking.

The statistics for 457 telescopic comet discoveries, from Kirch's sighting in 1680 to comet Levy 1987y, constitute the basis of this study. Specifically excluded are photographic and naked eye discoveries. Photographic discoveries, found primarily by professional astronomers, are generally of very faint comets, and therefore are not particularly relevant to the statistics of visual comet discovery performed with small and moderate sized instruments. Also, since most naked eye discoveries came during the pre-telescopic era, they tend to skew the data set, and so have also been excluded.

Of the 457 comets, 261 (57%) were discovered in the morning sky and 196 (43%) were discovered in the evening sky. The terms "morning" and "evening" sky are defined rather loosely in accordance with whether the comet was west or east of the Sun, respectively. It should be pointed out that a portion of the morning sky is visible in the evening and *vice versa*. In any event, the morning sky appears to be richer in comet finds by a ratio of almost 3:2 over the evening sky.

There have been studies which claim this ratio rises appreciably when considering where the comets should have first been discovered as opposed to where they actually were discovered. Some have claimed that as much as 75% of all comets should have been first discoverable in the morning sky. Such statements are invariably followed by the advice that comet patrols should be concentrated in the morning sky. Three somewhat questionable assumptions have been made in these analyses: firstly, the influence of moonlight can be ignored; secondly, cometary light curves behave in a smooth, well defined fashion; and lastly, the photometric parameters for the comets are well determined.

Ignoring the influence of moonlight can possibly be justified by assuming that in the long run, the morning and evening skies are equally affected. It would be possible to recalculate cometary observability with the inclusion of moonlight considerations, but the results would be worthwhile only if the other questionable assumptions can be put to rest.

With regard to the second assumption, sudden brightness changes have been observed for a fair percentage of comets, and there is growing evidence which suggests that the phenomenon of sudden brightening just before discovery is far from uncommon. Thus, determining the time at which a comet first crosses a given brightness threshold, in order to be visible in moderately sized telescopes, can prove to be a highly speculative matter.

The third assumption, the validity of the photometric parameters, poses an even greater problem. These parameters are derived from, among other factors, apparent magnitude estimates. Only recently has the task of making a valid magnitude estimate of a comet begun to be well understood and performed with anything even remotely approaching accuracy and consistency. This means that the vast majority of past cometary magnitude estimates, and thus their photometeric parameters, are highly suspect at best and possibly even potentially meaningless.

Until these matters can be cleared up, I would not put too much stock in any claims that the morning sky is overwhelmingly better than the evening sky for comet hunting. It is interesting to note that in examining the distribution of morning versus evening sky telescopic discoveries for the past ten years — a period during which much emphasis and effort has been placed on morning sky coverage — that only 55% of the comets were found there; a far cry from the supposed 75% we have been led to expect.

Hunting Grounds

Since comets tend to be brightest when in the vicinity of the Sun, the first law of comet hunting is naturally, "search near the Sun." (The zeroth law of comet hunting is Peltier's dictum: "keep looking!") Traditional wisdom dictates that the so called *comet haystack*, the area within approximately 100 degrees or so of the Sun, should be of prime concern to comet hunters. By examining the discovery elongation statistics, a more articulated picture comes forth. Referring to figures 1 and 3, we note that the area of sky between 30 and 75 degrees elongation has been far and away the richest zone for discoveries, followed by the area from 75 to 105 degrees as well as 25 – 30 degrees elongation. Of least profit are the areas greater than 105 degrees or less than 25 degrees from the Sun. Undoubtedly, the scarcity of sightings inside 25 degrees is due to the effects of twilight and/or atmospheric extinction on the visibility of comets this close to the Sun. Perhaps the advent of some of the new narrow band light pollution filters will aid comet hunting during twilight, opening up a new gold mine of comets embedded in the bright murk.

There are times of the year when the advice to sweep for comets near the Sun is generally not heeded. The region of Virgo and Coma Berenices known as the "Realm of Galaxies" has often been considered the bane of comet hunters, causing some to shy away from attempting to spot an interloper among the galaxies, even when this region is situated such that it becomes a likely place for comets. For quite some time during my own comet hunting career, I blindly followed the common wisdom and avoided this region. When I finally did dare to venture forth into this melee I was pleasantly surprised to find that, in fact, the high density of galaxies makes impostor identification relatively straight forward.

Usually, an isolated nebulous object lying in a field of stars forms a pattern that must be compared with an atlas in order to identify the field. In the case of Virgo/Coma, the galaxies are so closely grouped that generally a number of them will form a pattern in the same eyepiece field. This galaxy pattern can be used when referring to the atlas, and the whole group can be identified at once. Although it is tedious to sweep this region the first time, after highlighting one's atlas with all of the galaxies visible through the telescope, checking these objects in bunches becomes quite routine.

My own experience has been that portions of Ursa Major pose a much more difficult challenge for the comet hunter than does Virgo/Coma. In Ursa Major, there are a fair number of isolated, faint, small, deceptively comet-like galaxies which must be eliminated, one by one, before proceeding.

With regard to object identification, I do have one complaint. A flaw with most sky atlases is that non-stellar objects are generally displayed according to apparent size but not by apparent magnitude. When attempting to identify a suspect, a cursory examination might lead one to mistakingly believe that any non-stellar object placed on such an atlas at that location is the suspect. But what if the suspect is ninth magnitude and the charted object is twelfth? It might be argued that the probability that a comet would appear precisely at the location of a non-stellar object is slim, and so misidentification of this kind would be rare. The problem is that one generally wishes to identify a suspect as quickly as possible in order to reduce time lost away from the telescope. Therefore, comparing the configuration of the eyepiece field with a chart to a high degree of precision would prove to be prohibitively time consuming. More than once, I have resumed my sweep with the uneasy feeling that I had perhaps overlooked something in my haste. (The recently published *Uranometria 2000.0* atlas, with its plethora of non-stellar objects, exacerbates this problem considerably.) A computer assisted object identification system is perhaps the best way to attack this problem.

Comet Corral

The strong predilection for spotting comets in the area from 25 to 105 degrees elongation suggests an intriguing alternate tack for a patrol program, known as the *fence method*. Rather than trying to cover the vast area from 25 – 105 or even just 30 – 75 degrees, the fence method consists of sweeping a small area of sky at a predetermined elongation from the Sun during each available night. The idea is that most comets will have to cross this "fence" on their way into or away from the Sun. Because only a small portion of the sky needs to be examined, sweeps can performed more slowly and carefully, using a larger instrument and/or higher magnification than might normally be convenient for a more general search program. At least two fences are needed: an inner fence for comets emerging from the solar glare, and the other for comets on their journey in towards the Sun. The fences might perhaps be set up to cover areas from 25–30 and 105–110 degrees elongation. The idea, of course, is to catch the comets before they enter the primary hunting grounds, where the majority of the comet hunting pack is concentrating their efforts.

Although appealing in theory, the fence method is difficult to execute in practice. It would be effective only where local weather conditions provide a reasonable percentage of clear nights. Too long an interval between successive sessions may allow a comet to slip through the fence unnoticed. The mean daily motion at the time of discovery for the 457 comets studied, is a shade under 1.5 degrees per day. So for a fence of say 5 degrees width, on average most comets would need at least 3 or 4 days in order to cross the fence. In this case, one would need to be in a climate which permits at least one clear night in three or four. Cloudier climates would require widening the fences. The effects on the visibitity of comets during the bright of the Moon also disrupts the regularity of fence coverage.

Another practical consideration to overcome is that ideally the telescope should be mounted in such a fashion that it describes an arc of points of equal elongation from the Sun on each sweep. The diurnal motion of the sky tends to complicate matters, so that perhaps some compromises may need to be made in how the fences are swept.

The Olympiad

Besides the Sun, the location and phase of the Moon strongly influence the areas available for sweeping. The Moon acts as the referee in this grand competition. It dictates where and when the patrol can take place. Full Moon is the great equalizer. Its bright light washes the night's dark slate clean from all of the probing eyes of the previous lunation. Each lunation marks a new Olympiad for all who aspire to the quest. (For the comet hunter it is more natural to consider a lunation to be the span between successive Full Moons rather than the formal definition of a lunation being from New Moon to New Moon, since Full Moon more clearly demarcates the endpoints of an observing period.) During the first few days after Full Moon, comet hunting takes on the spirit if not the essence of a race. Each night, the Moon uncovers virgin territory and allots increasingly lengthier portions of search time. There is a vast area of sky to cover and too little time to cover it. An effective comet patrol program is one which is in tune with the ethereal fugue performed by the comets and their sentinels, the Sun and Moon, which guard them as they prance unmolested among the constellations. (Only when these giant beacons are not present do comet hunters venture out after their prey.)

The hunt begins with a full head of steam two nights after Full Moon, and drops off appreciably after the twenty-fifth night. There appears to be something almost magical about the twelfth night, with its prodigious output of comet finds. This might be explained in part by the fact that the illuminated lunar disk has by that time become so slender that it finally no longer interferes with comet discovery near the Sun in the morning sky. (See figures 2 and 4.)

Methodology

For athletes, training periods are an important ingredient of success. Technique must be refined and equipment tuned, exercises performed to identify weaknesses and sharpen skills. There is no reason that comet hunting should be any different. Most comet hunters "train under fire", consuming precious dark time fumbling with equipment or discovering limitations, resulting in frustration and loss of enthusiasm. Maintaining a positive and aggressive attitude is critically essential to the vitality of any comet patrol program. I heartily suggest that newcomers to this endeavor use the time when bright moonlight or intermittent clouds prohibit serious searching, as a training and equipment tweaking period, in order to minimize the time it may otherwise take to go from weekend duffer to seasoned world class competitor.

After getting the kinks out of equipment, the next challenge is to develop a sweeping pattern which covers a targeted area in a smooth, timely, and efficient manner. The significant parameters to consider in this regard are: the amount of dark-time available, the horizon, atmospheric extinction, the obliquity of the eclipitic, the incessant diurnal motion of the sky, and the hundreds of phantom comets — the nebulae - which interrupt the regularity of the sweep motion.

Altazimuth mounts are usually preferred when sweeping near the horizon or polar region. In other areas of the sky, the ability to sweep along arcs of constant declination makes overlap between sweeps more uniform, so an equitorial mount is preferred. (Incidentally, an equitorial mount can be converted to an altazimuth simply by pointing the polar axis at the zenith. Pointing the polar axis at the horizon, however, will not result in a true altazimuth configuration.) Attempting to cover an area of constant elongation from the Sun, Moon or perhaps even the ecliptic, would call for yet another, more sophisticated mounting system, the like of which I have never seen — *ATM*s take note! Perhaps surprisingly, usually the driving consideration in selecting a mount system and sweeping pattern is not so much efficiency of sky coverage but rather the convenience of the eyepiece position as the telescope swings through its sweep arc. A carefully thought out telescope mounting system and sweeping methodology is an all too often neglected aspect of the gentle art of comet hunting.

It will probably take a few a hundred hours of searching to spot most of the non-stellar objects within grasp of one's telescope. With my six-inch refractor at 30x, I have identified about 400 such comet-imposters, and it is not unusual for me to add a new one each month or so. Learning the sky thoroughly will facilitate quick identification of suspects, minimizing time lost away from the eyepiece.

With regard to technique, I believe experimentation, analysis, and constant refinement are essential. Keep in mind that there are comet hunters the world over, constantly contriving to develop schemes to snatch what could have been your own treasure had you only tried a bit harder or been a bit better prepared. A few of the more obvious ideas are: plan ahead; before a session scan your sky atlas to refresh your memory of the nebulae found in the past; keep good records of areas swept and nebulae encountered; and keep track of the locations of all the known comets within grasp of your telescope. After a comet hunting session, it is a good idea to check that objects spotted during previous sessions, or currently known comets, were not overlooked: a sign that something may be amiss in your technique. Don't be too surprised if you spend as much time in planning and analysis as you spend sweeping — I do!

For planning and record keeping, I have found that it's simplest to make a photocopy of a planisphere for each session, demarcating areas of noteworthy solar elongation (30, 75 and 105 degrees are the probably the most important), on which is outlined the region swept during a patrol. A microcomputer with a plotter makes easy work of generating such customized planispheres. I also make a separate copy of a planisphere for each lunation, on which I mark all the regions of sky I have swept during that lunation, as well as the paths of the known bright comets. In order to keep track of the known comets, serious observers subscribe to the IAU *Circulars* of the Central Bureau for Astronomical Telegrams (cf *Sky & Telescope*, October, 1987, pp. 420–421).

Undertaking a systematic comet patrol program can be an enjoyable and rewarding activity which can span a lifetime. In addition to the pleasure of coming across the many deep-sky objects and enchanting stellar asterisms sprinkled throughout the Heavens, there is the adrenalin-packed thrill of encountering and dealing with a comet suspect. With a bit of luck and patience, one of these suspects may very well prove to be your very own chariot of fire in the sky.

2003 12 16 Correction for sending for S. Murakami

A STUDY OF VISUALLY DISCOVERABLE COMETS IN THE TWENTIETH CENTURY

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Abstract. Prediscovery ephemerides have been computed for 247 new comets discovered visually and 83 new comets discovered photographically during the period 1901-2000, which were reported as observed to be as bright as total mag 10-11 or brighter.
A statistical study of comet visibility conditions has been carried out, and the results obtained are compared with the estimates of Everhart (1967a). It is evaluated that more than 40% of the comets considered were missed by visual observers during this century. The rate of comet's passing a perihelium is not less than one comet per two months.
It is shown that had the LINEAR CCD program been applied, it would have been able to discover 67% of the comets studied, because part of them spent their brightening period being in the southern sky and at small elongations (E<90 deg).

INTRODUCTION

We see a progressive increase in the heliocentric distances to which comets can be observed.
Between January 1, 1901 and December 31, 2000, 630 new comets have been discovered per ten decades, exluding sungrazing comets (nearly 700 discovered by SOHO spacecraft) which were not observable from the earth.

During the period 1801-1900, 250 new comets have been discovered, which were included by B. Marsden (1997) in his catalogue. For the present study (1901-2000), 330 comets have been chosen that were reported as observed to be as bright as total mag 10-11 or brighter. Of them, 247 comets were discovered visually, and 83 comets were discovered photographically and via CCD as faint objects which then reached visual limit. Some of the latter comets became bright objects such as, for example, comets C/1956 V1 (Arend-Roland), C/1975 V1 (West), etc. Almost all of the selected comets have small perihelion distance (q<1.5 AU) and bright absolute magnitudes (Ho<10). As is apparent from the statistics, from 1801 till 2000 the average rate of visual discoveries (per 200 year) is the same, about 250 comets per century. However, there has been a decrease in visual discoveries in the past ten years.

The evaluation of various selection effects is important for solving our task to specify the conditions under which a comet searching program becomes most effective. This study could be useful for observers who are planning further comet search programs (visual, photographic and CCD).

VISUAL AND PHOTOGRAPHIC INSTRUMENTS AND EFFECTIVENESS OF DISCOVERIES

Many visual comet hunters over the world discovered bright comets with great success (William Bradfield, Minoru Honda, Antonin Mrkos, Leslie Peltier, Don Machholz, David Levy and others). Many of the comet hunters prefer apertures of about 15 cm, with a magnification of 25 and a clear field of two degrees. Some authours suggest that an optimum telescope aperture is 20-30 cm (Kresak 1982; Machholz 1985, 1995), yielding a limiting magnitude during comet searching of M=10-11 for diffuse cometary images. For comet sweeping, some observers in the beginning of the century used large refractors, for example, W.Brooks (26 cm), C. Perrine (30 cm) and M. Giacobini (46 cm). Then, about 60 years (until 1975) large telescopes were not used for comet hunting.

The discoveries of fainter comets by R. Meier (1978-1984) confirm that large reflectors (40 cm aperture) are effective visual instruments for comet hunting.

Most of the problem in using large aperture telescopes is raised by a large supply of faint comet-like objects in the sky. Large reflectors have a narrow field and, therefore, a lot of time is consumed when searching an area. It is impossible with one large telescope of the field diameter 1 deg to provide a complete sky coverage. Authour's experience shows that it takes 50-70 hours to sweep the whole sky with a 48 cm (x65) telescope in order to detect a 11-12 mag comet. Faint comets (11-12 mag) became detected visually after 1983, thanks to the activity of K. Cernis, D. Levy, H. Brewington and other observers. One of the most difficult visual detection was the discovery of comet C/1988 F1 (Levy), at elongation E=39 as object 11.5 mag. It is worth mentioning, however, that a few very faint comets were discovered in the beginning of this century (1900-1907) by such skilled observer as Giacobini.

The distribution of the visual discovery magnitudes is shown in Fig.1 and Fig.2 with the peak between 8 and 10 mag.

Fig 1. The distribution of the visual discovery magnitude for comets discovered in 1901-2000.

Fig 2. Visual magnitudes, M, versus solar elongation, E. The comets discovered in the period 1901-1975 are denoted by circles and those discovered in 1976-2000 are marked by triangles. The open symbols refer to discoveries in the evening sky and the filled symbols are for the mprning sky. The threshold of visual detectability is shown by a line curve.

Fig 3. Visual magnitude, M, versus telescope aperture, D (in cm). The curve shows the detectability limit. Doubling the aperture size from 20 to 40 cm only reveals comets that are about 0.5-1.0 mag fainer.

Fig 4. The number of patrol hours for discovery a new comet, T(h), versus telescope aperture, D (in cm). The open symbols refer to discoveries in 1946-1974. The filled symbols are for the period 1975-2000. The triangles refer to discoveries done in the southern hemisphere. The line shows the average number of hours for various apertures. The bigger aperture telescopes have an advantage of using much less discovery hours.

From the diagram (Fig.3) we see that at larger apertures and magnifications used the real discovery gain is about 0.5-1.0 mag. For the discovery of one comet it is necessary to use, on the average, about 400-500 hours. Using a rich-field telescope, the number of hours for one comet reaches 600-700 hours, whereas with a large aperture telescope (more than 40 cm) about 100-200 hours are needed (see Fig.4). The distribution of resultative visual comet searches throughout the world is shown in Fig.5.

Fig 5. The distribution of resultative comet visual searches throughout the world. Black points refer to comet discoveries in 1901-1949, the open circles are for later discoveries (1950-2000).

During the past decades many faint comets were found photographically by a group of observers at Maunt Palomar Observatory using 46 cm Schmidt telescope (E. and C. Shoemakers, D. Levy, J. Mueller, E. Helin and others). Other active observers were M. Hartley, K.S. Russel, R. McNaught, P. Wild. Wide-field photographic comet discoveries with small cameras were done by K. Takamizawa, Y. Kushida, W. Liller, M. Jager and other observers.

CCD and photographic techniques with its lower brightness threshold are much better for new comet searching. Recently the wide-field CCD LINEAR program discovered 32 comets per 18 months (!), in the period 1998 April to 1999 October. It is apparent that CCD instruments are of much higher efficiency in detecting faint comets (16-20 mag). LINEAR CCD discoveries revealed that there are many comets in the solar system with large perihelion distances (q>3-4 AU) and with faint absolute magnitudes.

In 1998, 30 new comets discovered by groundbased observers, 23 of these remained below the detection threshold of visual comet seekers (total magnitude m1 approximately 10-11) during the whole apparition. Among all of the comets discovered during the period 1901-2000, photographic and CCD discoveries of long-period comets constitute about 60 %.

CLASSIFICATIONS OF COMETS BY THEIR DISCOVERY POSITION AND MOTION

When a comet passes through the inner solar system and becomes bright enough for visual observation, there are some factors showing whether it will be detected, that is, its position relative to the sun and earth, apparent brightness, altitude above the horizon at different geographic latitudes and etc. The present study is restricted to comets accessible visually (M<10-11), which usually have smaller values of perihelion distance q and brighter absolute magnitudes (Ho). It should be mentioned that the comets discovered from orbital solar observatories (Solwind, SMM, SOHO) have been excluded from our analysis.

Of the 630 new comets discovered during the period 1901-2000, 330 comets discoverable by visual means and their orbital elements were selected, mainly from the Marsden and Williams (1997) Catalogue. The comets discovered after 1997 were selected from Meyer (1998) and from recent IAU Circulars.

Prediscovery comet positions have been computed with Astrometrica (Raab, 1998). Part of values of absolute comet magnitudes and discovery were taken from Vseksviatskij (1958). Most visual comet hunters do not care about comet magnitudes and do not spend any care or effort in producing them. Photographic discovery magnitudes of comets have always been a huge problem. So discovery magnitude in my work is estimated with accuracy +/- 1 mag. Another problem was with comet brightening aspect. I did not actually look at all magnitude data to see how a comet brightened. There are very few published catalogues of comet-magnitude parameters that are very trustworthy. Part of discovery magnitude were taken from Rudenko (1986). Only in the past 20 years or so have comet magnitudes become good enough to become very trustworthy.

All of the comets considered were assigned to four groups, depending upon their discovery and prediscovery elongation E, or angular distance from the Sun:

Group I :	E= 0- 22	deg	(very bright comets -naked eye objects, 0-4 mag)
Group II:	E= 23- 45	deg	(bright telescopic objects in twilight, 4-9 mag)
Group III:	E= 46- 90	deg	(faint telescopic objects, 9-11 mag)
Group IV:	E= 91-180	deg	(usually photographically discovered objects)

The comets whose positions at the time of discovery were east of the sun by their ecliptic longitude are marked by the letter "E" (evening sky) and those west of the sun are indicated by "M" (morning sky). To indicate the comets having positive ecliptic latitudes, the letter "n" is added, and those with negative ecliptic latitudes are marked by "s". Most of the comets are moving westward of the sun. Similar movement is of all the stars in the sky with respect to the sun (by about one degree westward per day), like of the major planets such as Jupiter, Saturn, etc. In the case of a distant comet, the change in elongation is similar to what is seen for the major planets. This is due to orbital rotation of the earth around the sun. In our study, by the letter "Ea" are marked the comets whose elongations at the time of discovery were decreasing in the evening sky, while those marked by "Ma" had increasing elongations in the morning sky. In the case of a nearby comet, its movement relative to the sun is sometimes complicated, however, in the sense that its elongation decreases and, after some time, increases and vice verca. In this work the following definition criteria were adopted:

- if at the time of discovery the elongation was increasing when in the evening sky, i.e. the comet was moving away from the sun, it is marked by "Eb" (comet is moving eastward). Such comets usually fade after visual discovery.
- if the comet in the morning sky was moving toward the sun, with its elongation decreasing, it is marked by "Mb". Such comets have larger brightening rate.
- in the case when the comet near the time of its discovery was brightening and held nearly the same elongation or was moving within the same angular distance from the sun, it is marked by "Ec" or "Mc". For example:

C/1994 T1 (Machholz) - MaIIIn. The comet discovered in the morning sky at the angular distance from the sun larger than 46 deg and smaller than 90 deg. The elongation was increasing at the time of discovery, and the comet was in the northern hemisphere of the ecliptic.

C/1998 J1 (SOHO) - EbIs. The comet would have been discovered in the evening sky, in the southern hemisphere of the ecliptic, when it was <22 deg from the sun and moved away from it (see Fig.9).

Tables 1 and 2 contain data about comets discovered visually and photographically (or by CCD means), respectively.

The comets have been assigned to different columns according to two moments:

1. for the time near the moment of discovery (t2);
2. for the time when the comet was accessible with a 0.4 m reflector, usually at larger elongations, when it reached 11.5 mag (t1). It is time before discovery for visually detected comet. In the case the comet had a small elongation (the object is in twilight), a brighter threshold was chosen.

The first three columns in Table 1 contain the running number, comet designation and the name of the first discoverer. Four further columns give the elongation value, classification, brightening rate per 10 days (a negative value indicates brightening of the object), discovery magnitude (moment t2). of the comet. Column "d" gives the number of days between the two moments (t1 and t2), then the following three columns contain the elongation value, classification and apparent magnitude for the computed moment t1, and the last two columns indicate the probability of the discovery by CCD means if both hemispheres are taken into account (C) or only LINEAR telescope is used (L).

Fourth column in Table 2 contains, in mostly cases, the moment t2 when the comet reached theoretical visual discovery magnitude, obtained from available light curves for photographically discovered comets. Then, further columns give the elongation value, classification for moment t2, real brightening rate per 10 days, theoretical discovery magnitude (moment t2), the approximate number of days between the two moments (t1 and t2), classification and the discovery magnitude for a 0.4 m telescope (t1) taking into account visibility conditions. The last two columns are the same as in Table 1.

The analysis of the comet discovery by means of CCD has been performed under the following assumptions:

- CCD fields taken at elongations larger than 90 deg (for Group IV);
- CCD discovery impossible at the moment the comet reached E< 90-110 deg for short time (several days).

The letter "C" denotes that the comet might have been discovered by means of CCD (explained below).

The last column of the table refers to the case if the sky scanning is performed with the LINEAR program, that is, if the sky is examined from latitude {fi}= 32 deg N with the coverage declination {delta} from 90 to -30 deg. The comet would have been discovered if it had been brigher than 18.0-18.5 mag at elongations larger than 90 deg. The letter "L" indicates that the comet would have been discoverable with the LINEAR program. For the comets which would not be discoverable by either CCD or LINEAR means, or both, the most effective way of discovery is visual.

Table 1. List of comets discovered visually

Comet	Discoverer	E	Cl(t2)	br.	m(t2)	d	E	Cl(t1)	m(t1)	C	L
1. C/1901 G1	Viscara etc.	17	Ma I s	1:	1.5	110	96	EaIV n	11.5	C	L
2. C/1902 G1	Brooks	42	Mb IIn	-0.8	7.5	50	80	MbIIIn	11.5	-	-
3. P/1902 O1	Grigg	52	EbIIIn	0.1	9.5	65	46	EcIIIs	11.3	C	L
4. C/1902 R1	Perrine	101	MaIV n	-1.0	9	35	78	MaIIIn	11.5	C	L
5. C/1902 X1	Giacobini	132	MaIV s	-0.2	11	25	114	MaIV s	11.5	C	-
6. C/1903 A1	Giacobini	51	EaIIIn	-0.5	10	35	80	EaIIIn	11.5	C	L
7. C/1903 H1	Grigg	31	EbII s	1.1	9	60	37	MbII n	10.0	C	L
8. C/1903 M1	Borrelly	102	MaIV s	-0.7	8	70	58	MaIIIs	11.5	C	-
9. C/1904 H1	Brooks	109	MaIV n	0.1	9	115	118	MaIV s	10.4	C	L
10. C/1904 Y1	Giacobini	55	MaIIIn	-0.0	11	30	41	MaII n	11.0	C	-
11. P/1904 Y2	Borrelly	95	EaIV s	-0.1	10	90	122	EaIV s	11.5	C	-
12. C/1905 F1	Giacobini	81	EcIIIs	-0.2	11.5	30	86	EcIIIs	11.5	C	-
13. C/1905 W1	Schaer	110	MaIV n	-1.3	7	50	38	MaII n	10.7	C	L
14. C/1905 X1	Giacobini	57	McIIIn	-0.9	8	50	53	McIIIn	11.1	C	L
15. C/1906 B1	Brooks	87	MaIIIn	-0.1	9	110	45	EaII n	11.4	C	L
16. C/1906 F1	Ross	34	EcII s	0.6	8	45	27	EcII s	8.3	C	L
17. C/1906 V1	Thiele	90	MaIIIs	-0.5	8.5	70	74	MaIIIs	11.5	C	-
18. C/1907 E1	Giacobini	114	EaIV s	0.1	10.5	60	86	MaIIIs	11.5	C	-
19. C/1907 G1	Grigg, etc.	70	EbIIIs	0.0	6.5	60	43	MaII s	10.5	C	L
20. P/1907 L1	Giacobini	77	EaIIIn	0.0	12:	0	77	EaIIIn	12:	C	L
21. C/1907 L2	Daniel	81	MaIIIn	-0.6	9.5	45	65	MaIIIn	11.5	C	L
22. C/1907 T1	Mellish	69	MaIIIs	-0.3	9	100	64	EaIIIs	11.5	C	L
23. C/1908 R1	Morehouse, etc	89	MaIIIn	-0.6	9	40	59	MaIIIn	11.5	C	L
24. C/1909 L1	Borrelly, etc.	53	MaIIIn	0.3	9	55	68	MbIIIs	11.5	C	L

25.	P/1909 X1	Daniel	158	MaIV n	0.1	9	85	107	MaIV n	11.5	C	L
26.	C/1910 A1	several (Great C.)	12	Ma I s	-0.8	1	110	75	EaIIIn	11.5	C	L
27.	C/1910 P1	Metcalf	100	EaIV n	0.2	8.5	130	65	MaIIIs	11.5	C	L
28.	C/1911 O1	Brooks	127	MaIV n	-0.7	10	40	104	MaIV n	11.5	C	L
29.	C/1911 S2	Quenisset	78	EaIIIn	-0.7	7	65	64	MaIIIn	11.5	C	L
30.	C/1911 S3	Beljawski	26	MbII s	-1.0	2.5	60	39	MbII s	10.1	-	-
31.	P/1911 X1	Schaumasse	55	McIIIn	0.1	11	60	52	MaIIIn	11.5	C	L
32.	C/1912 R1	Gale	54	EaIIIs	-0.7	5	100	75	EaIIIs	11.5	-	-
33.	C/1912 V1	Borrelly	71	EcIIIn	-0.2	7.5	60	44	MaII n	9.7	C	L
34.	C/1913 J1	Schaumasse	87	MaIIIn	-0.5	9.5	40	46	MaIIIn	11.0	C	L
35.	C/1913 R1	Metcalf	66	MaIIIn	-0.5	9.5	35	41	MaII n	10.7	C	L
36.	P/1913 U1	Zinner	72	EaIIIn	-0.4	9.5	35	79	EaIIIn	11.5	C	L
37.	C/1913 Y1	Delavan	130	EaIV s	-0.1	10.5	60	140	MaIV n	11.5	C	L
38.	C/1914 F1	Kritzinger	123	MaIV n	-0.6	9.5	55	101	MaIV s	11.5	C	L
39.	C/1914 J1	Zlatinsky	31	MaII n	-0.6	4	20	28	MaII n	5.8	C	L
40.	C/1914 S1	Campbell	101	MaIV s	-0.3	3.5	210	126	MaIV n	11.5	C	L
41.	C/1915 C1	Mellish	69	MaIIIn	-0.3	9.0	50	42	MaII n	10.6	C	L
42.	C/1915 R1	Mellish	33	MbII n	-1.1	9.5	15	36	McII n	10.7	C	L
43.	P/1915 W1	Taylor	148	MaIV s	-0.3	10	50	114	MaIV s	11.5	C	L
44.	D/1917 F1	Mellish	36	EaII n	-1.4	7	50	85	EaIIIs	11.5	C	L
45.	C/1917 H1	Schaumasse	46	MaIIIn	-1.0	9.5	10	38	MaII n	10.4	C	L
46.	C/1918 L1	Reid	66	EaIIIs	0.2	10.5	60	93	EaIV n	11.5	-	-
47.	P/1919 Q1	Metcalf	140	MaIV n	-1.7	7.5	60	113	MaIV n	11.5	C	L
48.	C/1919 Q2	Metcalf	58	EaIIIn	-0.3	8	140	121	EaIV n	11.5	C	L
49.	C/1919 Y1	Skjellerup	31	MbII s	-2.1	8.5	10	44	McII n	10.7	C	L
50.	C/1920 X1	Skjellerup, etc.	116	MaIV s	-0.5	10	30	115	MaIV s	11.5	C	L
51.	C/1921 E1	Reid	52	MaIIIs	-0.6	9	20	38	MaII s	10.2	C	L
52.	D/1921 H1	Dubiago	62	EcIIIn	-0.2	10.5	45	73	EaIIIn	11.5	C	L
53.	C/1922 B1	Reid	121	MaIV s	0.0	9.5	180	51	MaIIIn	11.5	C	L
54.	P/1922 K1	Skjellerup	61	EcIIIs	-0.5	11.5:	10	62	EcIIIs	12.0:	C	L
55.	C/1922 W1	Skjellerup	74	McIIIs	-0.5	7	75	68	MaIIIn	11.5	C	L
56.	C/1923 T1	Dubiago, etc.	83	MbIIIs	-1.3	8	25	77	McIIIn	11.5	-	-
57.	C/1924 F1	Reid	51	EcIIIs	0.0	10	80	39	EbII s	10.4	C	L
58.	C/1924 R1	Finsler	30	EbII n	0.7	4	10	24	EbII n	3.4	-	-
59.	C/1925 F2	Reid	153	MaIV s	-0.4	8	100	70	MaIIIn	11.5	C	L
60.	C/1925 G1	Orkisz	36	MaII n	-0.2	9	10	29	MaII n	9.2	-	-
61.	C/1925 V1	Wilk, etc.	62	EbIIIn	0.0	8	35	58	MaIIIn	11.5	C	L
62.	C/1925 W1	van Biesbroeck	74	MaIIIn	0.0	8	170	49	MaIIIn	11.5	C	L
63.	C/1925 X1	Ensor	94	EaIV s	-0.6	8	60	96	MaIV s	11.5	-	-
64.	C/1926 B1	Blathwayt	98	MaIV s	-0.6	9.5	40	48	MaIIIs	11.5	C	L
65.	C/1927 A1	Blathwayt	51	MaIIIs	-0.6	9	30	37	MaII n	10.1	C	L
66.	C/1927 B1	Reid	44	EbII s	0.3	8	110	57	EaIIIn	11.5	-	-
67.	C/1927 E1	Stearns	119	MaIV n	-0.1	10	70	54	MaIIIn	10.8	-	-
68.	P/1927 L1	Gale	118	McIV s	-0.1	8	75	114	MaIV n	11.5	C	L
69.	C/1927 X1	Skjellerup, etc.	40	MbII s	-1.9	3	110	78	MbIIIs	11.5	-	-
70.	P/1929 P1	Forbes	167	MaIV s	0.1	10	100	127	MaIV s	11.5	C	-
71.	C/1929 Y1	Wilk	60	EaIIIn	-0.9	7	55	54	MaIIIn	11.2	C	L
72.	C/1930 D1	Peltier, etc.	146	EaIV n	-0.5	10	20	89	MaIIIs	11.5	C	-
73.	C/1930 F1	Wilk	29	EaII n	-1.0	6	55	65	EaIIIs	11.5	C	L
74.	C/1930 L1	Forbes	84	MaIIIs	-0.5	9	70	50	EaIIIs	11.5	C	-
75.	C/1931 O1	Nagata	43	EbII n	0.4	7	240	146	EaIV s	11.5	C	L
76.	C/1931 P1	Ryves	23	Ma I n	-2.5	5	5	22	Ma I n	6.5	C	L
77.	C/1932 G1	Houghton, etc.	106	MaIV s	-0.3	9	110	84	MaIIIs	11.5	C	-
78.	C/1932 M2	Geddes	110	EaIV s	-0.2	8.5	115	47	MaIIIs	11.4	C	L
79.	C/1932 P1	Peltier, etc.	83	MaIIIn	-0.8	8.5	60	71	MaIIIs	11.5	-	-
80.	C/1932 Y1	Dodwell, etc.	71	EaIIIs	-0.3	8	100	123	EaIV s	11.5	C	L
81.	C/1933 D1	Peltier	75	EaIIIn	-0.5	8	60	49	EcIIIn	11.5	C	L
82.	C/1936 K1	Peltier	62	MbIIIn	-0.3	9	65	90	MbIIIn	11.5	C	L
83.	C/1936 O1	Kaho, etc.	30	EbII n	0.7	5.5	70	58	MbIIIs	11.5	C	L
84.	D/1937 D1	Wilk	39	EaII n	-0.3	7	60	48	EaIIIs	11.5	C	-
85.	C/1937 N1	Finsler	50	MaIIIn	-0.9	7	23	33	MaII n	9.3	C	L
86.	C/1939 B1	Kozik, etc.	52	EaIIIn	-0.9	8	40	59	EaIIIn	11.5	C	L
87.	C/1939 H1	Jurlof, etc.	31	MaII n	-1.4	3	35	27	MaII n	5.7	C	L

88.	P/1939 O1	Rigollet	49	McIIIn	-0.5	8	45	64	MbIIIs	11.5	-	-
89.	C/1939 V1	Friend	58	EbIIIn	-0.5	9	30	43	EbII n	10.6	C	L
90.	C/1940 S1	Okabayashi, etc	43	MaII n	0.1	9	120	84	EaIIIs	10.7:	C	-
91.	C/1941 B1	Friend, etc.	72	EaIIIn	-0.5	10	35	78	EaIIIn	11.5	C	L
92.	C/1941 B2	de Kock, etc.	56	MaIIIs	-1.2	5.8	30	34	MaII s	8.7	C	L
93.	C/1941 K1	van Gent	150	MaIV s	-0.8	11	10	133	MaIV s	11.5	-	-
94.	C/1943 R1	Daimaca	52	MaIIIn	-0.7	8	20	35	MaII n	9.5	C	L
95	C/1943 W1	van Gent, etc.	100	MaIV s	-1.5	9	25	83	MaIIIs	11.5	-	-
96.	C/1944 K2	van Gent	100	EaIV s	-0.1	11.5	5	101	EaIV s	11.5	-	-
97.	C/1945 W1	Friend, etc.	51	EaIIIn	-1.3	7	55	92	EaIV n	11.5	-	-
98.	C/1946 K1	Pajdusakova, etc.	101	MaIV n	-0.8	6	40	43	MaII s	10.6	C	L
99	C/1946 P1	Jones	35	MaII s	-0.4	9	20	32	MaII s	9.8	C	L
100	C/1947 F2	Becvar	86	MaIIIn	-0.8	9	35	77	MaIIIn	11.5	C	L
101	C/1947 V1	Honda	43	MaII s	-0.6	9	20	35	MaII n	10.3	-	-
102	C/1947 X1	several, South. C.	14	EaI s	-0.5	0	130	141	EaIV n	11.5	C	L
103	C/1947 Y1	Mrkos	43	MaII n	-0.3	9.5	15	32	MaII n	10.2	C	-
104	C/1948 E1	Pajdusakova, etc.	78	MaIIIn	-0.2	10	40	50	MaIIIn	11.0	C	-
105	C/1948 L1	Honda, etc.	32	MaII n	1.9	3.5	5	18	MaI n	2.5	C	L
106	C/1948 V1	several,Eclipse C.	2	MaI s	-0.3:	-3:	170	90	EaIIIs	11.5:	C	L
107	P/1948 X1	Honda, etc.	38	MaII s	-0.2	9	60	71	EaIIIn	11.5	C	L
108	C/1951 C1	Pajdusakova	32	MaII n	-0.3	8.5	5	28	MaII n	8.6	-	-
109	P/1951 H1	Kresak	91	EaIV n	-0.2	10	55	130	EaIV s	11.5	C	L
110	C/1952 H1	Mrkos	43	MaII n	-0.3	10	90	89	EaIIIn	11.5	C	L
111	C/1952 M1	Peltier	82	EaIIIn	-0.2	10	65	139	EaIV n	11.5	C	L
112	C/1952 W1	Mrkos	48	MaIIIn	-0.7	10	10	44	MaII n	10.7	-	-
113	C/1953 G1	Mrkos, etc.	62	MaIIIn	-0.6	9	30	50	MaIIIn	10.8	C	-
114	C/1953 X1	Pajdusakova	128	EaIV s	-1.2	10.5	7	146	EaIV s	11.5	C	L
115	C/1954 M2	Kresak, etc.	117	EaIV n	-0.6	10	20	131	EaIV n	11.5	C	L
116	C/1954 O1	Vozarova	49	MaIIIn	0.5	9	150	59	EaIIIs	11.5	C	-
117	C/1955 L1	Mrkos	22	MaI n	0.0	3	130	64	EaIIIs	11.5	-	-
118	C/1955 N1	Bakharev, etc.	115	MaIV n	-0.3	8	100	79	EaIIIs	11.5	C	L
119	C/1955 O1	Honda	59	MaIIIs	-0.9	8	50	43	MaII s	10.9	-	-
120	P/1955 U1	Mrkos	78	McIIIn	0.1	9	110	79	McIIIn	11.5	C	L
121	C/1956 E1	Mrkos	78	McIIIn	-1.0	9	15	70	MaIIIn	11.5	C	-
122	P/1956 S1	27P(Pajdusakova)	61	MbIIIn	-0.5	10	35	83	MbIIIn	11.5	-	-
123	C/1957 P1	Mrkos	15	MaI n	-0.8	1	155	74	EaIIIs	11.5	-	-
124	C/1957 U1	Latyshev, etc.	152	MaIV s	-1.7	8	20	104	MaIV n	11.5	C	L
125	C/1958 D1	Burnham	115	EaIV s	-0.3	10	60	155	EaIV s	11.5	C	L
126	C/1959 Q1	Alcock	80	EaIIIn	-0.3	10	45	70	EaIIIn	11.5	C	L
127	C/1959 Q2	Alcock	35	MbII n	-2.3	6	25	45	McII n	10.7	C	L
128	C/1959 X1	Mrkos	28	McII n	0.1	8	60	26	McII n	8.4	C	L
129	C/1960 Y1	Candy	102	EaIV n	-0.8	8	40	70	MaIIIn	11.5	C	L
130	C/1961 O1	Wilson, etc.	17	Ma I n	-1.0	3	5	15	MaI n	3.5	C	L
131	C/1961 T1	Seki	31	MaII n	-0.7	8	5	26	MaII n	8.3	C	L
132	C/1962 C1	Seki, etc.	124	EaIV s	-1.3	8.5	30	121	MaIV s	11.5	C	L
133	C/1962 H1	Honda	38	MaII n	-0.3	8	60	54	EaIIIs	11.5	C	-
134	C/1963 A1	Ikeya	67	MaIIIs	-0.8	11.5	0	67	MaIIIs	11.5	C	L
135	C/1963 F1	Alcock	68	MaIIIn	-0.2	8	140	99	EaIV n	11.5	C	L
136	C/1963 R1	Pereyra	29	MaII s	0.0	2	5:	16	MaI s	2.0	C	L
137	C/1964 L1	Tomita, etc.	44	MaII s	-1.6	6	30	32	MaII s	9.7	C	L
138	C/1964 N1	Ikeya	37	MaII s	-0.9	8	15	28	MaII s	9.0	C	L
139	C/1964 P1	Everhart	94	EaIV n	-0.3	9	70	104	MaIV s	11.5	-	-
140	C/1965 S1	Ikeya, etc.	46	MaIIIs	-1.2	8	25	38	MaII s	10.4	C	L
141	C/1965 S2	Alcock	75	EcIIIn	-0.3	10	25	71	EcIIIn	11.5	C	L
142	C/1966 P1	Kilston	119	EaIV n	0.0	10.5	90	120	EcIV n	11.5	C	L
143	C/1966 R1	Ikeya, etc.	32	EbII n	0.5	8	20	25	EbII n	7.3	C	-
144	C/1967 C1	Seki	58	McIIIn	-1.1	11	5	60	McIIIn	11.5	-	-
145	C/1967 M1	Mitchell, etc.	29	EbII s	3.2	5	50	33	McII s	9.5:	-	-
146	C/1967 Y1	Ikeya, etc.	35	MaII n	-0.3	9	170	146	EaIV s	11.5	C	-
147	C/1968 H1	Tago, etc.	45	MbII n	-1.3	7	35	69	MbIIIs	11.5	-	-
148	C/1968 L1	Whitaker, etc.	137	EaIV n	0.3	9	40	100	MaIV s	11.5	-	-
149	C/1968 N1	Honda	30	MaII n	-0.4	8	150	146	EaIV s	11.5	C	L
150	C/1968 Q1	Bally, etc.	117	EaIV n	0.3	11.5	40	116	MaIV n	11.5	C	L

151	C/1968	Q2	Honda	70	MaIIIs	-0.7	10	35	49	MaIIIs	11.5	C	L
152	C/1969	P1	Fujikawa	54	McIIIs	-0.6	11	10	54	McIIIs	11.5	C	L
153	C/1969	T1	Tago, etc.	50	EaIIIn	-0.4	10	45	85	EaIIIn	11.5	C	L
154	C/1969	Y1	Bennett	72	EaIIIs	-0.4	8.5	80	110	MaIIIs	11.5	C	L
155	C/1970	B1	Daido, etc.	35	MbII n	-1.8	8	15	42	MaII n	10.4	-	-
156	C/1970	K1	White, etc.	13	EaI s	-2.1	1	80	82	EaIIIs	11.5	C	L
157	C/1970	N1	Abe	62	MaIIIn	-0.5	10	15	48	MaIIIn	10.6	C	L
158	C/1970	U1	Suzuki, etc.	34	EbII n	1.2	7	10	24	MaII s	5.8	C	L
159	C/1971	E1	Toba	37	MaII n	-0.2	9.5	90	89	EaIIIn	11.5	C	L
160	C/1972	E1	Bradfield	31	MaII s	-0.5	10	5	26	MaII s	10.1	C	L
161	C/1974	C1	Bradfield	33	EaII s	-0.9	9	25	40	EaII s	11.0	C	L
162	C/1974	V2	Bennett	54	MaIIIs	-0.9	8.5	15	42	MaII s	10.3	C	L
163	P/1975	A1	Boethin	61	EcIIIn	0.0	11.0	30	64	EaIIIs	11.5	C	-
164	C/1975	E1	Bradfield	30	EaII s	-0.3	9	100	67	EaIIIs	11.5	C	L
165	C/1975	N1	Kobayashi, etc.	133	MaIV n	-1.1	7.5	25	109	MaIV s	11.5	C	L
166	C/1975	T1	Mori, etc.	66	MaIIIs	-0.3	10.5	30	46	MaIIIs	11.5	C	L
167	C/1975	T2	Suzuki, etc.	52	MaIIIn	-0.9	8.5	30	37	MaII n	10.9	C	L
168	C/1975	V2	Bradfield	58	MaIIIs	-1.1	9.5	25	62	MaIIIs	11.5	C	L
169	C/1975	X1	Sato	78	McIIIn	-1.4	9.5	20	73	MaIIIn	11.5	-	-
170	C/1976	D1	Bradfield	56	EcIIIs	-0.6	9.5	35	55	EaIIIs	11.5	C	L
171	C/1976	E1	Bradfield	44	MaII s	-0.6	9	35	37	MaII s	10.3	C	L
172	C/1977	R1	Kohler	67	EaIIIn	-0.5	9.7	45	87	EaIIIn	11.5	C	L
173	C/1978	C1	Bradfield	48	MbIIIs	-1.0	7.5	60	51	McIIIs	11.5	C	L
174	C/1978	H1	Meier	71	EaIIIn	-0.1	10.3	90	124	EaIV n	11.5	C	L
175	D/1978	R1	Haneda, etc.	147	EaIV s	-0.6	9.5	30	174	EaIV s	11.5	C	L
176	C/1978	R3	Machholz	73	MaIIIs	-0.1	10.5	35	41	MaII s	10.9	C	L
177	C/1978	T1	Seargent	35	MaII s	1.1	5	65	37	EaII n	9.7	-	-
178	P/1978	T2	Fujikawa	40	MaII s	-0.2	10.2	45	74	EaIIIs	11.5	C	-
179	C/1978	T3	Bradfield	32	MaII s	0.0	8.5	5	25	MaII s	8.5	C	L
180	C/1979	M1	Bradfield	44	EaII s	-0.7	10	25	83	EaIIIs	11.5	-	-
181	C/1979	S1	Meier	70	MaIIIn	-0.1	11.3	20	76	EaIIIn	11.5	-	-
182	C/1979	Y1	Bradfield	26	MaII s	-0.6	5.5	90	88	EaIIIn	11.5	C	-
183	C/1980	O1	Cernis, etc.	44	EbII n	1.0	8.7	15	34	EbII n	7.8	C	L
184	C/1980	V1	Meier	74	EaIIIn	0.0	10.5	70	101	MaIV n	11.5	C	L
185	C/1980	Y1	Bradfield	22	MaI s	-2.2	5.5	3	21	MaI s	6.0	C	-
186	C/1980	Y2	Panther	63	EaIIIn	-0.1	10	120	130	EaIV n	11.5	C	L
187	C/1982	M1	Austin	68	McIIIs	-0.7	10.5	25	67	McIIIs	11.5	C	L
188	C/1983	H1	IRAS, etc.	90	MaIIIn	-2.1	7.2	35	81	McIIIn	11.5	-	-
189	C/1983	J1	Sugano, etc.	29	MaII n	-0.1	7	50	51	EaIIIs	11.5	-	-
190	C/1983	O1	Cernis	73	MaIIIs	-0.2	10.7	185	115	EaIV n	11.5	C	L
191	D/1984	A1	Bradfield 1	46	MaIIIs	-0.1	10.5	20	42	MaII s	10.6	C	L
192	C/1984	N1	Austin	69	MbIIIs	-1.5	5.8	30	86	McIIIs	11.5	C	L
193	P/1984	O1	Takamizawa	172	MaIV s	0.2	9.5	(150)	83	MaIIIn	11.5	C	L
194	C/1984	S1	Meier	52	EaIIIn	0.0	11.5	40	106	EaIV n	11.5	-	-
195	C/1984	V1	Levy, etc.	59	EaIIIn	-0.3	9.5	70	132	EaIV s	11.5	C	L
196	C/1985	K1	Machholz	49	MbIIIn	-1.1	9.5	30	49	McIIIn	11.5	C	L
197	P/1986	J2	Machholz 1	39	MaII n	1.2	9.8	5	30	MaII n	9.0	-	-
198	C/1987	A1	Levy	42	MaII n	-0.1	10.4	90	132	EaIV n	11.2:	C	L
199	C/1987	B1	Nishikawa, etc.	66	EaIIIn	-0.2	8.8	75	124	MaIV n	11.5	C	L
200	C/1987	B2	Terasako	41	EbII s	1.2	8.0	80	31	MbII n	9.6	C	L
201	C/1987	P1	Bradfield	81	EaIIIs	-0.3	9.8	70	141	EaIV s	11.5	C	-
202	C/1987	Q1	Rudenko	61	EaIIIn	-0.4	9.7	50	123	EaIV n	11.5	C	L
203	C/1987	T1	Levy	33	EbII n	0.9	9.5	75	37	MbII s	10.2	-	-
204	C/1987	W1	Ichimura	141	MaIV s	-1.4	8.8	25	131	MaIV s	11.5	C	L
205	C/1988	F1	Levy	39	MaII n	0.2	11.2	190	39	McII s	10.0	C	L
206	C/1988	P1	Machholz	67	MbIIIs	-1.1	8.6	30	69	McIIIs	11.5	C	L
207	C/1988	Y1	Yanaka	38	MaII n	0.5	9.0	25	25	MaII n	8.8	C	-
208	C/1989	A1	Yanaka	81	MaIIIn	0.0	10.6	80	46	MaIIIs	10.7	C	-
209	D/1989	A3	Bradfield 2	41	EbII s	1.1	10.5	10	33	EbII s	9.4	-	-
210	C/1989	Q1	Okazaki, etc.	75	EaIIIn	-0.4	10.3	30	93	EaIV n	11.5	C	L
211	C/1989	W1	Aarseth, etc.	49	EaIIIn	-0.8	8.3	50	78	EaIIIn	11.5	-	-
212	C/1989	X1	Austin	83	EaIIIs	-0.3	10.6	30	96	EaIV s	11.5	-	-
213	C/1989	Y1	Skorichenko, etc.	58	EaIIIn	-0.2	10.5	60	84	EaIIIn	11.5	C	L

214	C/1990 E1	Cernis, etc.	49	EcIIIn	-0.1	9.1	110	56	EaIIIn	11.5	C	L
215	C/1990 K1	Levy	53	MaIIIn	-0.4	10.2	15	45	MaII n	10.9	C	L
216	C/1990 N1	Tsuchiya, etc.	67	EaIIIn	-0.2	8.7	80	112	MaIV n	11.5	C	L
217	P/1991 A1	Brewington	73	EaIIIs	-0.1	9.0	(190)	114	MaIV n	11.5	C	L
218	P/1991 L3	Levy	54	McIIIn	-0.3	8.5	60	61	MaIIIs	11.5	C	-
219	P/1991 N1	103P(Kryachko)	85	McIIIn	-0.5	10.5	20	86	McIIIn	11.5	-	-
220	C/1991 Y1	Zanotta, etc.	57	EaIIIn	-0.9	9.5	25	68	EaIIIn	11.5	-	-
221	C/1992 B1	Bradfield	65	MbIIIs	-0.9	10	25	70	McIIIs	11.5	-	-
222	C/1992 F1	Tanaka, etc.	37	MaII n	-0.3	9.8	5	34	MaII n	10.1	C	-
223	C/1992 J2	Bradfield	47	MbIIIs	-1.5	9.4	10	47	McIIIs	10.7	C	L
224	C/1992 N1	Machholz	30	MbII n	-0.5	9.2	55	56	MbIIIn	11.5	-	-
225	P/1992 Q1	Brewington	52	MaIIIn	0.1	11.3	40	39	MaII n	10.9	C	-
226	P/1992 S2	109P(Kiuchi)	61	MaIIIn	-0.6	10.5	20	51	MaIIIn	11.5	C	L
227	C/1992 W1	Ohshita	46	MaIIIn	0.1	10.7	55	43	EaII s	11.5	C	-
228	C/1994 G1	Takamizawa, etc.	62	MaIIIn	-0.5	10.4	25	46	MaIIIn	11.3	C	-
229	C/1994 N1	Nakamura, etc.	54	MaIIIn	-0.3	9.3	80	78	EaIIIn	11.5	C	L
230	P/1994 P1	Machholz 2	72	MbIIIn	-0.3	9.7	40	116	MbIV n	11.5	C	L
231	C/1994 T1	Machholz	80	MaIIIn	-0.2	11.3	10	70	MaIIIn	11.5	-	-
232	C/1995 O1	Hale, etc.	158	EaIV s	-0.0	10.5	110	88	MaIIIs	11.5	C	-
233	C/1995 Q1	Bradfield	33	EaII s	-0.3	5.5	65	79	MbIIIs	11.5	C	L
234	P/1995 S1	122P(Nakamura)	39	MbII s	-0.9	6.5	60	59	MbIIIs	11.5	-	-
235	C/1995 Y1	Hyakutake	54	MaIIIs	-0.5	9.9	25	47	MaIIIs	11.5	-	-
236	C/1996 B2	Hyakutake	87	MaIIIs	-0.8	10.2	20	67	MaIIIs	11.5	-	-
237	C/1996 N1	Brewington	70	EaIIIn	-0.4	9.6	45	99	EaIV s	11.5	-	-
238	C/1996 Q1	Tabur	81	MaIIIs	-0.7	10.0	35	73	MaIIIs	11.5	-	-
239	C/1997 N1	Tabur	58	MbIIIs	-0.9	9.8	20	64	MbIIIs	11.5	C	-
240	C/1997 O1	Tilbrook	73	EaIIIs	0.4	9.7	75	70	McIIIs	11.5	C	-
241	C/1997 T1	Utsunomiya	111	EaIV n	-0.3	10.0	30	96	MaIV n	11.5	C	L
242	C/1998 H1	Stonehouse	148	MaIV n	-0.3	10.7	15	109	MaIV s	11.5	-	-
243	C/1998 P1	Williams	103	EaIV s	-0.1	8.7	50	108	MaIV s	11.5	C	L
244	C/1999 A1	Tilbrook	55	EaIIIs	0.4	10.3	35	101	EaIV n	11.5	-	-
245	C/1999 H1	Lee	121	EaIV s	-0.8	9.3	30	90	MaIIIs	11.5	C	-
246	C/1999 N2	Lynn	50	EbIIIs	-0.7	7.2	45	55	McIIIs	11.5	C	-
247	C/2000 W1	Utsunomiya, etc	83	MbIIIs	-1.7	8.5	15	88	McIIIs	11.5	-	-

Table 2. List of bright comets discovered photographically

Comet	Discoverer	Time t2	E	Cl(t2)	br.	m(t2)	d	Cl(t1)	m(t1)	C	L
1. C/1906 E1	Kopff	1906 Mar	168	MaIVs	0.0	10.0	75	MaIIIn	10.8	C	L
2. P/1906 Q1	Kopff	1906 Aug	153	MaIVn	0.0	10.5	20	MaIVn	11.5	C	L
3. C/1911 N1	Kiess	1907 Jul	31	MaIIn	-0.2	6	135	EaIVs	11.5	C	L
4. P/1913 R2	Neujmin 1	1913 Sep	164	MaIVn	-0.3	10	30	MaIVs	11.5	C	L
5. D/1916 D1	Neujmin 2	1916 Feb	158	EaIVn	-0.3	10	40	MaIVn	11.5	C	L
6. C/1916 G1	Wolf	1917 Mar	79	MaIIIn	-0.3	10.5	30	MaIIIn	11.5	C	L
7. C/1922 U1	Baade	1922 Oct	98	EaIVn	0.1	10.5	110	MaIV n	11.5	C	L
8. C/1925 F1	Shajn, etc.	1925 Mar	176	EaIVn	-0.1	10.8	60	MaIV n	11.5	C	L
9. C/1930 E1	Beyer	1930 Mar	115	EaIVn	0.1	10	60	MaIV s	11.5	C	L
10.C/1935 A1	Johnson	1935 Jan	71	EaIIIs	-0.7	10.0	20	EaIIIs	11.5	-	-
11.C/1937 C1	Whipple	1937 Feb	127	MaIVn	-0.7	11	10	MaIVn	11.5	C	L
12.C/1940 O1	Whipple, etc.	1940 Aug	160	EaIVn	-0.8	10.5	15	MaIVn	11.5	C	L
13.C/1940 R2	Cunningham	1940 Sep	109	EaIVn	-0.4	10.5	25	EaIVn	11.5	C	L
14.P/1941 O1	du Toit, etc.	1941 Jul	166	MaIVn	-0.1	9.5	70	MaIVn	11.5	C	L
15.C/1942 C1	Whipple, etc.	1942 Feb	118	MaIVn	-0.5	10.0	25	MaIVn	11.5	C	L
16.C/1942 X1	Whipple, etc.	1942 Dec	139	MaIVs	-0.5	10.0	25	MaIVs	11.5	C	L
17.P/1944 K1	du Toit	1944 May	119	MaIVs	0.0	10	20	MaIIIs	11.5	C	-
18.P/1945 G1	du Toit	1944 Apr	146	EaIVs	-0.3	10	25	MaIVs	11.5	C	L
19.C/1945 L1	du Toit	1945 Jun	74	MaIIIs	-0.5	10.0	20	MaIIs	10.6	C	L
20.C/1945 X1	du Toit	1945 Dec	46	MbIIIs	-1.8	7	25	McIIIs	11.5	-	-
21.C/1946 C1	Timmers	1946 Feb	153	MaIVn	-0.1	9	70	MaIVs	11.5	C	-
22.C/1946 U1	Bester	1946 Nov	115	MaIVs	-0.1	10	80	MaIVs	11.5	C	L
23.C/1947 F1	Rondanina, etc.	1947 Mar	120	MaIVs	-0.9	10.5	10	MaIVs	11.5	C	-

24.C/1947	K1	Bester	1947	May	141	EaIVs	-0.7	11.0	5	EaIVs	11.5	C	-
25.C/1947	S1	Bester	1947	Sep	108	MaIVs	-0.5	11.0	10	MaIVs	11.5	C	-
26.C/1948	W1	Bester	1948	Nov	79	MaIIIs	0.0	7.5	30	MaIIs	10.0	C	L
27.C/1950	K1	Minkowski	1950	May	131	MaIVn	-0.3	8.0	100	MaIIn	9.9:	C	-
28.C/1951	P1	Wilson, etc.	1951	Aug	99	EaIVn	-0.2	10.0	30:	EaIVn	11.5	C	L
29.C/1952	Q1	Harrington	1952	Nov	120	EaIVn	-0.2	10.5	40	MaIVn	11.5	C	L
30.C/1953	T1	Abell	1954	Apr	63	EaIIIn	-0.4	10.5	40	EaIIIn	11.5	-	-
31.C/1954	O2	Baade	1954	Nov	81	MaIIIn	-0.1:	10.5	100	EaIIIn	11.5	-	-
32.C/1956	F1	Wirtanen	1957	Jan	57	MaIIIs	-0.4	10.0	30	MaIIs	9:	C	L
33.C/1956	R1	Arend, etc.	1956	Nov	162	EaIV n	-0.4	10.0	45	MaIVn	11.5	C	L
34.C/1958	R1	Burnham, etc.	1959	Feb	149	MaIIIn	-0.1	11.0	30	EaIIIn	11.5	C	L
35.C/1959	O1	Bester, etc.	1959	Jul	157	EaIV s	0.2	8.0	90	MaIVn	11.5	C	L
36.C/1959	Y1	Burnham	1960	Jan	61	EaIIIs	-0.4	10.5	30	EaIIIs	11.5	C	L
37.C/1961	R1	Humason	1961	Oct	153	MaIVn	-0.1:	10.5	50	MaIVn	11.5	C	L
38.C/1966	P2	Barbon	1966	Feb	131	MaIVs	0.0	9	170	MaIIn	10.0	C	L
39.C/1966	T1	Rudnicki	1966	Dec	107	EaIVs	-0.9	9.7	25	EaIVs	11.5	C	L
40.C/1967	C2	Wild	1967	Feb	111	EcIVn	-0.5	10.3	25	EbIVn	11.5	C	L
41.C/1969	O1	Kohoutek	1967	Feb	71	EcIIIn	-0.2	10.5	30	EcIIIn	11.5	C	L
42.C/1972	U1	Kojima	1973	Mar	51	EaIIIs	-0.2	9.7	80	EaIVs	11.5	C	L
43.C/1973	E1	Kohoutek	1973	Oct	37	MaIIs	-0.7	10.0	10	MaIIn	10.7	C	L
44.C/1975	V1	West	1975	Nov	67	EaIIIs	-0.3	10.5	40	EaIVs	11.5	C	L
45.P/1978	A2	Wild 2	1978	May	78	EaIIIn	-0.2	10.8	50	EaIVn	11.5	C	L
46.C/1980	E1	Bowell	1982	Jun	144	MaIVs	-0.0	10.5	120	MaIIIs	11.3	C	L
47.C/1983	M1	IRAS	1983	Sep	140	MaIVn	-0.2	10.6	40	MaIVn	11.5	C	L
48.P/1983	V1	Hartley, etc.	1983	Dec	59	EaIIIn	-0.5	10.6	20	EaIIIs	11.5	C	-
49.C/1984	U2	Shoemaker	1984	Dec	132	EaIV s	-0.3	10.2	40	EaIVs	11.5	C	L
50.C/1985	R1	Hartley, etc.	1985	Sep	144	MaIVs	-0.9	11.0	5	MaIVs	11.5	C	L
51.C/1985	T1	Thiele	1985	Oct	106	MaIVs	-0.6	11.0	10	MaIIIs	11.5	C	L
52.P/1985	V1	Ciffreo	1985	Nov	155	MaIVn	-0.5	10.5	30	MaIVs	11.5	C	L
53.P/1986	A1	Shoemaker 3	1986	Jan	150	MaIVn	-0.1	10.0	90	MaIVs	11.5	C	L
54.C/1986	P1	Wilson	1986	Aug	133	MaIVn	-0.3	10.6	40	MaIVn	11.5	C	L
55.C/1986	V1	Sorrells	1986	Dec	130	EaIVn	0.0	10.2	40	MaIVn	11.5	C	L
56.C/1987	U3	McNaught	1987	Oct	51	EaIIIs	-0.4	9.5	40	EcIIIs	11.5	-	-
57.C/1987	W2	Furuyama	1987	Nov	161	MaIVn	-0.2	10.5	30	MaIVn	11.5	C	L
58.C/1988	A1	Liller	1988	Jan	60	EaIIIs	-0.4	10.2	45	EaIIIs	11.5	-	-
59.C/1989	R1	Helin, etc.	1989	Nov	43	EaIIIs	-0.5	10.2	30	EaIIIs	11.5	C	L
60.C/1991	A2	Arai	1991	Jan	151	MaIVs	0.0	10.1	30	MaIVs	11.5	C	L
61.C/1991	B1	Shoemaker, etc.	1992	Jan	68	McIIIn	0.0	10.0	35	MaIIIn	11.5	C	L
62.C/1991	F2	Helin, etc.	1991	Dec	57	MaIIIs	-2:	9.0	10	MaIIIs	11.5	C	L
63.P/1991	V1	Shoemaker, etc.	1991	Dec	137	EaIVn	-0.2	10.5	30	EaIVn	11.5	C	L
64.C/1991	X2	Mueller	1992	Feb	110	EaIVn	-0.8	10.4	15	EaIVn	11.5	C	L
65.C/1993	A1	Mueller	1993	Sep	74	MaIIIn	-0.4	10.5	35	MaIIIn	11.5	C	L
66.C/1993	Q1	Mueller	1993	Nov	111	EaIVn	-0.3	10.5	40	EaIVn	11.5	C	L
67.C/1993	Y1	McNaught, etc.	1994	Mar	66	EcIIIs	-0.8	9.5	30	EaIIIs	11.5	C	-
68.P/1994	A1	Kushida	1994	Jan	140	MaIVn	-0.2	10.2	60	MaIVn	11.5	C	L
69.C/1994	J2	Takamizawa	1994	May	145	MaIVn	-0.3	10.2	40	MaIIIn	11.5	C	L
70.C/1996	B1	Szczepanski	1996	Jan	109	MaIVn	-0.4	9.0	70	MaIIIn	11.5	-	-
71.C/1996	E1	NEAT	1996	Jul	35	EaIIn	-0.2	9.8	30	EaIIn	10.5	C	L
72.C/1996	R1	Hergenrother,etc.	1996	Sep	133	MaIVn	0.1	10.5	20	MaIVn	11.5	C	L
73.C/1997	J2	Meunier, etc.	1998	Jun	88	MaIIIn	0.0	10.6	75	MaIIIn	11.5	C	L
74.C/1997	K2	SWAN	1997	Jun	85	MaIIIs	-0.3	10.0	40	MaIIIs	11.5	-	-
75.C/1998	J1	SOHO	1998	May	20	EbI s	1.5	3	10	MbIn	0.0	-	-
76.C/1998	M5	LINEAR	1998	Dec	65	EaIIIn	-0.1	10.5	80	EaIVn	11.5	C	L
77.C/1998	T1	LINEAR	1999	Jun	90	MaIIIs	-0.5	10.0	25	MaIIIn	11.5	C	L
78.P/1998	U3	Jager	1998	Nov	110	MaIVn	-0.3	10.5	30	MaIVn	11.5	C	L
79.C/1998	U5	LINEAR	1998	Nov	120	EaIVn	-0.5	8.5	15	EaIIIn	11.5	C	L
80.C/1999	J3	LINEAR	1999	Aug	46	EaIIIn	-1.0	9.5	15	EaIIIn	11.5	C	L
81.C/1999	S4	LINEAR	2000	May	35	MaIIn	-0.8	8.8	10	MaIIn	9.6	C	L
82.C/1999	T1	McNaught, etc.	2000	Jul	65	McIIIs	-0.3	10.5	30	McIIIs	11.5	C	-
83.C/2000	S5	SWAN	2000	Nov	44	EbIIs	1.0	8.5	10	EbIIs	7.5	C	L

Fig.6 shows a histogram of visual telescopic comet discoveries, partitioned into 10 degree elongation intervals. As is seen from the distribution, the peak of comets is observed at elongations between 40 and 70 deg. Comet discoveries abruptly drop off outside of 100 deg.

Fig 6. The distribution of the comet elongation at discovery.
A histogram of all visual telescopic comet discoveries partitioned into 10 degree elongation intervals.

Fig 7. Plots of the relative positions of comets with respect to the Sun one month before and at the time of their discovery (black points).
The field shown is for elongations to about 90 deg.

Fig.7 shows the positions of the comets and the directions of their movement at the time of discovery. Given in the tables are the number statistics, or the distribution of the comets in various groups. We clearly see in the figure the two clusterings of the comets, one at elongation of about E=30-40 deg in the morning sky and the other at about E=60 deg in the evening sky. The morning sky clustering is more pronounced, and this is due to a steeper rise in the brightening rate. The average for morning discoveries (Group) M is a brightening of -0.52 mag per 10 days. The average for evening discoveries (Group E) is a brightening of -0.20 mag per 10 days, so the average comet found in the morning sky is brightening 2.5 times faster than the average comet found in the evening sky. Before perihelion in the morning sky the earth is, on the average, moving towards the comet and in the evening sky the earth is often moving away from the comet.
Of the 330 comets considered, 197 comets, or 60 %, were detected (or would be detected) in the morning sky (Group M) and 133 comets, or 40 %, in the evening sky (Group E) at the time of discovery (t2). For the time when a comet becomes discoverable (11.5 mag), t1, the results are similar: 210 comets fall into Group M (64 %) and 120 comets into of Group E (36 %).

According to Everhart (1967a), the percentage of the comets discovered at the moment t2 over the period 1840-1967 is similar to our results: 61 % and 39 % for Groups M and E, respectively. However, for the moment t1, Everhart gives quite different numbers of the comets which could have been detected in the morning sky: 70% of the direct and 81% of the retrograde comets (about 76% and 24% for Group M and E, respectively).
One of the reasons which can cause this difference might be in different evaluation of visibility conditions during the period of brightening.
Of particular note in this regard is that, according to both Everhart and our results, the discovery probability in the morning sky is larger for comets moving in retrograde orbits than for those with prograde motion.

To arrive at a more exact than in the present work number statistics of comets discovered in both the morning and the evening sky, the following factors should be taken into account:

- reliability of the photometric parameter n for a given comet;

- brightness of the sky influenced by different phases of the moon;
- comet detectability at different altitudes above the horizon and effects of atmospheric extinction;
- rapid brightness variations of some comets;
- difficulty of discovery a comet in the Milky Way areas.

Table 3. The distribution of the comets by their elongation at the moments t1 and t2

Group	N(%) at t1		n	s	N(%) at t2		n	s
M I	8	(2%)	4	4	6	(2%)	4	2
M II	45	(14%)	28	17	58	(18%)	33	25
M III	88	(26%)	53	35	86	(26%)	42	44
M IV	56	(17%)	30	26	60	(18%)	36	24
E I	3	(1%)	0	3	0	(0%)	0	0
E II	22	(7%)	11	11	12	(3%)	7	5
E III	65	(20%)	41	24	62	(19%)	31	31
E IV	43	(13%)	24	19	46	(14%)	25	21
Total	330	(100%)	191	139	330	(100%)	178	152

As is apparent from the Table 3 that highest probability to discover new comet by visually means is in zones MIII (26%), EIII (19%), MII (18%) and MIV (18%). If a new comets of Group MIII were discovered almost every year, comets of Group EI were discovered, on average, every 33 years.
The number of comets discovered in the northern ecliptic hemishere is 1.4 times higher than in the southern ecliptic hemisphere.

Table 4. The distribution of the comets in three groups of different movement relative to the sun.

	t1		t2	
M a	159	(48%)	168	(51%)
M b	22	(7%)	18	(6%)
M c	16	(5%)	24	(7%)
E a	101	(31%)	103	(31%)
E b	19	(6%)	7	(2%)
E c	13	(3%)	10	(3%)
Total	330	(100%)	330	(100%)

We can see from Table 4 that about 80% of all comets had movement to west relative to the sun (comets of Group Ma and Ea) near the discovery moment and only about 13% had the movement in contrary direction (comets of Group Mb and Eb).
Normal EaIII comet before discovery could be as:
MaIV (11.5 mag) at t1 then, EaIV (11.0 mag) and at t2 EaIII (10.5 mag).
Normal MaIII comet is often as:
EaIII (11.5 mag), then EaII (10.5 mag) and at discovery time MaII (8.0 mag).

Table 5. Number statistics of the comets which were discovered (Cols.2-4) or missed (Col.5) in the period 1901-2000

Decade	N (vis)	N (phot)	Total	N(missed)	d*
1901-1910	25	2	27	25	54
1911-1920	24	4	28	27	66
1921-1930	22	2	24	31	66
1931-1940	18	3	21	34	67
1941-1950	18	15	33	22	46
1951-1960	21	10	31	24	59
1961-1970	26	5	31	24	47
1971-1980	28	4	32	23	39

1981-1990	31	14	45	10	42
1991-2000	34	24	58	2	35
Total	247	83	330	222	

* d is the factor of visual detectability defined as the average span (in days) between t1 and t2 over a decade (see Table 1 and 2).

As it can easily be seen from the Table 5, the average discovery rate was nearly constant up to 1980s.However we can notice that few people were hunting for comets during the World Wars, for example, and that good searching instrumentation is much better and cheaper (and thus easier to obtain) today than it was half a century ago or more, a big issue for amateur astronomers. There is also a difference in types of photographic surveys, with the big Schmidt telescopes that became available in the middle part of the 20th century being much more adept at discovering comets than the earlier photographic refractors and astrographs, with their wide fields and fast optics. And the emulsions became much better in the second part of the 20th century, allowing surveys to go fainter. But during the last two decades, due to numerous Mount Palomar photographic searches as well as to efficiency of CCD means the number of discoveries has reached a saturation, i.e. about 58 visually discoverable comets per decade. However, it seems unlikely that we are finding all of the potentially discoverable bright comets. C/1997 K2 and C/2000 S5 SWAN comets are an example of a comets which probably brightened to 9 magnitude and escaped detection by amateur and CCD observers. NEO CCD surveys are not optimazed for comet detection. Most of objects that become bright enough for visual observation have relatively small perihelion distances and hence fast rates of motions, some can be "missed" by LINEAR or other survey. Also a look at the sky coverage plots shows that LINEAR doesn't always cover as much sky as they should. This is usually due to weather especially during the summer monsoon season. So there is ample time for some comets to slip by.

If to assume for each of the decades considered the same rate of comet's passing a perihelion (58 comets per decade), we can evaluate the number of comets which were missed by visual observers. As can be seen from Col.5 (Table 5), a total of 222 comets (40 %) might have additionaly been detected throughout this century.

The factor of detectability, d, correlates with the number of comets which could have been, but, unfortunately, were not, observed (Col.5). However, the analysis of comet light curves shows that about 15% of comets survive sudden changes in their brightness. For such comets both the factor d and the computed brightening rate are slightly incorrect.

By using the LINEAR telescope (1.0 m f/2.2+CCD), 221 comets or 67%, would have been discovered out of the whole number of comets under consideration (see columns "L" in Tables 1 and 2, see for example Fig. 8). However, LINEAR in fact does not notice that the majority of their discoveries are cometary. Most LINEAR discoveries are reported as simply asteroidai objects, and cometary activity is ascertained when the motion is noted to be sufficiently unusual that they become posted on NEO Confirmation webpages so that other observers look more carefully at them. But comets with little activity (and reported as asteroidal by LINEAR) that do not have such unusual motion will remain undetected. It is thought that a fair number of additional LINEAR objects might be comets, masquerading as minor planets due to short arcs of observation.

Fig 8. A plot of pre-discovery data for C/1990 E1 (Cernis-Kiuchi-Nakamura).

Visual magnitude, M, versus solar elongation for the comet.
The intervals between adjacent points refer to 15 days. The cross is for the discovery moment. When the comet reached magnitude 17 it would have been discoverable by LINEAR program for about a year when E>90 deg.

Fig 9. A plot of pre-discovery data for C/1998 J1 (SOHO). Visual magnitude, M, versus solar elongation for the comet. The intervals between adjacent points refer to 15 days. The cross is for the discovery moment.
When the comet reached 18 magnitude it had large elongation (90-120 deg) for 5 months. But its declination south of -30 deg was too low for the treatment with the LINEAR program. When the comet reached visual limit (10-11 mag) it had too small elongation (about 20 deg) to detect it from ground based observatories.

In many cases when comets reached large elongations (90 to 120 deg), its declination south of - 30 deg was too low for the treatment with the LINEAR program (see for example Fig.9).
The use of CCD means can ensure a much greater number of comets which will be detected from both hemispheres: 267 (81%) comets (columns "C" in Table 1 and 2).
It should be noted, however, that only the comets brighter than mag 18 with elongations >90 deg were included into my analysis. This is because most of the successful CCD and/or photographic searches are focussed on such elongations. I assume here that the comets with their apparent magnitude brightening to visual detectability limit (10-11 mag) and which are at elongations smaller than 90 deg can be detected by neither CCD nor LINEAR means. The number of such comets in our survey amounts to 63 (19%) and these are marked in Tables 1 and 2 by "minus" signs.(The "minus" signs appear in the last two columns of Tables 1 and 2.)

CONCLUSIONS

After analysis of prediscovery positions of more than 329 comets, the following conclusions have been reached:

1. The best searching sky areas for discovering of new comets with CCD and photography are zones of comets of Groups M III and M IV in the morning sky when a comet is before its opposition. For more efficient comet searching it is necessary to install a CCD program observatory like the LINEAR project in the southern latitudes and observe more near the sun (E about 50-180 deg).
According to Marsden (1994), CCD searches at small elongations from the sun have several advantages over photographic searches, and the experience of the visual searchers suggests that it will be essential to experiment at small elongations.
Another problem is searching for comets in the Milky Way regions and small field of view using CCD devises.

2. Visual detectability of the comets depends on how favorable the configurations are when q is small. In some cases the configuration sun-earth-comet is such that the comet can be detected only at small elongations, and not earlier. Nearly all the brightening time such a comet spends near the horizon. Naked-eye objects (Group I) and bright telescopic comets (Group II) are still being discovered in the morning predawn and

evening dusk skies. Visual discoverability also depends on comet's absolute magnitude and inclination of the orbit. Comets with bright absolute magnitudes (Ho < 5) are often discovered far from the Sun (Group IV).

According to Everhart (1967a) and our results the eastern morning sky is better than the evening sky, with a discovery probability higher by a factor of 1.8-2.0.

The evening comets are usually discoverable shortly after Full Moon (4-14 days), meanwhile the morning comets are most frequently discovered from one week before New Moon to few days before Full Moon.

Analysing the frequency of visual telescopic comet discoveries versus time of year there are some maximum in autumn months. Explanation for it would be in part high ecliptic position in the morning sky for northern observers. One must also consider weather factors (summer has short nights that are often hazy; winter nights can be very cold and dampen enthusiasm for visual hunters; etc). We do not know: what effect does snow cover have at mid-northern latitudes in the winter by brightening the sky significantly? Other question is: what effect has light pollution had during the course of the 20th century? D. Green thinks that light pollution must have a pronounced effect on comet-discovery statistics at some level and light pollution is less of a factor when there is no snow and when there are leaves on the trees.

For large-reflector comet search programs at their mean discovery magnitude, M=11-12, more efficient are the areas for the hemisphere east of the opposition in the morning sky because of the motion of the earth.

Visual observing is efficient for comets of Groups I and II as well as for catching the fast nearing us comets in the zone of Groups III and IV. Some of the comets show a very rapid brightening rate. Retrograde comets unfavorably situated with respect to the earth are more easily detected, because they remain at small solar elongations at shorter time intervals. It is advisable to sweep zones of Groups MI and MII every night, and zones of Group MIII and EIII every five days. For comets of Group IV it is advisable to sweep the whole sky once a month, during dark-moon periods. An improvement would require a more organized effort, with different areas of the sky surveyed with 25-40 cm telescopes simultaneously by a number of observers. A similar program (with 10 cm binocular telescopes) was undertaken in Skalnate Pleso observatory. The operation lasted 14 years (1946-1959) and produced 18 discoveries by five observers.

3. Comets are observable visually at heliocentric distances of a few AU. The great majority of comets with faint absolute magnitude are such that they remain undetectable even when they are passing perihelion at 2 AU from the sun.
It would be interesting to analyze the selection effects introduced by absolute brightness, perihelion distance and inclination of the orbit. The first two parameters determine the apparent magnitude of the comet (Everhart, 1967b; Kresak, 1982), which is dominant factor for the detectability of a comet.
According to Kresak (1982), a new comet passes the limit of M=10 every four months (brightening for example from 11 to 9 mag). Our study confirms this conclusion. It has been obtained that correcting for the effects of incompleteness, this passing shortens to every two or less months.

Nearly all of the comets with Ho<8-10 inside the Venus orbit can be easily detectable by modern equipment of potential discoveries.
J. Bortle (1991) showed that very few comets with q< 0.5 AU and Ho>8 actually survive their perihelion passages.

As regards the distances between the Earth and Mars, the completeness of comet discoveries, however, drops considerably (see Fig.10).

4. We see more visually discovered comets denoted with the letter "n". This apparently results from the better coverage of the northern hemisphere by comet visual searches.
It should be noted that after 1965 the activity of comet hunters in the northern hemisphere fell off somewhat in Europe but bursted in Japan

and USA. Most active visual comet hunters were M. Honda, A. Mrkos, L. Peltier and other observers. From the southern hemisphere, the grasp of new comets is less numerous. The number of comet discoveries made in South Africa clearly diminished, meanwhile the Australian comet hunters raised considerably their activity. On the whole, the number statistics of comet discoveries is much more favorable for the northern hemisphere than for the southern and this is due to uneven distribution in geographic latitudes of potential observers.
According to my estimates, the northern sky visual surveys are ten times more intensive in comparison with the southern ones. There are no southern-hemisphere CCD searches for near-earth objects (NEOs) in 2000. NEO surveys that discover most of the comets nowadays LINEAR, Spacewatch, NEAT, LONEOS are situated in the northern latitudes.
There were the periods during which discoveries from the southern hemisphere were completely lacking (1948-1963) and the periods during which they were rare (1907-1918 and 1930-1940). A considerable improvement of this situation is mainly due to active visual comet hunters from southern hemisphere as W. Bradfield, Reid, Skjellerup and other observers.

Fig 10. The distribution of perihelion distances for 20th-century comets discovered visually plus those that eventually reached mag 10-11. As seen from the distribution, the peak of perihelion distances is observed at q=1.0-1.2 AU. The completeness of visual discoverable comets with a large q drops considerable.

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But that didn't stop Levy. With five telescopes on the night skies, his October discovery also has a meaning. While the comet will not collide with Earth, Levy said it will come back around again some time in 2011 and be visible in the sky.

The comet is located at a prime space between the earth and the moon, which is a good location for experts to study a comet more closely. However, Levy, 59, said he doesn't know what experts will do with the information.

Levy [illegible] in his backyard in Vail. He has lived in the Corona and Vail areas for the last 30 years. He has what looks like a small mobile shed with a retractable roof. Inside are five telescopes. While Levy searches the sky manually through one of the bigger telescopes, the other four scan the skies and feed information into computers.

When asked what the key to discovering a comet is, Levy said it just comes down to knowing the sky.

"You choose a portion of the sky and move from one field to the next knowing a comet could be in the next field," he said.

Levy said he got started when he was 8 and bored at summer camp. He recalled watching the July 4 fireworks, but what made an impact was what he saw driving home later that night.

"I saw a shooting star on the way home and that called to me," he said.

Discovering comets came years later when he was at another summer camp.

"We were given a project and told that it could be something that could take us a lifetime and also told it could be a challenge we failed at," he said. "A month later it hit me that I could search for comets."

Levy recalled that at 17, on Dec. 17, 1965, he got a telescope out that he had used when he was younger and started his search. His first discovery came 22 years later in his back yard in Corona De Tucson.

Levy, who was an English literature major in college, said he will still continue to scan the skies, but he is also looking at the past. He is writing a doctoral thesis on what the skies were like in the days of William Shakespeare.

"It's one thing to know the sky now, but what about then? This paper will be based on images described in the writing of William Shakespeare," he said.

The project has already taken nearly six years, with Levy hoping to have it finished this year.

In the future, Levy said he hopes to teach both English literature and astronomy.

"I feel that the work that I do gets young people interested," he said. "Not necessarily to become astronomers, but to have an interest in the night sky. It gets you outside and allows you to see the environment in which we live."

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ruby wrote on Mar 6, 2008 3:49 PM:
" your the best at comet discoveries "

Annett wrote on Mar 20, 2008 4:29 AM:
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keep up the great work. will soon be back to visit again.

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All the best Jack & Annett

Review of David Levy's Guide to Observing and Discovering Comets

A Comet Hunting Guide from a Master

David H. Levy is one astronomer who bridges the gap between science and the arts. One of the most successful comet hunters in history, he is pursuing a Ph.D. in literature at the Hebrew University of Jerusalem; a recent book of his is about how astronomy is presented in poetry. Several of his 29 books have been about comets, but *David Levy's Guide to Observing and Discovering Comets* ($17.00, Cambridge University Press) is his first to go into detail about techniques to view and hunt them. It is an informative and fascinating book, peppered with anecdotes and literary references, that captures not only the nuts and bolts of comet hunting but also its spirit, as Levy tries to instill in the reader the joy and thrill of searching the night sky for these elusive objects.

Levy provides a history of cometary study, starting with the Roman writer Lucius Seneca, who was put to death by his emperor, Nero. Seneca's writings are a compelling look into early thinking about comets. Levy includes brief biographies of many of the most notable comet hunters: Charles Messier, who in 18th-century Paris became the first to systematically hunt for comets by telescope; Jean-Louis Pons, Messier's "successor", whose 26 comets is second only to Carolyn Shoemaker on the all-time list; Caroline Herschel, the comet hunter in a family of famous astronomers; William R. Brooks and Edward Emerson Barnard, rival American comet hunters in the late 1800s (Brooks, an upstate New Yorker, is tied with Levy for third among comet hunters with 21); and various 20th-century comet hunters in America, Japan, Europe, and Canada. Levy tells how a colleague of Barnard's had perpetrated a hoax by convincing a San Francisco newspaper that Barnard had devised an automated telescope that would track down comets while he was asleep, and set off an alarm when it found one. It took two years for Barnard to prove to the paper that they had been deceived and get them to print a retraction.

Levy has extensive experience in hunting comets visually, photographically, and electronically through CCD imaging, and he provides a detailed account of his work with each of these methods. He started visual comet hunting in 1965, and found his first in 1984, after 917 hours of searching. By 1989 that year he joined Gene and Carolyn Shoemaker in photographically searching for comets with an 18-inch telescope at Mt. Palomar. Among the comets he co-discovered with the Shoemakers was Shoemaker-Levy 9, which collided with Jupiter in 1994. Although he hasn't found a new comet in almost a decade, he still regularly hunts for comets both visually and as part of a CCD project to find comets and asteroids—the Jarnac Sky Survey—he conducts with his wife, Wendee.

The book includes pointers on how to find comets by each of these methods (and how to report a suspected comet), as well as a section on finding SOHO comets that includes pointers by several of the most successful SOHO comet hunters. Levy also details his efforts to try to find a comet "on paper". Clyde Tombaugh, discoverer of Pluto, had told Levy of a comet he had detected, but never reported, in Lowell Observatory images in the 1930s. Levy searched Lowell's photo archives, and found three images of the comet from January 1931. For an orbit to be calculated and it to be officially recognized as a comet, more images need to be found, and Levy has searched other observatory archives, and even published an article on the object in an effort to find more images, so far without success.

Levy reflects on the future of visual comet hunting. Despite the encroachment by professional sky surveys, which will make amateur comet hunting all the more difficult as time goes by, he believes there will always be comets for amateurs to find visually, though it may take decades for some searchers to find one. He thinks that amateur CCD sky surveys, which found two comets in 2002, will continue to be fruitful.

The book also has detailed instructions for people interested in observing comets, drawing and photographing them, and measuring their size and magnitude. There is an appendix consisting of Levy's list of 220 "comet masqueraders and other interesting objects". It contains some Messier objects but also many less-well-known objects; those that look particularly cometlike are marked with an asterisk.

I noticed two errors in the text. On page 39, Levy blends the description of the Great Comet of 1882 with that of another bright comet seen the previous year, as if they were the same object—a particularly surprising error as the 1882 comet is especially famous, in fact the brightest comet on record. On page 81, he incorrectly states that XingMing Zhou uses a 6-inch reflecting telescope to search for SOHO comets. (Zhou does use such a telescope, but to hunt for comets in the night sky.) Nonetheless, these errors do little to detract from a lucid, comprehensive, and inspiring handbook for amateurs interested in conducting their own comet searches.

To My AstroWeb

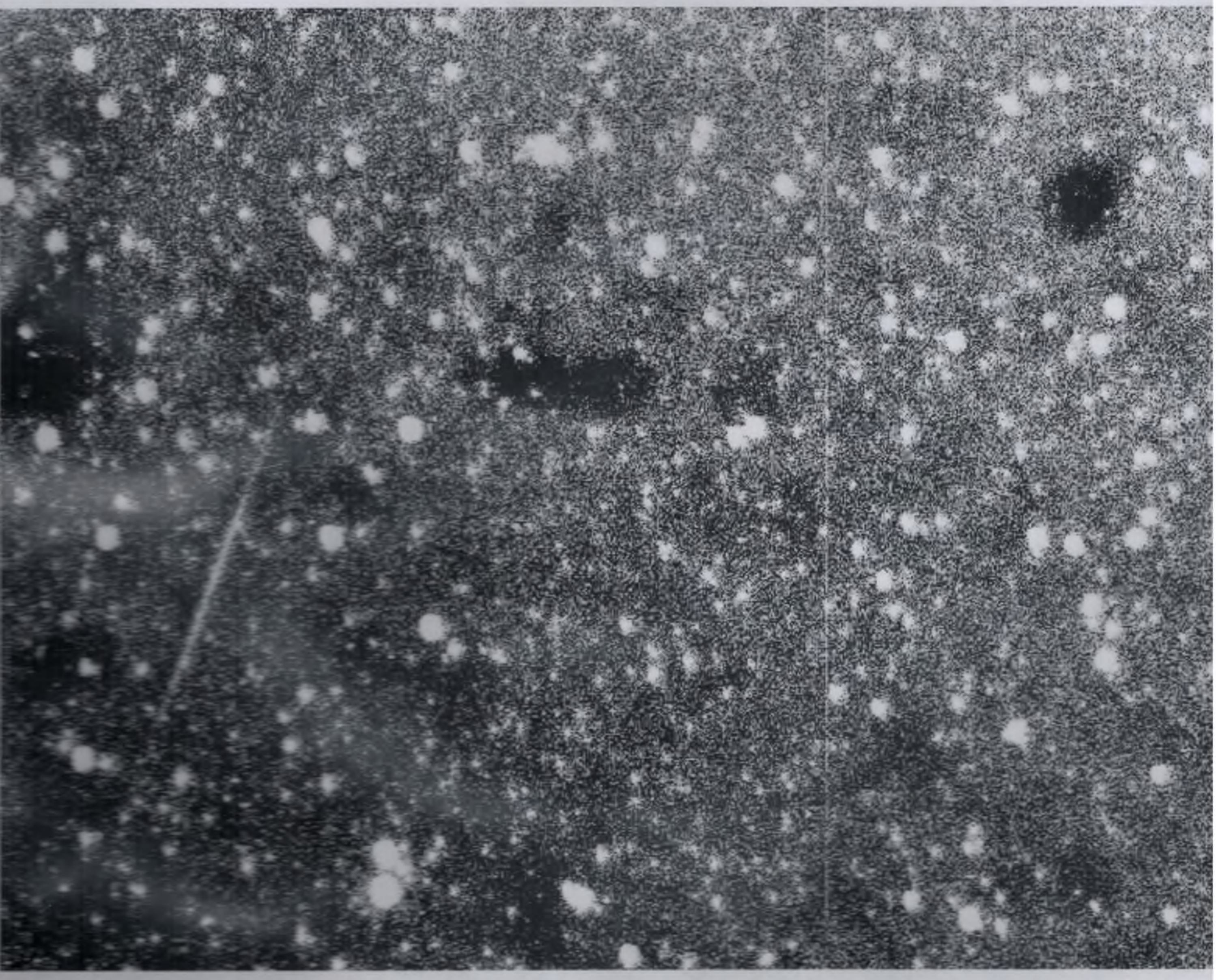
CN3N-11.
Comet hunting the Bart J. Bok way—reminding us the we need to look up at the sky, just look, to make sure we're making bloody sense.

Begun on Friday, December 17, 2010.

CN3011

A meteoric meteor!.

May 2015.



Chapter Seven
Putting the S in UNESCO

"UNESCO ... is not a little mental Security Council that comes running with a first aid kit to patch up each threat to the peace. It is the organization that looks into the basic causes for war and suggests remedies for their removal."

Bart Bok, 1949. [1]

With the end of the war in Europe, Bok's quiet international newsletter operation had grown into a major effort with the news that a new type of organization-- the United Nations Educational and Cultural Organization (UNECO)-- would be formed as part of the United Nations to help rebuild devastated countries through the transfer of technology and education. During the war years, Bok had worked with the Boston-Cambridge Branch of the American Association of Scientific Workers, consisting largely of people at Harvard and MIT, to propose a similar post-war institution to use the world's scientific resources in this way.

Not surprisingly, Bok strongly supported the United Nations idea but insisted that "there should be an 'S' in UNECO." By the end of the war the AAScW had lost much of its effectiveness, each of its various members pursuing separate directions. Besides Bok, chemist Isadore Amdur was the only AAScW member really pushing the UNESCO idea. The two scientists mounted a campaign that included articles and letters. At first their work met a brick wall: one official from American Association for the Advancement of Science even warned Bok that he was premature in thinking about international relief efforts in the closing months of the war and that the AAAS would not support any such plan. After those heady early days in the late thirties, it seemed as though the AAScW was dead, and so might be the idea for a post-war international scientific organization.

By the opening day of the April-through-June 1945 San Francisco conference to draft the United Nations Charter, the title and purpose of UNECO were still in dispute. With some members opposing even the inclusion of the word "education," it looked as though the science

Poem 103, I am like a slip of comet

More than any other poem by ~~any~~ a Victorian writer, "I am like a slip of comet" shows that its author had a penetrating insight into space science. Even a brief glance ~~at~~ shows that Hopkins knew that com[ets] ~~from come from deep space (line 4)~~ "come out of space", and are ~~usually~~ normally faint when discovered. He ~~was also~~ also kn[ew] ~~aware~~ that ~~it is sunlight~~ as it approaches the s[un] sunlight causes a comet to glow and to sprout a coma and tail, and that after its encounter it returns to "the cavernous dark."

That Hopkins' fascination for comets lasted his lifetime can be found in a perusal of ~~his~~ his private writings. The Journ[al] for July 13, 1874 contains his impression of what m[ust] have been Coggia's comet:

"The ... threatening." [footnote on shuttlecock] OED: The shuttlecock is a small piece of cork or similar light material fitted with a crown or circle of feathers ... in the game of battledore + shuttlecock, + also in badminton.

A year later, he wrote to his mother concerning a possible new comet discovery "I have seen one three nights ... in Cancer. It is small and pale but quite visible. If it is not a comet it must be a nebula + then it is strange I should have noticed it before. ~~It~~ at 10:00 it is well visible in the northeast, not high, ... it would be higher. In his ~~ne~~ following letter, he ...

There is n ... confirmed his sighting H had no reason for thinking wh...

...ge. ~~The beehive cluster in Cancer~~. When ...

* The reference to Gideon's fleece is from Judges ~~7:14, 18 & 20.~~ 6:36 – 37:

Judges 6:36

Then Gideon said to God, "If thou wilt deliver Is.... behold, I am laying a fleece of wool on the threshing floor; if there is dew on the fleece alone, and it is dry on all the ground, then I shall know that thou wilt deliver Israel by my hand, as thou hast said." And it was so. When he rose early next morning & squeezed the fleece, he wrung enough dew from the fleece to fill a bowl with water.

~~and~~ ~~There~~: In ~~his later~~ "lines for a Picture of St Dorothea", written al writings H leaves us a hint of his thinking on the odd analogy of ~~a~~ comp comet's soaking up light with a fleece trying to soak dew:

In starry, starry, shire it grew:
Which is it, star a dew? This appears ag in 1881:

** ~~This~~ From accounts in both the Times and & a very extens ~~-ive~~ article in the Review, there is absolutely no question that comets come out of space. But, ~~both articles~~ th point out that the Aristotelian view that comets are created in the upper atmosphere was accepted ~~in~~ the time of Florus of Italy, so that H would have had to include the outdated view of "sudden engender'd / By heady elements." in this speech

7EL3 157. Just continue . . . .

8EL, 238: ___________

CN3p designated December 17 2013

Letters to Nature.

These form an interesting + unusual part of Hopkins' legacy for Nature was (and is) one of the most respected scientific magazines, and he may be the only great EP to have been published in such a magazine. Most of the letters concern "cloud-like shapes" in the sky that may involve volcanic eruptions.

The references are here listed; including a ~~result~~ to one of them which has apparently not been collected

4LN/A: 16 Nov 1882

5LN/B: 15 Nov 1883.

6LN/C: 3 Jan 1884, – not a letter but a full article

7LN) A newly collected letter, in October 1884[1] makes the startling, and scientifically provable conclusion that Krakatoa's "volcanic wreck had become . . . . . one."

[1] P.M Ball, The Science of Aspects: The Changing . . . Hopkins. London, Athlone, 1971 p. 150.

8LN- ___________

This letter

→ Nat. Oct 30 1884 xxx P633

To Patmore's ~~demerit~~ discredit, he did not accept ~~G.M.H.~~ H–
[ad]vice to clarify this image, and his poem ~~surely~~ suffer[s]
[for] it, while Hopkin's own Comet poem, when studied
closely is in a very clear focus.

The fragment involves Hopkins had in mind a composite of at least two comets of which that 1861 predominates. ~~This is probably~~ That Hopkins refers to a compo[site] of at least two comets, of which 1861 predomina[tes] will be shown.

The ~~persona~~ speaker ~~in this poem is~~ compares herself
to a "slip"[15] ~~of~~ of a comet, which at discovery is scarcely
worth ~~noticing~~ a look.

In some "corner" seen ~~could~~ ...
~~be~~ ~~say~~ implies what ~~he~~ ~~later~~ his 1872 he would call a "bay" (cf. —)
~~a section~~ of the sky, ~~perhaps~~ ...
~~development~~ of his concept of "bays" ~~of~~ ...
(cf. —). ~~That surfaces in 1872 (cf. —)~~

The third line ~~suggests~~ points to a particular comet, but
~~at~~ at this stage of research I am unable to ~~pinpoint~~ show
one with ~~any~~ confidence. An ~~exhaustive~~ check of
GMH's likely sources, including the Times, Illustrated L.N.,
even Cornhill Magazine, turned up nothing ~~positive~~ ...
other sources rejected both the Comet of 1861 ~~;~~ & the comet of 1862
~~which was~~ ...
bright ~~unusual~~ object was discovered in Wales by Tebutt
and rapidly moved northward so that its first appea[rance]
in England was an explosive one.

Donati's comet of 1858 remains a likely possibilit[y]

15OED: An example or specimen of something having an elongated or slender form 1730.

development of ~~the~~ ~~to~~ coma and tail of but with sudden irregular gushes of gas from the head. Both Donati's and 186 exhibited this feature but for two reasons I ~~the~~ consider this line to refer to the latter. First, ~~the~~ the several gaseous enve of Donati's comet were released at irregular intervals while observers ~~ca~~ watched the 1861 comet shed eleven envelopes of gas at the fairly regular rate of one every two days. The rhythm of this part of the poem —

"while her central star
Shakes its co coon ing mists"

— also suggests that the shaking occurred at regula intervals.

The ~~reference~~ use ~~is~~ in line 11 of Gideon's fleece re ~~is superficially odd since the~~ the biblical passage con a lamb's fleece that soaks up dew: * now quote.

Her tether, ~~a one-word summary of orbital mechanics"~~, causes the comet to "shred her smock

As her "tether," (a one word summary of her or mechanics)" calls her, she shreds her coma, tail, her mists" now ~~becoming~~ called a "smock". —

Her "tether" is / The OED defines its use as "the limit." ~~She leaves the~~ c
as she "falls off" she

tether
slip

SOED: 'The cause or measure of one's limitation; t one's field of action; scope, limit. 1579

Save. 10. [ast.] To s. the appearances, said of a hypothesis which explains all the observed facts - 1667. - to contrive to keep up an appearance.

~~One other possibility.~~

~~But~~ there is another idea. Since in the R. stars and planets were used interchangeably, could not "slender distance" refer to the long, thin path between the orbits of two distant planets, ~~the~~ along which the comet must travel as it approaches the sun? ~~The answer is no, because the following lines suggest that~~ ~~"roman lines 4 and 5 suggest becau~~ This would be possible only if this thought is to be united with "Come out of space", and juxtaposed against the alternative that comets could have been formed "by ... ~~Otherwise.~~

~~The more so common~~ I would suggest that ~~alternate~~ reading would be to end the first thought ... ~~the poem~~ the opening these lines would read that ... ~~scene~~ with discovery; either it comes out of ... ~~bridging~~ the slender difference of the orbits ... ~~—~~ it is suddenly born in the atmosphere ...

B.

The second, and more likely reading, would end the first thought at the word "stars", putting us ~~put us~~ back on the search for two real stars; ~~we~~

"I am ~~so~~ very faint when seen ~~tho~~ in a corner of space between two ~~little~~ stars. I may have come from space or could have been suddenly born in the atmosphere."

Will ~~poems~~ #7 "A vision of the Mermaids help on this line? As the ~~s~~ speaker looks on the water in this poem he is aware of "something . . . . air and more ... eyes. In this context the two stars seem to be ~~indeed~~ two real stars, with little planets forming around them.

ARJ P170 July 9, 1868

Before sunrise looking out of window saw a noble scape of stars – the plough all golden falling, Cassiopeia on end with her bright quains pointing to the right, the graceful bends of Perneus* underneath her, and some great star whether Capella or not I am not sure risen over the brow of the mtn. Sunrise we saw well...

(*he means Perseus)

? → [Is missp. in text or in ms.

(look up diamond) Unless we ~~accept~~ consider earlier – diamond wells "thrown down" in line, brings the dark earth on

~~In dim woods~~, the diamond delves. ~~seems~~ could to refer to the wealth of stars even in a dimly lit section of the sky, but one wonders if a reference to Orion hunting in the woods might be intended also esp. as Orion would have dominant const. ~~in the sky~~ at t the poem's ~~composition~~ writing the mid

(Put 9B here now)

The Starlight Night ~~would~~ was written in a tir of intense appreciation not only of God in Natur as many critics argue, but also of nature in n a year earlier he had ~~ex~~ thought ~~he~~ to exper the ~~the comet-hunter's~~ thrill of discovering a comet in Cancer (cf. const. sectn) and in only one week af he drafted the poem and before sending it to his mother he ~~almost missed~~ an eclipse of the moon / was very disappointed at almost having mi

or if the "dim woods" could ~~mean~~ although of leaven

SN

(cf p. 10) 96.

In describing this poem, ~~more than one~~ at least four critic~~'has~~ would have ~~his~~ their readers refer to his Journal entry of Aug 17, 187

ARJ254. 8/18/74

As we drove home the stars came out thick. I leant back to look at them & my heart opening ~~them~~ more than usual praised our Lord to and ~~or~~ in whom all that beauty comes home

① See also
D. McChesney (1968)
A Hopkins Commentary (London Press 1968) p 57

- Peter Milward, A Commentary on the Sonnets of GMH, Hokuseido Press, 1969, p. 7.
- Gardner ~~gto~~ refers ... gazed up at the stars + praised God ...
- John Pick: Gerard Manley H, priest + poet. London: Oxford ... p. 57

While this reference ~~involves~~ correctly implies a direct relation with the poem it surely is not the single ~~pre~~ experience which inspired the sonnet as ~~many~~ writers claim. ~~I~~ It does, however, mark a stage of development in ~~the poem~~ H's life that he had been so blithely approaching since at least 1861 when he most ~~likely~~ ... at the splendid comet of that year. While This ~~reference~~ ... representative of his feeling ~~but~~ I dare say it has been ... used.

actually, SN was written amidst a flurry of notes on ~~abnormal~~ eclipses constellations ... eclipses, a possible comet, northern lights and ~~innumerable halos~~ abnormal sunsets.

~~The word~~ And ~~the gold~~ H ~~is~~ may not be using poetic license in this line. ~~C~~ "Contemporary reports" show that ~~on~~ on June 30, 1861 the ~~c~~ G.C. was indeed gold. This color is very rare in a comet, ~~unless~~ but has been observed on both occasions when the earth actually passed through a comet's tail. This happened with Halley's in 1910 and with ~~with on June 30~~, 1861 the object on June 30.

The ~~poem~~ fourteenth line originally read "Between the sistering planets"; and it ~~has been suggested~~ suggests ~~suppose~~ to suggest that one interpretation ~~which involves~~ involving the comet ~~wandering~~ wandering out along the ecliptic, ~~past the planets one~~ image of the c[omet] spending time ~~between~~ in a part of the sky between two planets. This is ~~extremely~~ unlikely, ~~for~~ while ~~this~~ the comet was studied by astronomers with large telescopes for one year, ~~it~~ we have no ev. that it ~~was not~~ observed by GMH, from [illegible] Oxford, for that 'long' a time. A more likely theory suggests ~~GMH's view of~~ that the comet was actually receding into space, past the orbits of the ~~various~~ planets. This would match the ~~reference~~ ~~line~~ ~~movement~~ intent of "come out of space" ~~earlier in the poem.~~ in line 4.

That Saturn is called "the last and solitary" planet presents no problem, even though H must have been aware ~~, as was T, that Neptune had been~~ of U + N too

Starlight Night (9) [div. for philosophy of sc. entr

From the theologian's point of view ~~of the theologian~~ this poem is a delight, but from that of ~~ano~~ a scientist, it surely is an enigma. When we "look up at the skies" are we really meant to see towns, + castles? ~~and or forests ?grey towns?~~

Unlike many other Victorians, H is not content to describe any part of Nature with the wave of the hand. Since this poem was written in late February of 1877, Corona Borealis, a slightly oval group of ∴ six stars would just be ~~just~~ rising ~~in the late evening, ab~~ at ~~abou~~ ten o'clock at night, and he may have had this ~~it may be to these~~ this group in mind ~~that he refers~~ when he writes of "circle citadels."

But to the "boroughs" I can suggest no tradition meaning. He may well be inscaping the lines of stars in the February sky into his own private constellat of towns + streets

But if we are to accept James Cotter's argument' '(Inscape: The Christology + Poetry of GMH, Pittsburg, 19 p172.) that "H presents a world of fairyland a a mythological system through which ~~man~~ man views the universe, we must at least expect to find ~~references~~ some of the traditional mythological structure in this poem.

That GMH was aware of this structure is obvious from ~~this~~ his ~~this~~ the entry in his Journal of July 9, 1868:

The period of time represented by the Starlight sonnet represents a ~~major transition~~ [illegible] maturing process of his thinking concerning the stars. The borough of heaven ~~which~~ + Ch which forms the theme of the sonnet is explained later in one of his Foundation Notes (... Aug 1880)

= St's ... ms us: ... the start of ... ms us:

ARS 238 7SNS 238 ~~Aug~~ ~ 1880?

To know what creation is LOOK AT THE SIZE OF THE WORLD. Speed of light: it would fly ~~six~~ six or seven times round the earth while the clock ticks once. Yet it takes thousands of years to reach us from the Milky Way, which is made up of stars swarming together (though as far from one another as we are from some of them), running into ring, and looking like a soft mist, and each of them a million times as big as the earth perhaps (the sun is about that. And there is not the least reason to think that is anything like the size of the whole world.

This is ~~more of~~ an admission of amazement at the sheer size of the universe, an attempt to bring some order to the ~~immensity~~ ~~universe and God~~. God the universe. ~~The two~~ cf 13.

But ~~the years~~ of thought seem to reach a climax on ~~November 8, 1881~~, ~~What~~ With the single exception that light cannot travel ~~around~~ sound the earth, this statement is scientifically accurate, to every detail, and in the long story of his ~~conversion~~ marriage from science ~~to~~ and ~~[illegible]~~ writing he has not lost sight of observable truth in science

But its beginning ~~so~~ ~~closely resembles~~ - Look - World" ~~the Starlight~~ that of
sonnet, written ~~about 4~~ only 3 years before. ~~It's mess~~
"LOOK AT THE SIZE OF THE WORLD" ~~('Universe)~~
~~echoes the fir sonnet's first line as well as (and it~~ The line
echoed again in Bridges London Snow: ~~The opening p. is also~~ read by H about same time as the Look at the size passage: "O look at
Forth. the trees!' they cried, 'O look at the trees!')

(L, 112 and London Snow (Book III, ii Poem). ~~and the~~

The passage ~~may~~ could ~~explain~~ hints at what motivated ~~the motivation behind the~~ H's to
use ~~of~~ the starlight image: Int' The stars of the
MW swarm together in lanes that could form the ~~Way~~
of streets of Starlight's boroughs. ~~H. criticized~~
a ~~Bridgesian~~ ~~reference to the MWay:~~ In an earlier
of appendix "The letter to Bridges, H was careful to
~~point out to Bridges:~~ note that ..)

The "God in N" escalates to His consideration reaches a stunning climax in the following passage, in which H completes his fusion of space and theology:

13

What is made perfectly clear in H's own explanation, however, is clouded again by Dr. P J Treanor's note (Sermons p 307) He writes

This passage is based on the mythology of Draco + Hercules, two of the oldest constellations

We are treated to an image of the garden and tree of Knowledge. that echos the "... depwoods" of the Starlight sonnet

But this ultimate marriage of science + theology remains just that, never approach Coventry Pa more extreme view.

Same PP   read by H in 1887 (44) 1

In his "Love and Poetry", Patmore insists that "Natural sciences are definite, because they deal with laws ~~that~~ which are not realities, but conditions of realities. The greatest and perhaps the only real use of natural science is to supply similes and parables for poets and theologians." Even though it this position ~~answers~~ explains H use of Draco + Lucifer, it negates ~~This position negates~~ negates the carefully ~~studied~~ ~~dogma~~ developed marriages between religion + science that ~~Tennyson, w the a tried to had with his "one far off divine event / To which the whole Creation moves," with his pantheistic "far off divine event" and~~ and Hopkins had achieved. H wrote back ~~to Patmore~~ category at once; refusing ~~to~~ in a words to accept this view:

"The only use of natural science?" It is hard saying, who can hear it'? (L3 377)

J. C. Reid, The mind and art of CP . (London 1957) p. 135.

find another word.

III.

Of all the constellations, Orion (enters) the poetry of Hopkins in the most symbolic way. In the twenty-first stanza of "The Wreck of the Deutschland" she appears as Christ the "martyr-master": "– in thy sight / Storm flakes were scroll-leaved flowers, lily showers – sweet heaven was astrew in them."

J. Hillis Miller has ~~attempted to~~ explain~~ed~~ the ~~weather imagery~~ Orion image in terms of ~~it~~ both its weather portent and its ~~biblical~~ relation with Christ; I agree that Orion ~~was as~~ Gregorian is an appropriate image ~~to us; while other constellations are used as sure weather portends'~~; Orion is ~~identifiable~~ first the most conspicuous constellation of a ~~December~~ nearly sky and ~~is second, is~~ can be identif~~iable~~ied with Christ. But ~~Hillis~~ Miller's explanation of ~~the Orion as~~ ~~mis~~ meteorological significance is incomplete. First, he is mistaken in claiming that "Orion rises in the late fall and sets in the spring." (p. 511) ~~Hillis is~~

Like every other star Orion must rise and set within ~~a~~ any twenty-four hour period. ~~Hillis~~ Miller should have written only that Orion makes its first evening appearance in the late fall and its last evening appearance in the spring. In fact, Orion's rising ~~in the early morn~~ ~~predawn~~ just before dawn in July ~~has~~ (in Mediterranean latitudes) indicated the beginning of summer, his ~~midn~~ rising at midnight (in ~~Octo~~ early Oct) signalled the harvest, + his first evening appearance ~~its attendant~~ heralded the storm season.

(Yoo)

~~This was~~ Hopkins was aware that other asterisms were used as weather portents. ~~particularly the rising of Haedus, the "kids". In Hopkins translation He refers~~ includes, in his translation of Horace's _Odi Profanum Volgus et arceo_ to "fear the violent calendar at Haedus rise, Arcturus set."[1]

('~~Lit~~ Horace's original... see card followed by translation + References.) Haedus refers specifically to Zeta Aurigae, the western most "kid" bu various sources refer to the "kids" as both Zeta + η, ,, + ε ~~Modern sources have added ε to the~~ ~~trans~~ making the entire asterism, with Capella, "The Goat + the Kids." (P

The first autumn sight of this ~~co~~ asterism by Mediterrane mariners presaged the close of Shipping on the Mediterranean, in ant. of winter storms.

~~Similarly~~ The ~~setting~~ early evening setting of Arcturus, happening about the same time, ~~presaged similar~~ was also used as a weather...

Check Horace's odes III: i

ARP166

Sept 67 ~~to~~ - Easter '68

Nor fear the violent calendar
at Haedus-rise, ~~Arcturus~~ Arcturus-set,

what between
The dog-star with the fields ablaze

Haedus refers to the three kids. Their rise in the east presaged the fall stormy season + hence the close of shipping in the Mediterranean-
from Allen-Star Names, their lore + meaning

~~Hittis~~ after showing ~~the~~ with limited ~~successfully the~~ success ~~the~~ meteorological interpretation, ~~Hittis~~ Miller ~~points out~~ discusses the tradition ~~that~~ "associating Orion specifically with the martyrs of the church, ~~It~~ & using Gregory's point that ~~Gregory maintains that~~ Orion is ~~made~~ Christ the martyr", ~~though I cannot tell how he supports this with reference to Job.~~ ~~Hittis~~ Miller concludes that "the storms of winter are the symbols of persecution the martyrs arouse by their very agnate (513)" and in that light this reference is a ~~seminatore~~ 'makes sense'.

Surprisingly ~~Hittis~~ Miller fails to note that H ~~announces~~ himself ~~the comparison between Orion & Christ in~~ apparently himself sees ~~this~~ a similar relation (poem) in *Miror Surgentem*, one of his latin creations. ~~After~~ After a description of Orion, the poet ~~pray~~ prays, ~~++~~ to "~~Oh~~ O heavenly Jesus, you who gather up in your hand women and these lofty stars, all things come from you. I pray ~~that the years to say take its beginning from you~~.

The passage opens in a wonder similar to that he ~~[illegible]~~ felt with the Starlight sonnet:

I wonder at Orion rising . . round and round

~~That this poem was written in~~ This poem continues with a prayer for the new year, and Hopkins' placing of the moon "close at hand" is accurate for the poem's timing — for only ~~at~~ in ~~at the end of~~ in December & January does ~~is~~ the moon fall pass through ~~in~~ Gemini, the closest zodiacal constellation to Orion.

~~Hill~~ Miller Returning to ~~Hill~~ Miller's proposal of Orion as weather portent, (Does this flow from the other p. 17?)

~~Hill~~ He also ~~attempts~~ to connects Orion, as bringer of storms + rain ~~to the~~ and hence to the "dark side of the ba[y] of your blessing" in Stanza 12. ~~Unfortunately~~ ~~Hill~~ Hil[l] ~~has~~ in incorrect here, as this interpretation does not fit the stanza — ~~the dark side of the bay refers to the~~. Accordi[ng] to Hill, ~~it'd have~~ Hopkins must ~~to~~ rewrite this poem to ask if the storm should ~~save~~ rather than God's blessing "reeve even them in".

"~~Bay~~" — Hopkins uses "bay" in the architectura[l] sense, but he applies it ~~more~~ mostly to the sky.

[Take ~~fro~~ directly from Deutschland Seminar] The term ~~referred to astronomically~~, used astronomical[ly] is found in ~~line~~ the Eurydice:

"Bright sun lanced fire in the heavenly b[ay]

And in the ...

/ ARJ 193 [not here but use Donne's influence.] ; 11 9 120° (12d)

CN3 p

Two large planets, the one an evening star, the other distant today from it as in the diagram, both nearly of an altitude and of one size — such counterparts that each seems the reflection of the other in opposite bays of the sky and not two distinct things.

DB

IPJ 193

cf. Deutchland, 12 l. 7.

comment on critic's failure to compare this properly to "sides of the bay" in Deutschland.

In his criticism of Stanza 12, ~~Keating~~ first name 1861 ~~tries~~ to help in the regard by comparing ~~the~~ ~~the~~ dark side of the moon to the dark side of the bay, adding that both are beyond human knowledge. This ~~statement~~ is not valid, for ~~surely~~ Hopkins was aware that the unlit portion of the moon ~~was~~ is ~~surely~~ surely not a mys and that the back side of the moon ~~was~~ is not always dark.

But where does this go?

OK

3CJ228. Nov-27, 1872. "Great Fall of Stars, ~~identifie~~ id. with Biela's Comet. ... flight.

Biela's comet split into ~~to~~ two ~~comets~~ in 1845. On its ~~return~~ next return in 1852 it appeared as two separate comets, ~~which never~~ neither of which appeared again. ~~59, 66, 72.~~ This would have been the third return of ~~a~~ the meteor ~~shower~~ ~~craw~~ storm that was created when the two comets finally disintegrated.

+F The "pitch to the left" echoes ~~a~~ ~~one of the~~ Sonnet 65 "Pitched past pitch of grief" ~~and~~ where it refers to Lucifer's fall.

~~3CJ2~~
4CJ ~~42~~ 232 June 25 1873. "at ... "
Applies inscape to the observation of a fireball.

5CJ249. July 13, 1874 ~~See page~~ A comet. (Coggia's) see p.
6CL3 135. 24 Dec 1875 "Do ... comet? See page __ and page __ Shows again the quality of his eyesight, to sight such an object when low in the sky. One of the ~~flurry of~~ ~~[illegible]~~ ~~observations surrounding SN sonnet.~~
7CL3 137. "What ... comet" See page .

8 CL3 317. Crit. of one of C.P's poems. See page

Annotated Appendix

A Catalogue of Astronomical References in the wo[rks of]
Hopkins, ~~with a commentary~~.

~~A R~~
1C1 (P103 J46) Each reference is catalogued in the foll-ing manner:

1 = number in sub group. of
C = ~~Comets~~ References concerning comets.
P 103 No 103, Poems 4th ed.
J 46 also found in Journal, p. 46.

---

abbrevations
P - Poems, 4th Ed.
S = Sermons & Dev. writings
L_1 = L B
L_2 = C D
L_3 = F L, 2nd ed,

References to Comets

1 CP103J46. "I am like a Slip of Comet. cf. Essay Part I.

2CJ143. July 5, 1866. ... " ~~early~~ This reference ~~margin~~ provides early evidence of ~~H's keen~~ the ~~combination~~ of H's keen powers of observation with a ~~poetic~~ lively use of words. "Ellipsoid" implies the cloud was shaped like the elliptical orbit of a comet, ~~not like a comet itself~~

+ Astro-Mythological Refs.

Astrological References

1 AP14 "I - love" May 6 1865
2 AL, 260 "The ... strange." Aug 25 '87
3 AS264. astrol. is astron. Jan 1 88
2 4 AP50 Andromeda . Aug 12 '79
3 5 AL, 132 Hall Caine 16 June '81
4 AS198 Draco Nov 8/81

Compared to his scientific persuasion, referen to astrology are very few and ~~degrading~~ often degrading to ~~the~~ subject. In 1AP14 the speaker ~~sets~~ calls it a mere "fancy" and by 1887 (4L, 260) it is "gibberish". His only rational argument was made in 1888, ARL, 132.

I have placed the "astro-mythological" references here because the subjects are related. The central reference is to 2AP50, "Andromeda", and in it she ~~calls~~ called "doomed dragon food — perhaps an early reference to Draco ~~and 4AS198~~ - + Lucifer (4AS1

Lover's Stars

1 July 17 '64 P83. Lover's Stars

6 L, 161 - Nov 26-82 -

(125) 25

Eclipses -

1EP2: West - eclipse. ~~His describing:~~ An early sunset "inscape" during which the sun occasionally is eclipsed by horizon clo[uds]
Has nothing whatsoever to ~~to with SL they~~

2EP12. 1865. parapet? "~~heartsly~~ 'hornlight' of SL

3EL,12: Oct 1866: The sun..... came. A pithy comment on being able comparing the movement of great bodies in space to ~~a~~ that on a city road. Did he watch the eclipse reflected in a roadside puddle to protect his ey[es]

4EJ157. Sept 13, 1867. ~~A~~ There..... green. This ~~strange~~ remark implies that he did not see the eclipse himself - W[hy]
→ h. M?

5EJ220. This describes one of his many visits to Stonyhurst observatory. The "lunar rainbow" probably means ~~half a lunar~~ an arc of a l[unar] halo. On the same page is a drawing of ~~a double~~ an unusual rainbow, seen only a month after eclipse. ~~(cf.~~)

6EL3 143 SEE P. 176.
6EL3 145
8EL2 140 1883: There... them. Hopkin[s] ~~was continually criticising~~ others, ~~particul[arly]~~ corrected ~~for~~ scientific errors. Here he summar[izes] philosophy to Dixon, for example:
cf also

7. Comment on Card. Nos.

Other references connected with these letters.

1 LN(L, 202).

GRL-1-202 1 Jan 1885.

One word on Psyche & Volcanic Sunset - RB: (-portrait of the phenomena which followed the great eruption of Krakatoa)

The description of the one over the Cretan Sea so closely agrees with an acct I wrote in Nature even to details which were local only & that is very extraordinary: you did not see my letter, did you?"

1 LN J252.

~~Two beam~~ Beams .. sunset.

Here he suggests that they are 'atmospheric merely" - changes his mind in & the 1884 letter.

2 LN J216 V-clouds.

3 LN J222 Aug 7/72. The brow ... beam.

Hcwasthono [illegible]

 715

References to the Milky Way

1 MP98 cxxiii J 44 "Stars ... way" Sept 1864.

This entire passage concerns the Milky Way, for to the unaided eye the thousands of stars in it shine with the rays of a single luminosity. The sky is fleeced, ...

or en... 103, ... the s... passa... the ... an...

ARL 53 30 May '78

"The difficulty about the Milky Way is perhaps because you do not know the allusion: it is that in Catholic time Walsingham Way was a name for the M W, as being supposed a fingerpost to our Lady's Shrine at Walsingham.

~~I (1st?)~~ 101-2

That a starlight - wender of ours would say
The marvellous Milk was Walsingham Way
O well wept, mother ..

2 MP ... the ... the ... Ve... comp...

"~~with an~~ attaining stress".

3 MP 28:26 ~~while in December, the MW is~~ The winter M is not as bright as summer or early autumn, so "fleeced" would not be appropriate. It shines with a soft, ... light.

4 MH, 77 The ... made

(5 See draft P. 13)

~~A Esagr~~ References to the Moon (except lunar halo

~~As Many of the references to the moon are not of any significance; these will do not merit detailed comment.~~

1 LJ. This is the heading of a letter to his brother Arthur. The sky within the large D is a dusk sky no stars, but a moon, indicating the sketch was of a scene around dawn or dusk.

2 LP 79. A Fragment of anything You like. 1862. cf. 25F.

3 LP 3. The 1863 ... floats. Another reference to moon in daylight.

4 LJ 23. Moonlight... cobweb. Implies a ~~compar~~ spanish moss.

5 LJ 45. The moon ... blood
5 LJ 45-2 bleeding heavens.
cf .... now stars of blood.

A 6 LP 105 too late ... moon.
The close of an superb exquisite composition of A early Autumn; the inscape flowering plant. The October full moon is moon, follows the Harvest moon in September

7LP98F552 - The - shine.

8LJ58 - The moon glassy - possibly referring to a bright moon in a hazy sky.

1865
9LJ67 Mealy ... moon. cf. Hurrahing in Harvest, written 13 years later; also referring to clouds: "Meal-drift ~~mound~~ moulded ever and melted across skies?".

10LP129 - 1865
Moonless darkness
cf. ARS This is a prayer ~~for purity am~~ ; and a statement that the "moonless darkness" stands between the past and a brighter future to which the Bethlehem star will lead him. This thought is clearly echoed twenty-three years later, on Jan. 2, 1889, when the desperate ~~Hopkins~~ poet longs for "a happiness ... life. (S262 bott cf.

Feb 25 and 26 1868
11LJ161 This evening — milky. This passage includes a sketch of the crescent moon and ~~a bright object - possibly~~ Venus (so referred to in previous entry). The "dark part," ~~is visible~~ visibility is ~~known~~ caused by earthshine, or reflected light fro the earth.

12LJ169 But — river — it.

13LJ184 Sunlight dim but moonlight b. Aug 7. 8/2/68
14LJ185 " "; radiations in the sky at night
15LJ185 "Anquil— of moonlight."
Sept 10 1870
16LLs 112. "The yellow moonlight ... hills." References to yellow moonlight are not common, But cf. Dixon's poem "The Spirit of the Sphere" ~~t18~~ (p. 62-63)

By the sun's irradiate car
By the yellow-faced moon;
By the magic of each star,
We may find thee very soon.

Feb 23, 1872.

17LJ218. On another night ..... underneath.'
Brindled is also used in "Winter with the Gulf stream (cf. 3LP3)

" It's brindled wharves & yellow brim
(look up b) ⟶ uppere OED:

June 19, 1876.

18LP137: Moonrise. See p.

(note also ~~So~~ S226, a year after. moonrise, some comments ~~relating~~ on Maenefa's slope, } and relating St. Bueno's in key map to the Holy Land.

19LP35 May 1877
"Frequenting... wend."

Wear, in its meaning of waste, damage [illegible] strength, refers to the waning of the moon
wend - to go forward, proceed [illegible]
its waxing (SOED)

N References to Northern Lights.

Hopkins's description of the A Bor. very detail[illegible] intrica[illegible] possibly because the constant and ghostly movement of the rays enthralled him. 1870-1 ~~must have been~~ was a time of sun maximum.

1NJ200. First N. .. cloud. "horny rays" do not, as Mc. suggests, refer to the "hornlight" of Spelt from ~~Sy~~ Sibyl's Leaves, since that poem is set in the early evening. ~~The~~ H was one of the few who could tell an aurora ~~by~~ from a cloud by the former's failure "to dim the clearness of the sta[illegible] the bear." Today this is considered a common wa[illegible] confirming ~~identifying~~ a doubtful aurora. The ~~instress of this experience brings him again to God: The sta[illegible] but deliberate movements~~ "This ... fear."

→ Has nothing to do w. SL, which is set in evening

2NJ200. .. "an h ... stars." This [illegible] was seen also in Rome .. "and taken as a sig[illegible] God's anger." The "pale crown" refers to the ~~zenith~~ coronal form which ~~is commonly at app~~[illegible] the zenith during ~~t~~ major displays.

3NL3235. (Letter to Patmore?) We ... [illegible]

4NJ214. ~~The sunspots was~~ "N. L. [illegible]

common colour of Aur. [illegible]

occasionally ~~at ...~~

The light tends to [illegible]

Astronomical and Related References of a Philosophical Nature.

This section contains some of H's thoughts concerning philosophy of science, ~~which~~ ~~and~~ and which a[re] not easily placed in the other categories. These references trace a development in his thinking which may be of use in ~~other~~ later parts of this project: work.

1 PJ49 Novum Organum.

2 PJ75. "Science ... needed."

3 PJ83. All thought --- morality. ~~This~~ These ~~states~~ words expand the previous thought by stating that "genius" (art or morality) and science ~~form a unit~~ are one.

4 $PL_3$227 September 1865. "I ... parts"

~~The dis~~ Here the problem of ~~'see the~~ the separatio[n] of science from other fields of thought is applied to Christianity. ~~In~~ Consistent with his former views, he would naturally be ~~annoyed to see~~ noting the same ~~thing~~ problem rearing its head in his developing interest in religion.

5 ~~4~~ 5 A.RL.12

~~5 PJ222~~.

6 PS 90. Therefore — her. By Oct 25, 1880, the date of this writing, ~~science~~ It has put science into a position where it serves ~~religion~~ or at least can explain, ~~reg~~ religious concepts. The style of this passage is similar to Ecclesiastes I:

↗

7 PS 196. This is a demonstration of . . .

↗

Nov 15 1881

8 PS 166. "To praise . . . indifferent" ~~This is a puzzling statement, as puzzle~~ curious This ~~statement~~ is ~~at least~~ as puzzling as his refusal to write poems after joining the literary oriented S. J. Why should it be wrong for a Jesuit & ~~anyone~~ "to admire the stars" if a senior Jesuit, Fr. Perry 5 years earlier can travel all the way to ________ Island to observe a transit of Venus and then write a three-part article on the experience for the Month?

The Jesuit magazine is more specific

on its position.

~~The position of the Jesuit magazine becomes more telling~~

The Jesuit position ~~to~~ on the "admiring praising ~~themselves~~ the stars" is made clearer by this passage, quoted as part of a book review in the May 1876 issue of the Month:

~~Mivart~~, unsigned, Review of "Lessons from Nature, as manifested in Mind & Matter" (Book) By St. George Mivart.
Month, May 1876. 102-08. p. 106
~~Review of Lessons from Nature~~

quotes Mivart

- No one would deprecate the imparting to poor children rational conception of the starry heavens, on the ground that they cannot be taught to examine & calculate for themselves so as to have an independent knowledge of astronomical laws & phenomena. Now religion brings down to the popular apprehension & embodies the highest results of philosophy. Those therefore who would exclude it from our schools would deprive the masses of such share as is open to them of the highest truth. [Oh yes!]

Mav

9PP60 60B.

Despondency begins but just begins — to enter H's astron. world with such descriptive words as 'grimy" to describe the vault" of space,

10(PL2(140) "S ... scientific." A very appropriate comment, pertinent also to S's own astronomical ? references.

11 PL3 263) I have ... "dawn." . .

~~12 PP157.~~ F The only use . . .
12 PL3 377. See page 20. Consistent with his earlier views .

13 PS264. The astro . . . .

→

36

14 PS 261 MA ... Universe.

→ 15 PL, 281 →

References to Planets.

1 OJ317 – "The .... stars" eye-brights refer to planets (which ones).

~~2~~ 2 OJ19. Early 1864.

Ite .... capellae.

Trans: Get ye home, my ~~to~~ full-fed goats, get ye home – the Evening-star draws on!

Virgil. *Virgil*. Trans. John Jackson Oxford; Clarendon, 1921, p. 30.

~~o 69: "Aethiops~~ Two other nearby ~~astron~~. references ~~in the same vol as in~~ at the end of the tenth Eclogue are worth ~~quot~~ citing as Hop was familiar with them: line 69 mentions "Aethiop flock under Cancer's star".

while the ~~sext~~ ~~next~~ following line refers to the "heavenly sisters."

3QP14 May 6/65 ♀ Saturn.

3PJ147. Morning star . . . . dawn.

4PJ153. Home . . . lanes.

5 . . . .

~~(HLJ161)~~ ♃ cf.

5PJ161. cf ~~HLJ161~~.

11LJ161. Moon + venus close together Feb 25 + 26 1968

5P J168. St - - . . . bright.

6PJ162. Venus . . . . sky. Later the "quarter would become "bay".

~~7Q~~ J193 Planets + Bays P25

8Q J207 - ~~♂~~ P.24.

9 ~~7~~ Q J217. at 8:30 . . . sky. Few observers even professional astronomers - have ever seen Venus in daylight. ~~It~~ This feat requires keen eyesight and an accurate knowledge of the planet's celestial position

References to ~~Solar and Lunar~~ Halos.

1 HP126. Sept. 19, 1865.
"Upwards . . . . aureoles".
Aureole: an actual halo of reflected light such as that seen in eclipses. (SOED)

2 HJ163: April 6, 1868: "There were both . . halos, f

3 HJ165: May 22, 1868: "with faint S H"

4 HJ189: "One . . . ~~halo~~ . illustration." Re-reading it was used.

5 HJ211. June 17, 1871 "S H ooo like a rainbow inc

6 HJ213: also . . . rainbow . (aug 6 1871)

7 HJ218: ~~A lunar halo . . . outline~~
~~a lunar hallo . . . not quite round . . . ~~but~~, it fell on the nether left hand side!~~ ~~An example of the~~
→ whole thing.

8 HL180: 18 May 1883: "a solar halo"

References that may pertain to ~~from~~ Spelt from Sybil's Leaves

~~This~~

~~1885~~ A day... light.

1 SLJ 198 1870. This is G.M.H's single ~~observation~~ sighting of the zodiacal light. The fact that the ~~line~~ final ~~of explanation with~~ line was ~~inserted~~ on the left-ha MS page implies that H ~~reached this~~ drew his conclusion ~~after~~ sometime after the obs, possibly after consulta The time of year, spring, makes this ~~observ~~ conclu plausible.

too many big words

2 SL P61. Two common explanations for line 3.
FR Leavis proposed that hornlight ~~refers to~~ means soft moonlight and that ~~cold~~ hoarlight involves cold starlight. But this is evening, not quite night, and only the "earliest stars" ~~or (line 4)~~ are out. Also, nowhere else does H refer to starlight as cold. McChesney cites ~~so~~ a references about the horny rays of the sun; cf. ______

3 Schneider suggests that "as evening advances, bot warm yellow ... fade."

→ Coleridge

While I accept this explanation I would like to add at least the possibility that H may ~~have been~~ recall ~~referring~~ to his long gone observation of the z.l.

This ~~lore~~ interpretation would satisfy the "wild hollow hornlight hung to the height" since ~~by~~ zodiacal light does satisfy just two of the SOED definitions of hollow: "empty vacant void ... ME; Wanting soundness, solidity or substance ... 1529." The zodiacal light, when seen at all in northern latitudes, is usually very indistinct, and I do recall seeing ~~a~~ it with the outer ~~part~~ cone brighter than the ~~centre~~ inner, which would again justify "hollow." Also, the zodiacal light does indeed appear "hung to the height" since its triangular shape can ~~stretches~~ stretch almost to the zenith and appear ~~to~~ hung ~~there like a tent.~~ in the sky like a tepee.

This would also fit the setting of the Sibyl's leaves, with the early stars already shining, ~~this~~ the time would be about 45 mins. after sunset, when the z l first appear ~~becomes visible~~.

41

References involving The SN.

1 SNS254 See p. 15.

1 SNP31 God's Grandeur. Feb. 23, 1877.

"The world" means "the universe" cf. , P in which H uses "earth" to refer to this planet and "world" to refer to the universe.

2 SN P32. SN. cf P.

3 SN P32 (L3 145) March 3 1877. Poem sent to his moth[er] 3 days after eclipse.

4 SNP48 July 27 1879. "Dress his ... order

5 SNL1 112. cf. P.

6 SNL2 32. 1 Mar. 1880. "of them ... " Dix[on]

7 SNS238 - See P 17

7. SN P145 "Heaven ... Clitheroe."

~~Notice that~~ H2

References to Stars.

1 SP77 (L39) Silence - alone.
The only sight in the black night is that the stars..

2SP2
2SP81 You .... Plaid: ... El Khor.

→

3SP85 (J31) And ...... not.

(Ray?)

Fainter stars do not appear to twin as much as the brighter ones.
cf P. 178 .... flesh ... your.

5 ~~4~~ SP102(iii) "And .... sky" .. there. (Page 146)
is part of a flurry of ~~connect~~ stellar com
This ~~shows that H's attention to the sta~~
intensive ~~just before at the time~~ he wrote the Comet poem fragment ~~to~~
~~extensive~~ ~~and shows that his concern for~~
compass. The compass ~~prop~~ probably is a sextant used to measure precise stellar positions.
Milton, in ~~refers~~ ~~ref~~ ~~cont~~ writes in a similar vein
In his hand He took the golden Compasses, prepared circumscribe ~~the~~ This Universe (PL vii 224)
~~In~~ In any case, the speaker finds that ~~a~~ even though "it's place ... charted", he cannot find a star in daylight. ~~So love~~ Therefore "love prescriptive" means nothing if love really is not

335P157.
Where ..... star.

References to stars have shown a
? progression towards the spiritual,
(to) which ~~where~~ they d culminate in this line.

345S262. It is ... life. Jan 1, 1888.

a spark of hope, contrasted again to "vasty va
~~to~~ ... but just a spark, a p
of light

35SL, 273 Feb 10, 1888 The head ... star

⟶

36SP72. ~~Jan~~ July 26, 1888.

Man ..... black out

⟶ check critics for interp

37SL, 290. My – ~~performed~~ and
performed!

385P159. 1889. Hang ... earth. 10 Sept 8

39 ~~ARS~~ S164 undated.

There ...... stars.

another use of 'gold' to describe stars.

4OSS ~~ARS~~ 245 Do ...... Despair then.

41SP2C In... dew. of page. —.

Miscellaneous Astronomical References.

22L3(P77,L3 12) ~~12L312(P77)~~ Looks from the zenith round the sky.

—

~~1~~ 2(P77 L3 10) "Shewn... firmament; Tabout he

32 P2 ~~L3~~ "And tho'... firmament."

42P98c XXIV. "Night's... everywhere: The latern here refers to the light of stars; in Poem 40, "The lantern out of door" it is 'the light of men'.

~~P43~~ 52J (P1. 43). - a slight sketch... line. ~~No obvious relation to a comet~~

Suspected relation to comet unconfirmed

(51)

172 L, 243 Oct 31, 1886.

In a letter to Bridges, H criticizes
~~the first line~~ ~~hoped~~ ~~time~~ to cover a count
the first line of Bridges's Prometheus. He ends +
"And ... heaven."

cf. ... Ernest ... stupendous "vaulty" in SfSL

(earliest possible date is 18

30 —

(51)

172 L, 243 Oct 31, 1886.

In a letter to Bridges, H criticizes use of "dome" to cover a court the first line of Bridges's Prometheus. He ends

" And . . . heaven." "vaulty" in SfSL;

cf. . . Ernest . . . stupendous.

(earliest possible date is

— 30 —

Direct or and Indirect References to "Music of the Spheres."

The concept of ~~heaven~~ music and dancing of the spheres has been used to ~~signify~~ show the order ~~that the~~ in the ~~heavens~~ universe exist. ~~Pythagoras~~, In the fifth century BC, Pythagoras suggested that "There is geometry in the humming of the strings. There is music in the spacings of the spheres." ¶ I have collected ~~H' references~~ Hopkin's writings that ¶ that relate to this subject:

1 KP122: The aug 1865.

The . . down.

2 KP173 april 1876. Just ....
quarter: and "~~But . . itself.~~"

3 KS200. They . . joy.
cf Devlin's note p 307 concerning
MV . : ~~There's . . cherubins~~:
V:i. 60-63.

4 KL1 249. 5 Jan 1887 It [counterpoint] . . . architecture.

5 KL3 377 20 Jan 1887. Writing . . . . one.

CN3p.

The M.A. Thesis

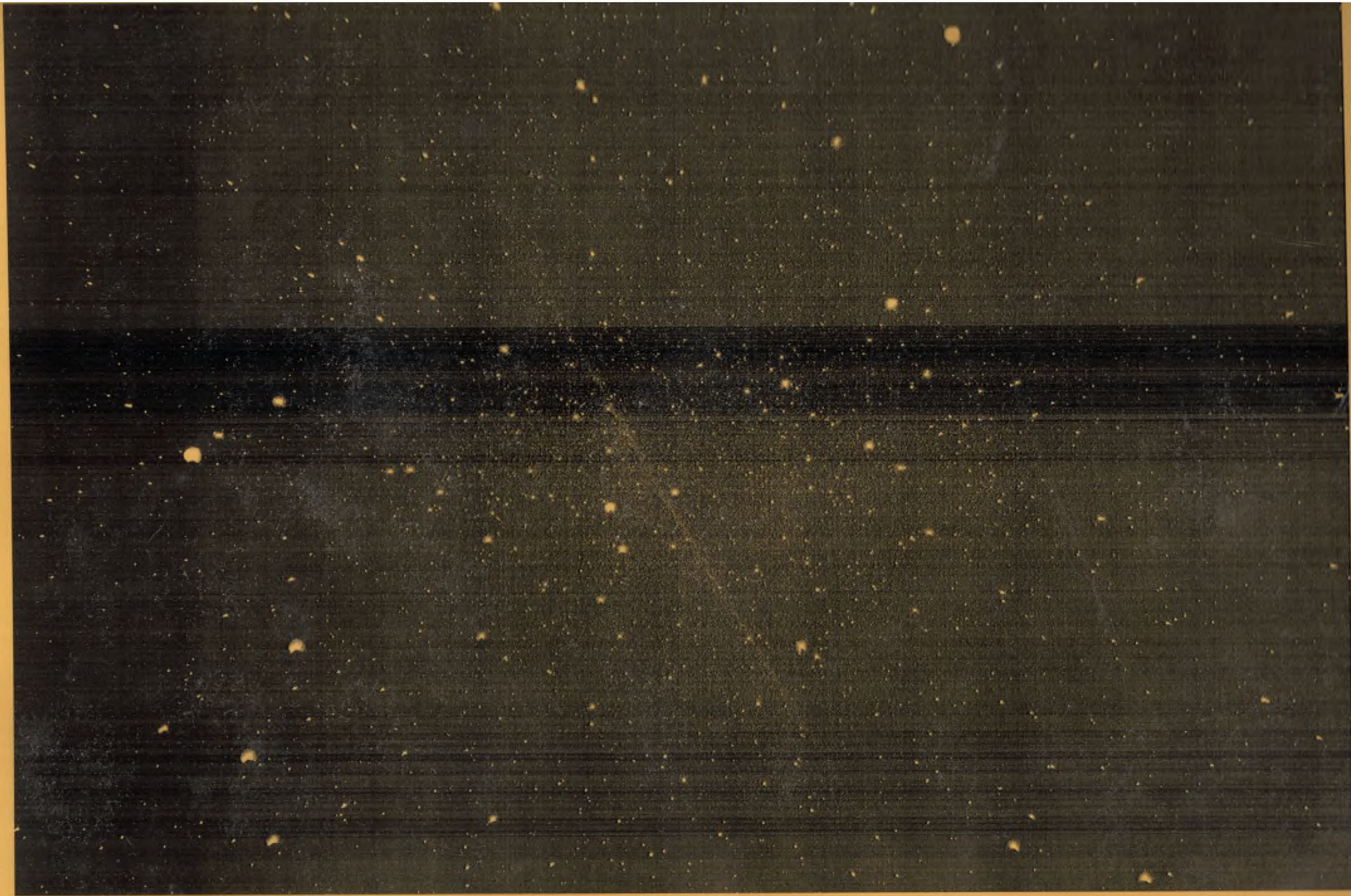
The Starlight Night.

CN3Q11

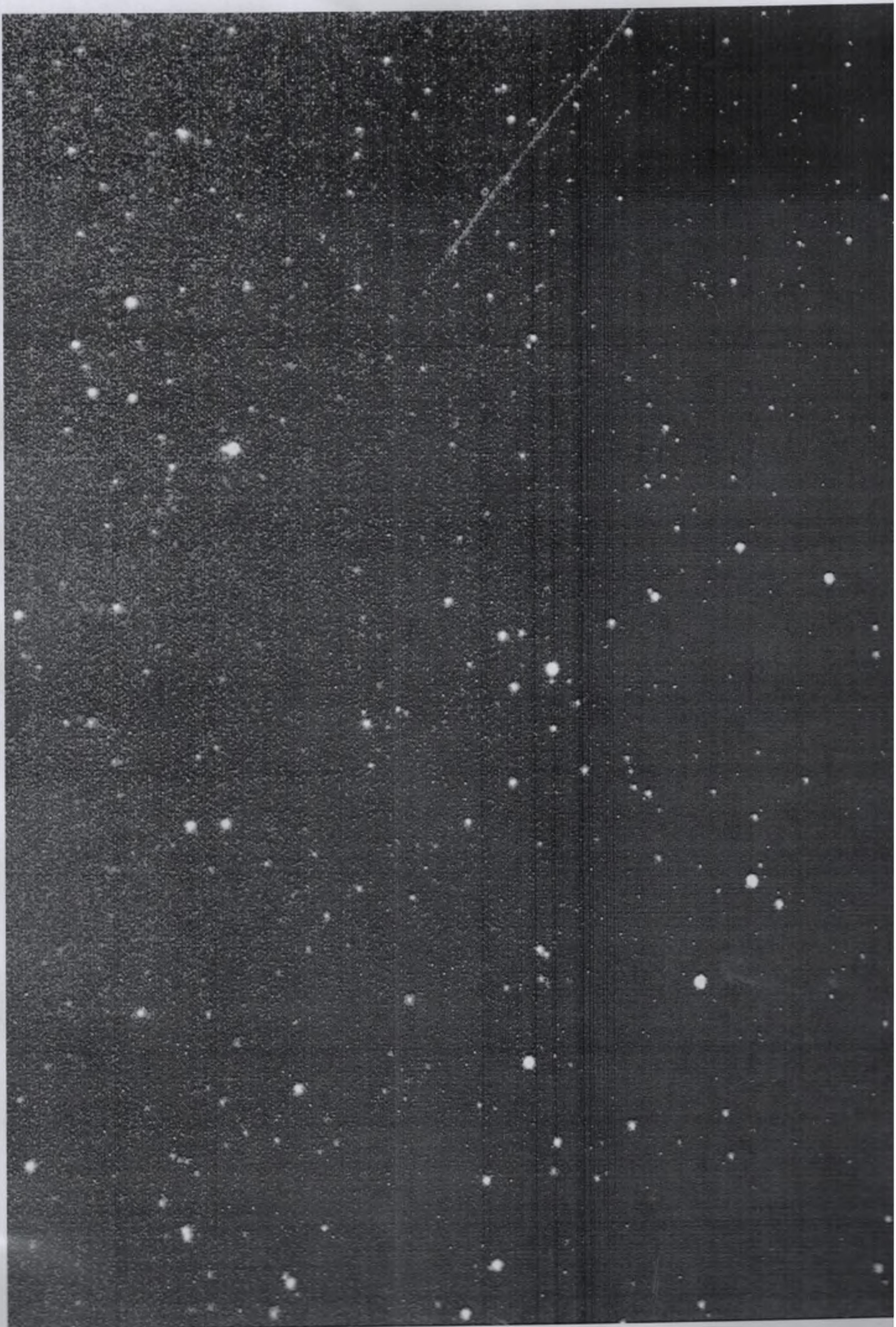
Comet Hunting the Shakespeare Way

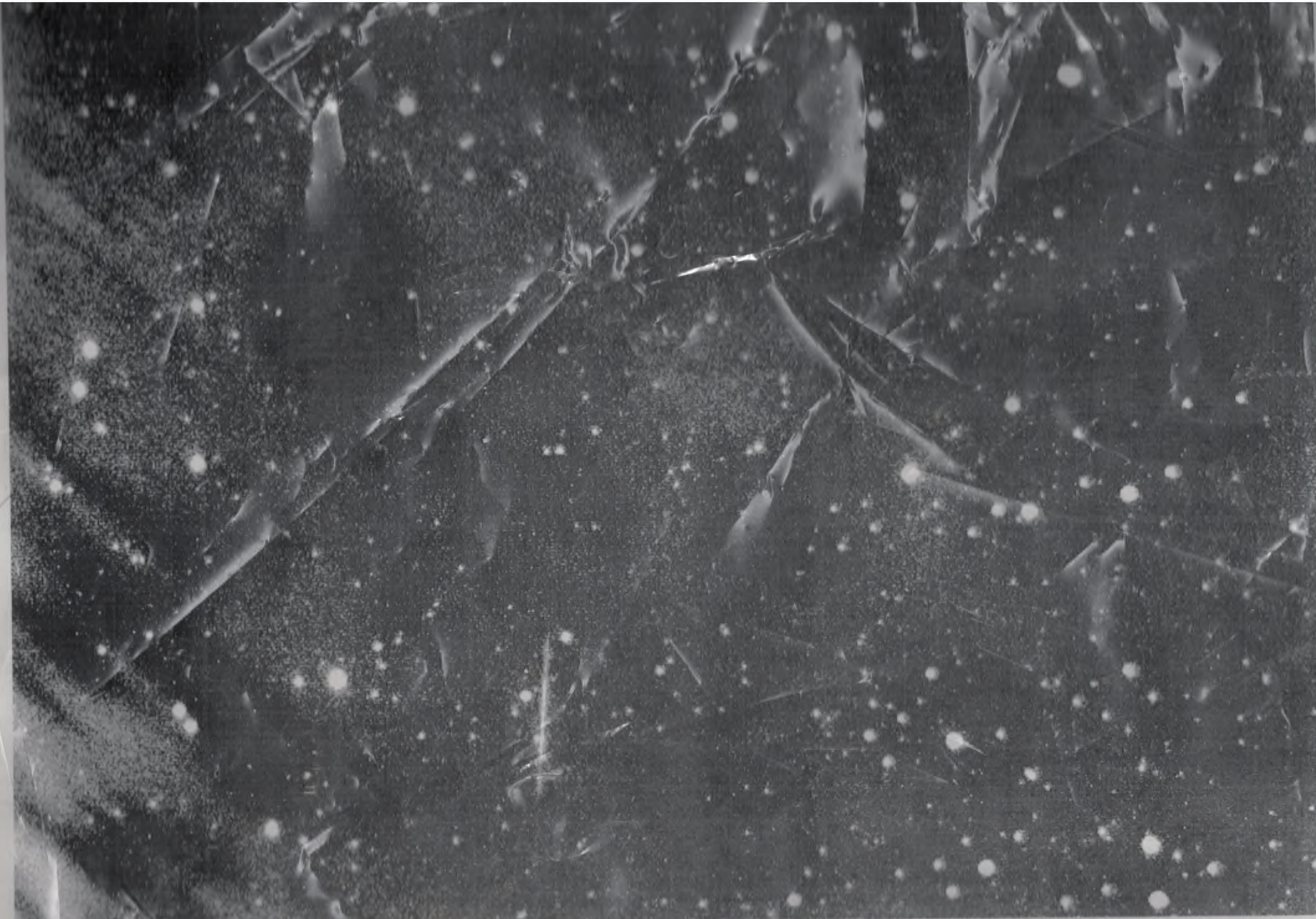
CN3811 2011 04 01. predawn

April 2 2011 Morning sky with J2 dome



CN3911 faint n Aquid May 5 2011





CN3g 11 probable Oriond Meteoric Meteor 2012 10 20

CN 3g 11 First
Meteoric Meteor
Jan 7/8, 2011.

MN30LL 2012 12 16 Geminid ? meteor norm.

CN3011 Shakespeare — Milky Way plus Quadrantid Meteor

CN3011 Shakespeare — Milky Way plus 2 Quadrantid Meteor

CN3Q11

Comet Hunting the Shakespeare Way

Philosophy.

CNEq11 is a different kind of comet search. It is designed to find bright comets in areas that might have been overlooked or missed during the regular visual search. It takes advantage of the extremely wide field of the Canon 20Da with its Honeywell Pentax standard lens.

CN3q11 is the last of the three new searches that began upon the delivery of a Meade LXD75 just after December 17, 2010. At first the program took place with the Canon atop the mount, later with the Canon atop Potus, and most recently with the Canon atop Shakespeare, a Meade 5-inch ETX. The images are very satisfying to admire, and to scan.

וניברסיטה העברית בירושלים
THE HEBREW UNIVERSITY OF JERUSA
Au ity for Resea Students לתלמידי-מחקר

TRANSLATION

The President, the Rector and the Senate
of the Hebrew University of Jerusalem

Hereby Confer upon

Mr. David H. Levy

The degree of Doctor of Philosophy
after his thesis -

"The Sky in Early Modern English Literatu
A Study of Allusions to Celestial Events in Elizal
and Jacobean Writing 1572 – 1620"

has been approved by the Faculty of Humanities
Senate

Jerusalem
June 6th, 2010

President Rector De

למכתבים: קמפוס ע"ש אדמונד י. ספרא, גבעת רם ירושלים 91904
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מדעים עיוניים Humanities & Social Sciences

האוניברסיטה העברית בירושלים

נשיא האוניברסיטה, הרקטור והסינט

מכתירים את מר

דוד ה. לוי

בתואר

דוקטור לפילוסופיה Ph.D.

לאחר שאושר חיבורו

"השמים בספרות האנגלית המודרנית המוקדמת:
מחקר על ההתייחסות לתופעות שמיימיות
בספרות האליזבטנית והייעקובינית 1620-1572"

מטעם הפקולטה למדעי הרוח והסינט
ולראיה באנו על החתום

Putting Hubby Through

To all whom these presents may come, Greeting:

Be it known that

he Friends of Doveed (Shakespeare) Levy and of also the Wife thereof, hereby confer upon

Wendee Esther Wallach-Levy

who has amply completed all the requirements appropriate for this Distinction
by unflaggingly encouraging her spouse towards a Doctorate,

the Degree of

Ph.T.

together with all the rights, privileges and honors
which appertain thereto,
This Sixteenth Day of October, 2010.

David H. Levy

Grateful Hubby

האוניברסיטה העברית בירושלים
THE HEBREW UNIVERSITY OF JERUSALEM
Authority for Research Students
הרשות לתלמידי-מחקר

Jerusalem May 24th, 2009

TO WHOM IT MAY CONCERN

This is to certify that

MR. DAVID H. LEVY **Student no. 55504020**

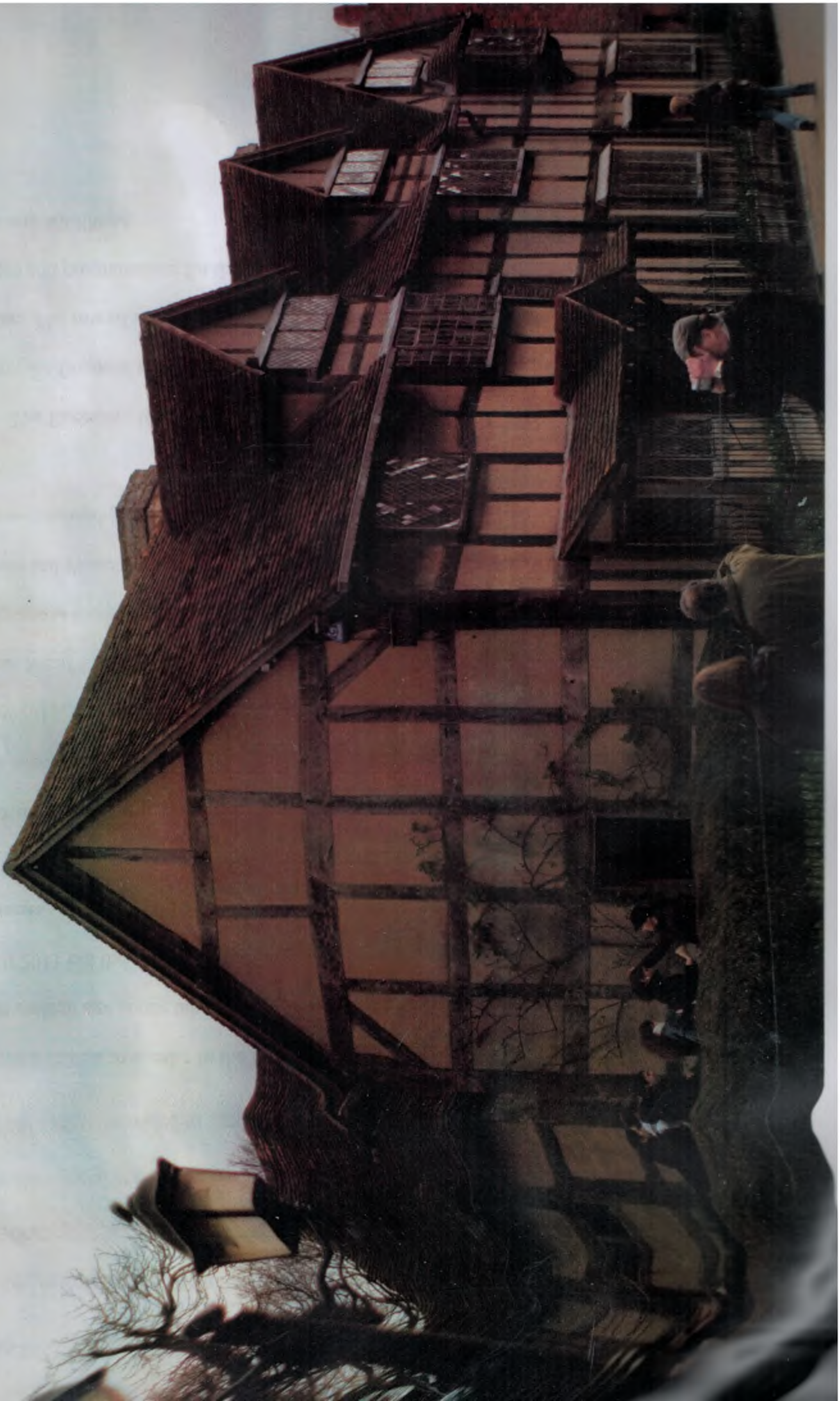
has completed all the academic requirements (supplementary courses, written reports) for his Ph.D. degree and has submitted his dissertation to the Senate of the Hebrew University of Jerusalem on May 21st, 2009.

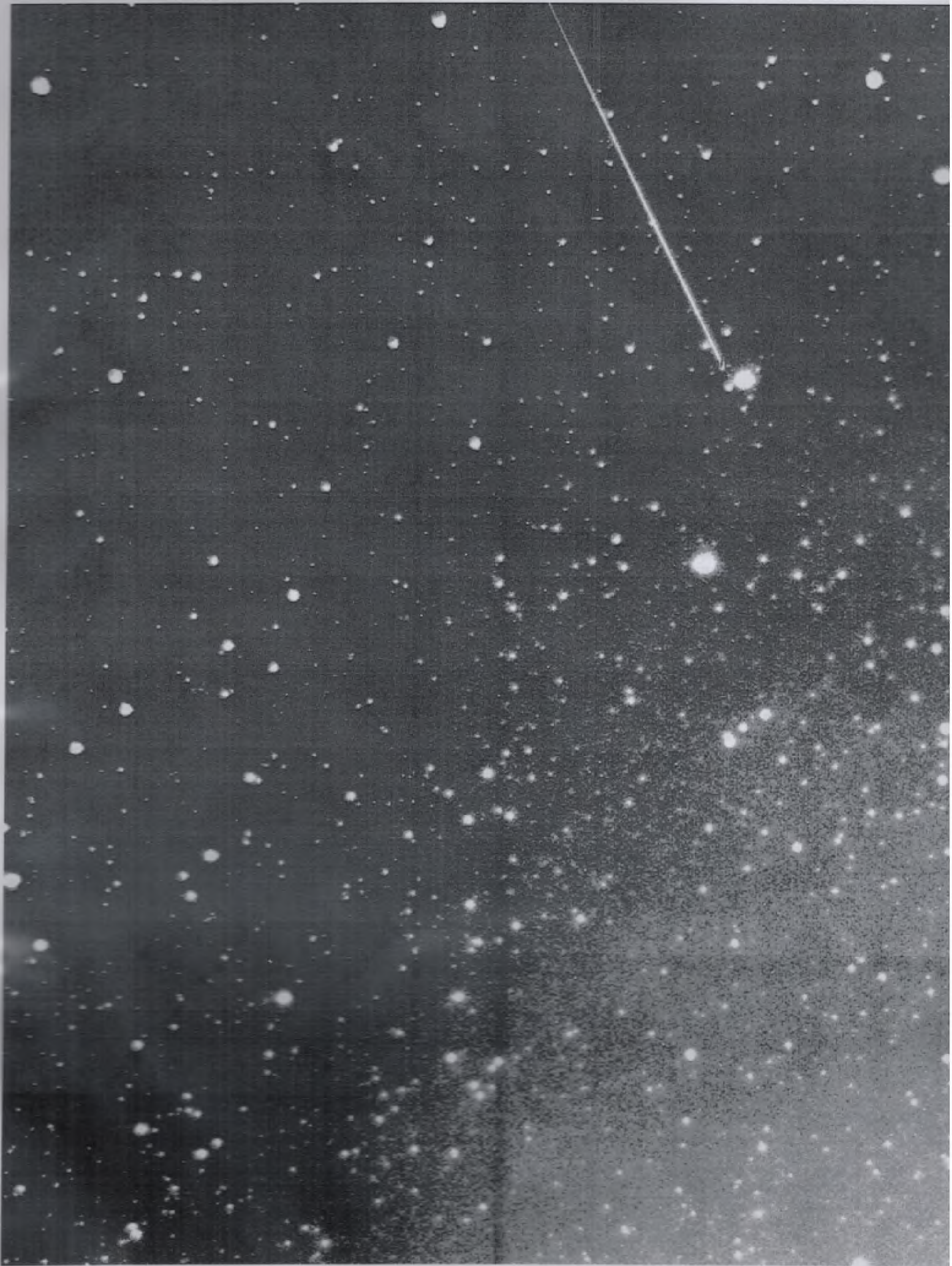
The dissertation has been sent to the examiners.

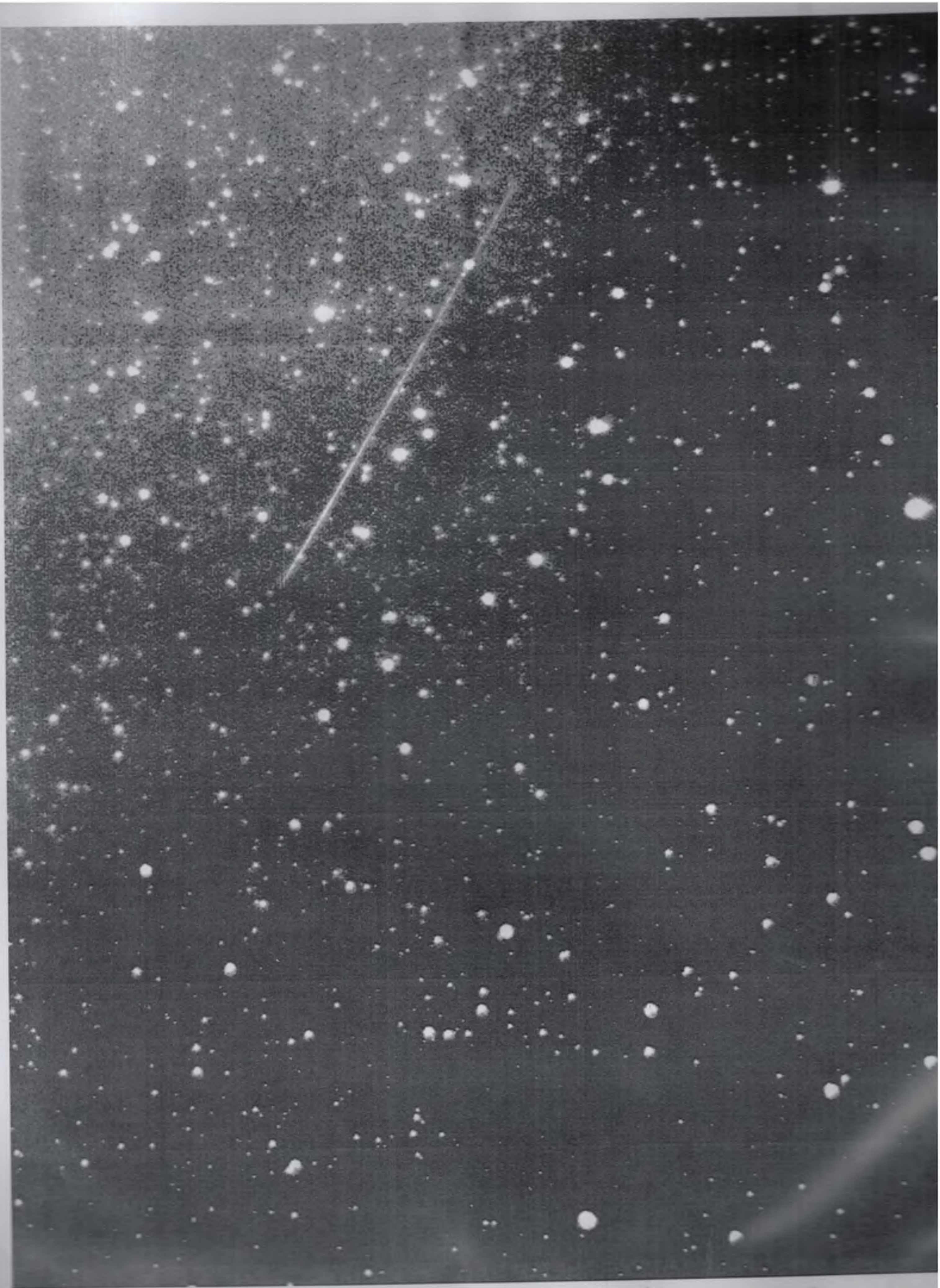
Sincerely

The Hebrew University of Jerusalem
The Authority for Research Students

Elka Tirnover
Authority for Research Students







Star Trails 101

The Third Star

by David H. Levy

It's late on a Saturday afternoon in downtown Jerusalem, perhaps 2500 years ago. A man stands outside the Temple, anxiously looking upward. He sees a bright star rising in the east, and a second one overhead. This man knows the sky well, and as he turns to the Northwest, he glimpses Capella in the gathering darkness. "That's it!" he thinks. Three stars have appeared, and that ancient Sabbath of millennia ago has ended.

Although the Jewish tradition of sighting stars is no longer generally practiced, it dates back to the dawn of skywatching. On cloudy nights, the observer would look at two strings, one white, one blue, and would judge the sabbath over when he could no longer tell their colors apart. All of Judaism is based on a lunar calendar. For many of us, the sky goes beyond equations; our interest in the night sky has a strong spiritual component, whether it is the sighting of three stars or the phase of the Moon. I realized this many years ago, on the eve of Judaism's holiest day. Kol Nidre evening, a long and beautiful service, is known for some of the most soaring music of the Jewish liturgy, but for me its meaning extends literally to the sky. While walking home after one of these services, I noticed the bright 10 day old gibbous moon dominating the evening sky, its impact craters Copernicus and Tycho having just seen sunrise after their frigid two-week night. I realized that the Moon displays the same phase every Kol Nidre night, and has through the ages. That moonlit walk home joined my senses of science and spirituality.

That sense of spirituality is strong in our family, six generations of which have been with Congregation Shaar Hashomayim. This synagogue, whose name means Gates of Heaven, is celebrating its 150th anniversary this year. William Levy, my grandfather, helped design the sanctuary which was built in 1922. The synagogue is especially known for its exquisite choir, whose renderings of Jewish liturgical music have made Sabbath and holiday services a joy to attend. When I am hunting for comets late at night, I often think of the choir's renderings: they end so beautifully and peacefully that they almost command their listeners to look up.

Having a spiritual sense of the sky is not just a feeling. In Judaism the relation is a literal one, since the calendar is based on the orbit of the Moon about the Earth. It is not a coincidence that the Moon is always 10 days old every year after Kol Nidre services, nor is it by accident that the total lunar eclipse of April 3 this year took place on the first Passover seder, which always occurs on the night of full

Moon. This spring's eclipse is one of several I have seen during the first night of Passover; in 1968 I rushed away from a seder early to catch one.

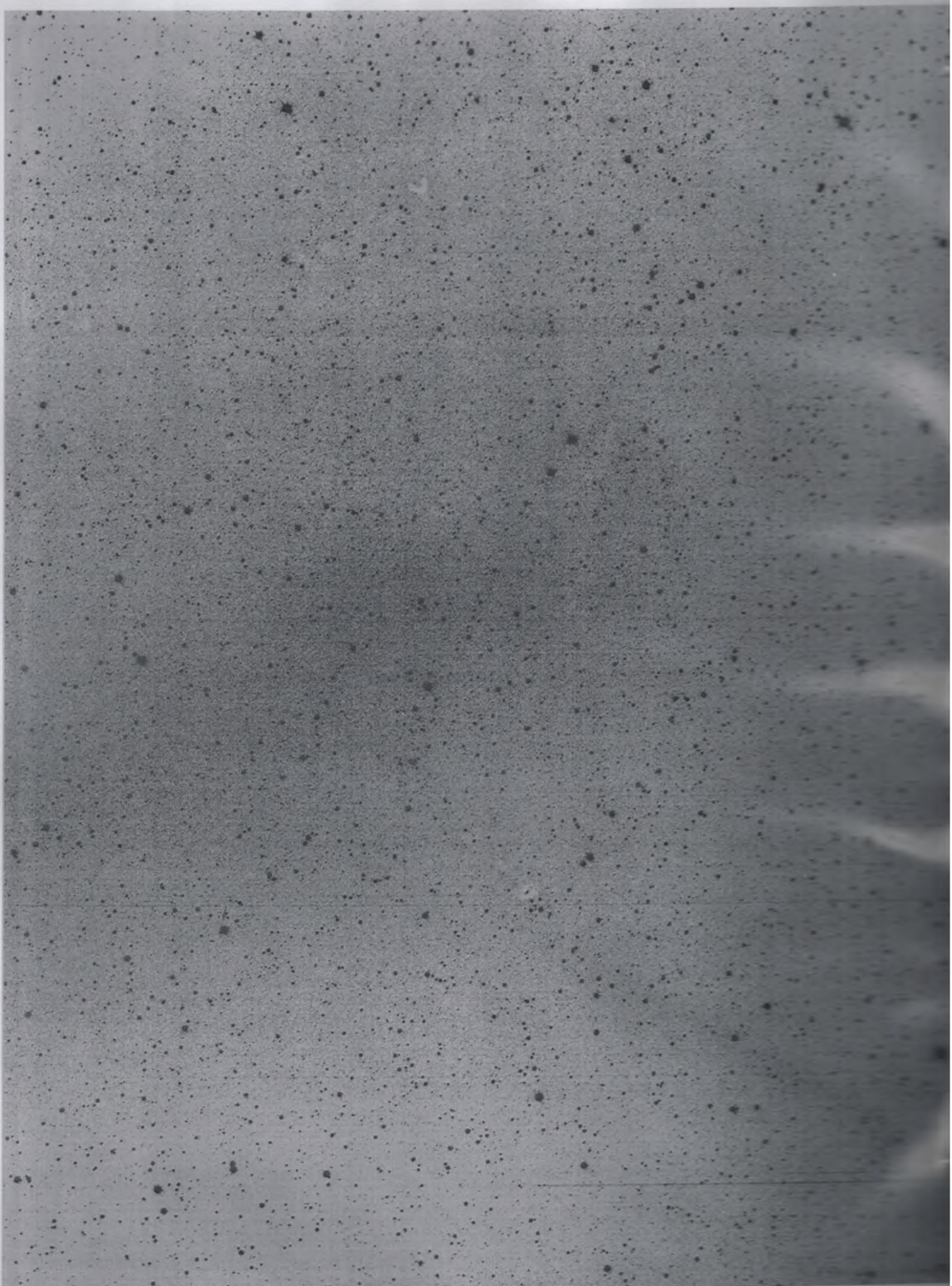
A culture so closely connected to the sky will go more deeply than moon phases. The first book of Chronicles describes what could be a comet-- the comet of 971 BC appeared near that time-- which protested an ill-advised census King David had ordered. The biblical passage is read every year at the Passover seder: "And David lifted up his eyes, and saw the angel of the Lord standing between the earth and the heaven, having a drawn sword in his hand stretched out over Jerusalem."

Connecting the words of liturgy to a love of the sky is easy, as anyone who has attended Stellafane knows. But though the words are there, the feeling more complicated. "The Heavens declare the glory of God," trumpets Psalm 19; these words remain prominently inscribed on the clubhouse through sixty years of telescope conferences. Russell Porter, Stellafane's 1920s founder, took those words very seriously even though he was not an active churchgoer. In his biography of Porter, Berton Willard noted that "One Sunday morning when he and Oscar Marshall were heading for the clubhouse, they were approached by a deacon and asked whether they were going to church. Porter replied they were going to Breezy Hill and would not make any noise that would disturb him. He also reminded the deacon of the inscription on the gable of their temple to the stars." Porter felt that there was no place closer to his spirit than an observatory like Stellafane. Years later and a continent away, he built the telescope at Palomar that the Shoemakers and I used in our comet discoveries. In all the many hours we worked there, my favorite part was when the dome shutters started to open, slowly revealing a darkening sky. No matter how busy the next 13 hours of photography would be, I cherished the minute that passed by as the opening shutter cajoled the sky to enter. It is a spiritual feeling that can separate from a specific religious belief, but doesn't have to be, and I am sure many skywatchers, regardless of their religious feelings, have a similar experience at the start of a beautiful night.

Equations can explain the physics of what we see in the night sky, but the wonder goes beyond the numbers. Each of us has a personal reason for enjoying the precious beauty of the night sky. For some, the background of a religious liturgy helps. The Jewish framework is its ancient tradition of a nomadic people that depended on the Moon for their calendar. It was also a part of that tradition that the Sabbath and festivals ended after an official observer noticed that the evening sky was dark enough that three stars had appeared. That man who stood outside the Temple in Jerusalem, waiting with anticipation for the sky to darken so gradually and carefully until three stars appeared, must have felt his cosmic role. Sabbath would not end until the sky presented him with three stars. It must have been a singular and personal way to get acquainted with the sky. Seeing that third star must have felt as wonderful as discovering a comet.

**13665E. Saturday, November 8, 2003/1730-2300/7-fm/Westmount Lookout/Eclipse No. 64. Total Eclipse of the Moon.


CN35
ASC-
AAR
Observatory



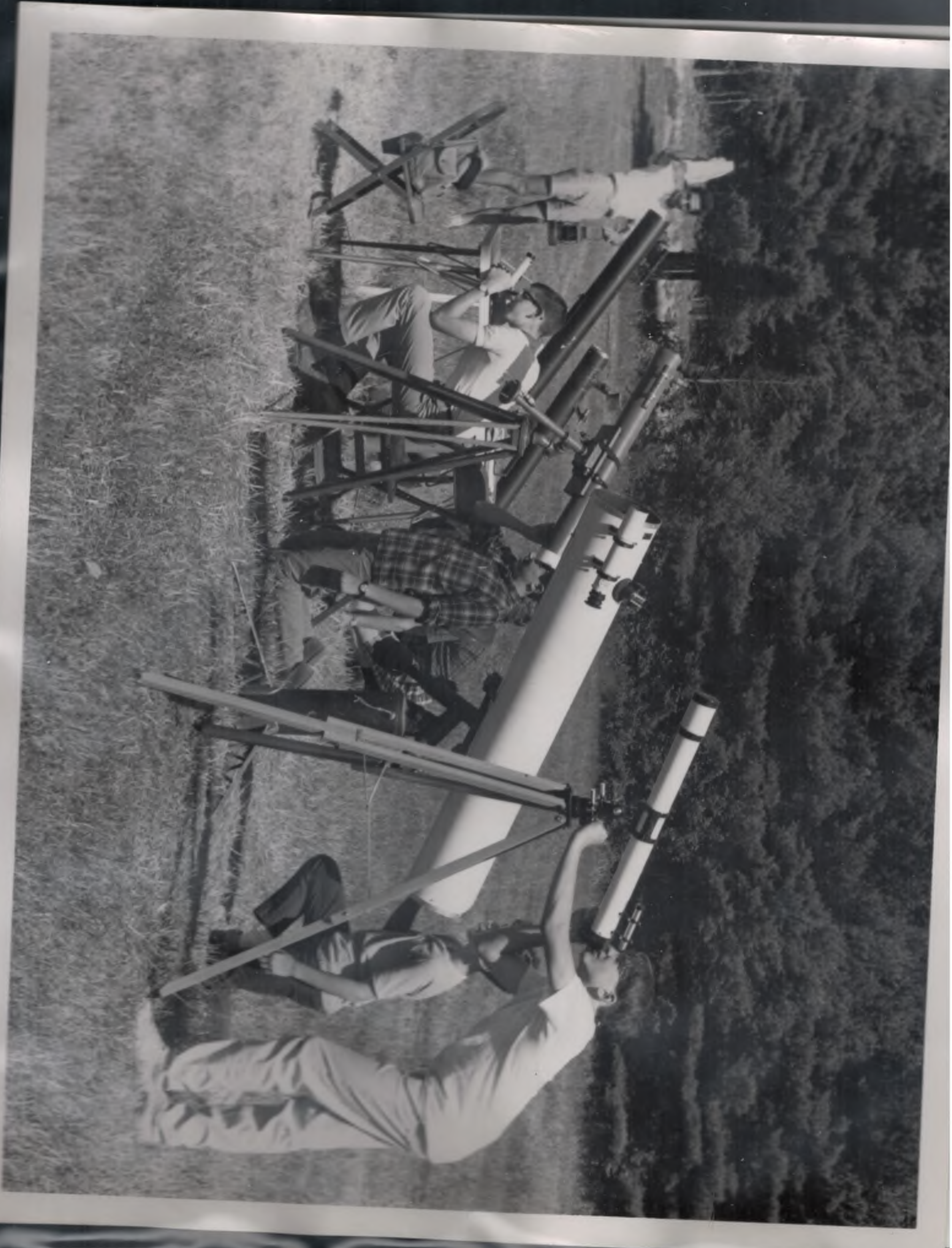



Observato






Observatory



@50%

FIG 27


SLOAN'S LAKE
Lake M.S.

CN3s

Comet Hunting

And

Sharing the Sky

Adirondack Astronomy Retreat

Adirondack Science Camp

December 17, 2004

THE ROYAL ASTRONOMICAL SOCIETY OF CANADA
LA SOCIÉTÉ ROYALE D'ASTRONOMIE DU CANADA

First Light for RASC Remote Observing Project

Contributed by Peter Jedicke, National Office
Feb 1, 2006, 02:37

It's two o'clock in the morning. I'm observing under clear skies and my throat is sore. But not because of the cold! No, I'm sitting at my desk at home in London, Ontario, with a mug of hot chocolate. The telescope I'm using is southeast of Tucson, Arizona, at the Jarnac Observatory. The reason my throat is sore is that I've just spent 133min on the phone with RASC member David H. Levy (Honorary President of both Montreal Centre and Kingston Centre; 1980 Chant Medal winner), learning about David's web-based interface for remote observing.

David has agreed to make some time available on one of his telescopes ("Clyde") for RASC members. Members of the Astronomical Society of the Pacific will also be invited to join in the fun. Although David wants to do some more work on his system before opening it for general use, he let me take it for a spin, so to speak. We recorded this in David's observing log: it turns out this is session #15000EM3 since David began his observing career in 1959. Imagine having clear skies like that!

Now, I'm no digital imaging guru, so I wasn't expecting my first attempts to look like a Paul Mortfield or Jon Gunning sky masterpiece. Here's the result of targeting M79, the Milky Way Globular Cluster south of Orion:

Globular Cluster M79 by Peter Jedicke

It's pretty easy to use. I entered M79 in the database query textbox and the system found the proper coordinates for me. No Sky Atlas needed! Then I chose the exposure time (20sec) and clicked "Acquire." A few minutes later, Presto! The system also generated a FITS image of this picture, so if I knew how to massage the data, I could have some fun teasing more detail out of this. Stay tuned for further updates, particularly if you think you'd like to do some remote observing in the near future.

Thanks for opening your dome to us, David!

Public Outreach: What Wendee and I do

Meeting at Planetary Science Institute

October 29, 2004

Dear friends,

This month marks the 25th anniversary of my arrival in Tucson. The day after I arrived I visited Flandrau, and in 1982 I began my long association with the Planetary Science Institute. For me, organizations like the Planetary Science Institute and the Flandrau Science Center have played a major role in the public outreach I have tried to do during all these years.

I hope that we can find some way to turn the following pages into a proposal that could be funded. We hope to put in place a program that is far-reaching, and which will have an impact on how the public, and particularly young people, perceive the cosmic show. It is our hope also that the funding would include a position at least person—hopefully Wendee—to manage the logistics of Project Skywatcher.

Especially since Comet Shoemaker-Levy 9's collision with Jupiter in 1994, I have been increasingly involved in a large number of activities designed to increase public perception of science. They include my 31 books (soon to be 32), my writing in *Parade, Sky and Telescope,* and other magazines and journals, my public lectures, our radio show *Let's Talk Stars,* as well as the boards of Flandrau, The Astronomical Society of the Pacific, and Planetary Science Institute. All these activities—some funded, and some not—together take up most of Wendee's and my waking hours. In recent months I've been trying to find a way, in my own mind, to bring these disparate roles together.

Project Skywatcher is the result. It summarizes all the outreach activities Wendee and I do. It does not include the other major project of my life—the search for comets-- which is still my primary passion. However, even the comet search has a big outreach component which I hope can become a part of what we are trying to accomplish—the idea that young people can enjoy watching asteroids and comets creep through the sky, and maybe even find some for themselves, as part of the show that never ends.

Sincerely

David H. Levy

Project Skywatcher

I stood and stared
The sky was lit
The sky was stars all over it
I stood, I knew not why
Without a wish, without a will
I stood upon that silent hill
And stared into the sky until
My eyes were blind with stars and still
I stared into the sky.

--*Ralph Hodgson*, Song of Honour, 1917

I. Purpose: To motivate young people to discover the night sky. We hope to provide young people with the "pursuit of happiness"—with the means to develop a passion for observing the sky, and in turn to acquire an intelligent interest in science. We want to place telescopes in selected areas around the United States and in the Southern hemisphere, so that children look through them both visually on site, and from their classrooms and homes via the web.

II. Overview

With the advent of many Education and public outreach projects, we want to take advantage of David and Wendee Levy's passion for the night sky to provide a motivation for as many young people as possible to enjoy the night sky. We wish to set up a network of telescopes on one hand both for direct viewing and to gather images, and a network of schools and universities on the other to allow students to enjoy and learn from these telescopes.

III. Joining forces

The following organizations are interested in participating in Project Skywatcher. Besides each is listed the major contribution it could provide for the project:

Jarnac Observatory, Inc.: "home base" for several of the telescopes and computer systems. Also host of our web-based radio program *Let's Talk Stars* that shares the night sky with amateur and professional astronomy guests around the world.

Flandrau Science Center: This University of Arizona Facility will host an interactive exhibit that allows visitors to look at the "object of the week." As the primary science outreach outlet of the University of Arizona, Flandrau has made major contributions to increasing public awareness of science.

CN3t
Comet and asteroid hunting

with
Tom, Wendee,
and
Hyperion.

From: quai@cfa.harvard.edu
To: OBSERVE@jarnac.org
Subject: IAUC 9125: C/2010 D4; P/2010 E2 [XXXXX-XXXX/XX-F1]

Circular No. 9125
Central Bureau for Astronomical Telegrams
INTERNATIONAL ASTRONOMICAL UNION
CBAT Director: D. W. E. Green, Room 209; Department of
Earth and Planetary Sciences; Harvard University;
20 Oxford St.; Cambridge, MA 02138; U.S.A.
CBAT@IAU.ORG; CBATIAU@EPS.HARVARD.EDU
URL http://www.cfa.harvard.edu/iau/cbat.html ISSN 0081-0304

COMET C/2010 D4 (WISE)

A. Mainzer, Jet Propulsion Laboratory, notes that an object found on WISE satellite images (discovery observation tabulated below) appears "soft" in 12-micron images with a 'blurry' central condensation of size about 14"; 22-micron images show it to be brighter, with diameter about 17". Numerous ground-based observers have been unable to detect cometary activity.

2010 UT	R.A. (2000)	Decl.	Observer
Feb. 28.01782	17 15 03.30	+41 02 22.1	WISE

The available astrometry, parabolic orbital elements (T = 2009 Mar. 30.939 TT, q = 7.17413 AU, Peri. = 43.916 deg, Node = 266.488 deg, i = 105.482 deg, equinox 2000.0), and an ephemeris appear on MPEC 2010-E63.

COMET P/2010 E2 (JARNAC)

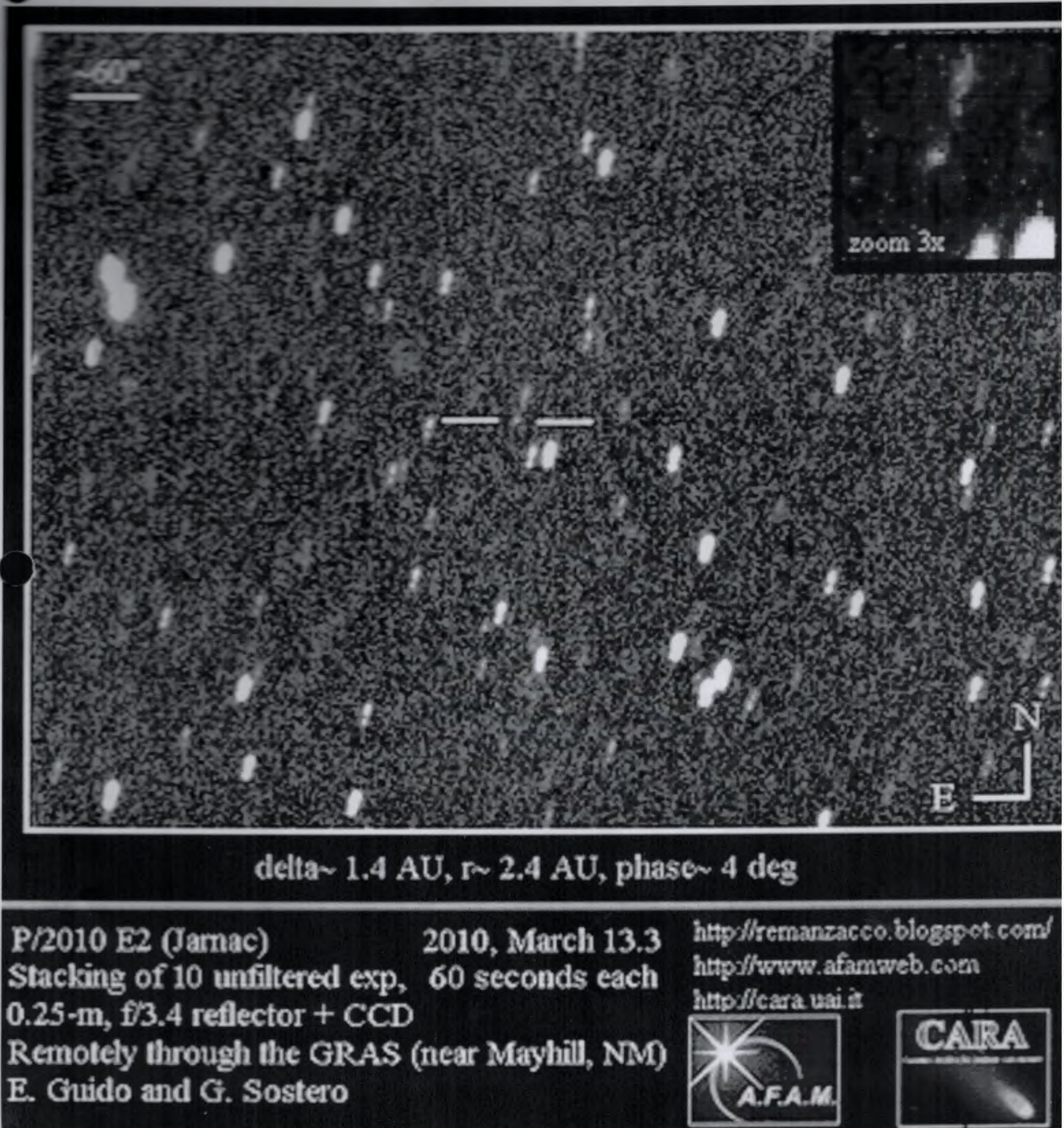
An apparently asteroidal object reported by T. Glinos on CCD images taken with a 0.64-m f/7.2 Ritchey-Chretien telescope at the Jarnac Observatory in Vail, AZ, U.S.A., on Mar. 9, 10, and 12 (discovery observation tabulated below; observers listed as D. Levy, W. Levy, and T. Glinos), and linked together by the Minor Planet Center staff and also with observations from the Mount Lemmon survey taken on Feb. 17 before being posted on the MPC's 'NEOCP' webpage, has been found to show cometary appearance by other CCD astrometrists. D. Chestnov and A. Novichonok write that three co-added 300-s unfiltered CCD images taken remotely with a 0.36-m f/3.8 reflector at the Tzec Maun Observatory near Mayhill, NM, U.S.A. on Mar. 13.23 UT show a faint 0'.3 coma of mag 19 with a strong nuclear condensation and no tail. CCD images taken by W. H. Ryan and E. V. Ryan with the Magdalena Ridge Observatory (not McDonald Observatory, as erroneously written on IAUC 9117) 2.4-m f/8.9 reflector on Mar. 13.4 show a coma extending toward p.a. about 280 deg.

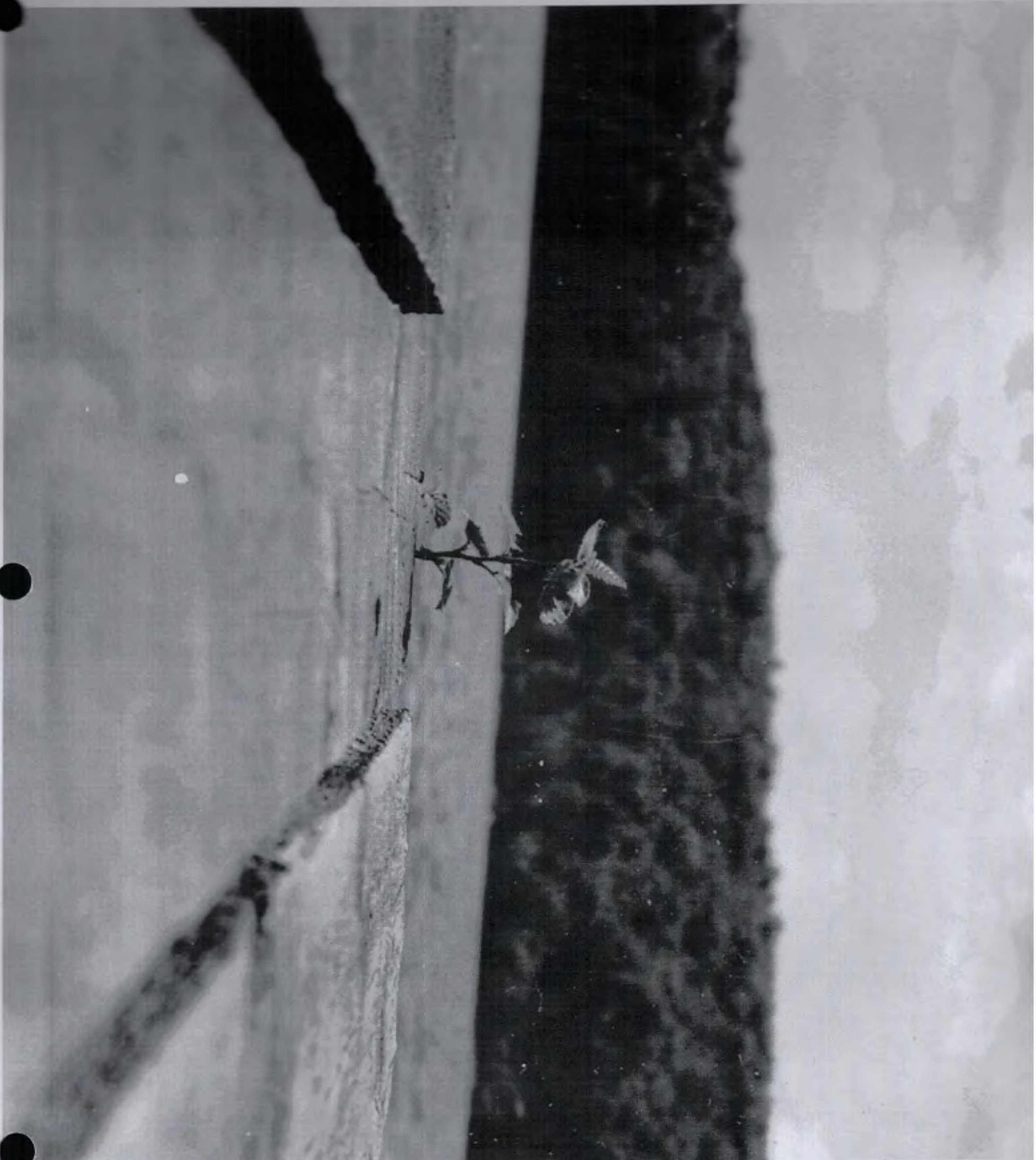
2010 UT	R.A. (2000)	Decl.	Mag.
Mar. 9.30939	12 02 57.94	- 1 17 03.0	18.7

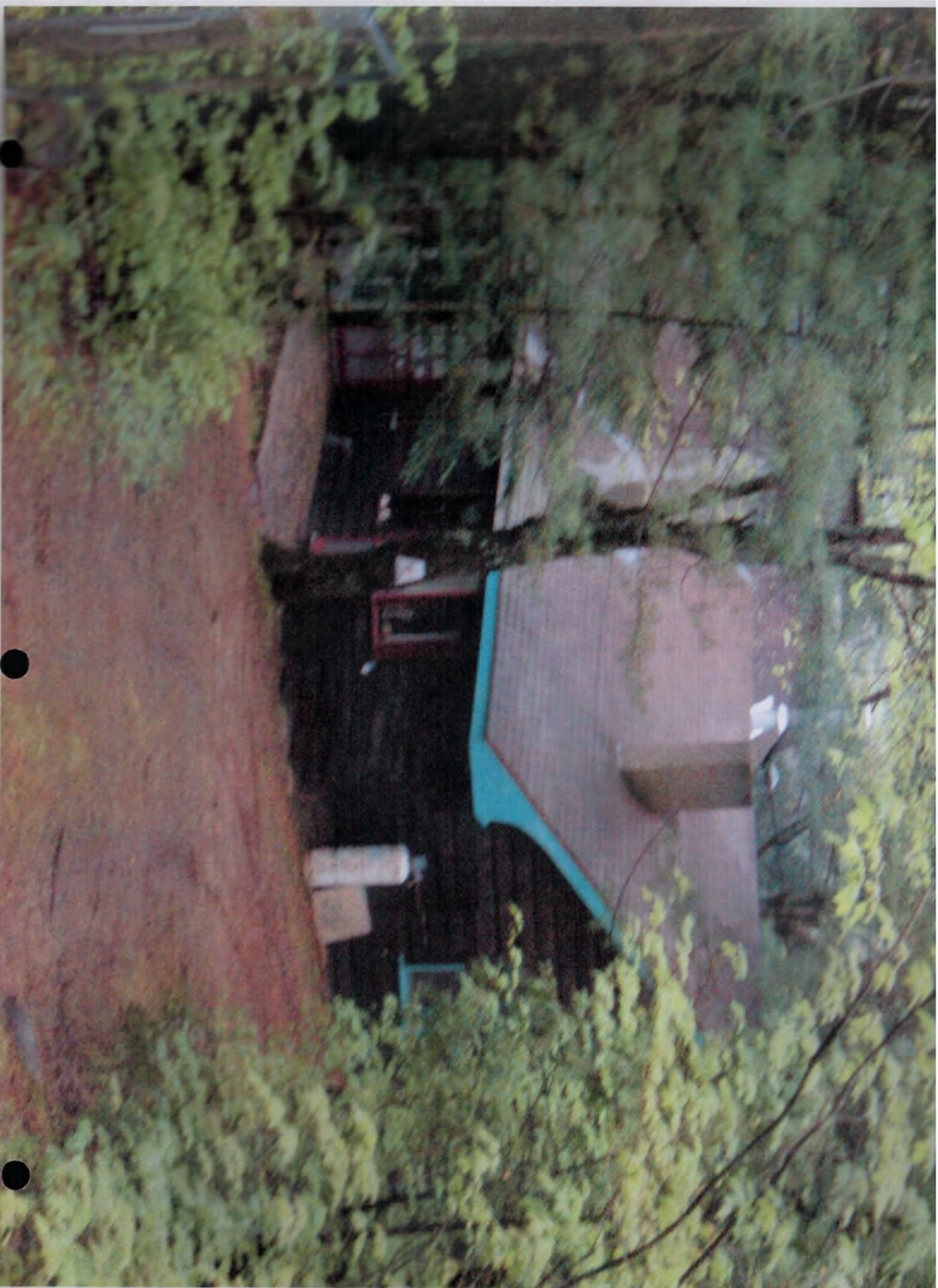
The available astrometry, the following elliptical orbital elements, and an ephemeris appear on MPEC 2010-E64.

T = 2010 Apr. 7.8086 TT   Peri. = 8.2567
e = 0.721879   Node = 177.8984 2000.0
q = 2.397960 AU   Incl. = 15.4256
a = 8.621986 AU   n = 0.0389308   P = 25.3 years

2010 March 13   (9125)   Daniel W. E. Green


~60"
zoom 3x
N
E
delta~ 1.4 AU, r~ 2.4 AU, phase~ 4 deg
P/2010 E2 (Jarnac)
2010, March 13.3
Stacking of 10 unfiltered exp, 60 seconds each
0.25-m, f/3.4 reflector + CCD
Remotely through the GRAS (near Mayhill, NM)
E. Guido and G. Sostero
http://remanzacco.blogspot.com/
http://www.afamweb.com
http://cara.uai.it
A.F.A.M.
CARA





JCS

Jarnac Comet Survey

Contents

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30 July 2001

A New Way to Survey the Sky

The Jarnac Comet Survey (JCS) is a completely new approach to searching for potentially hazardous near-earth objects. As the name suggests, our primary emphasis is on comets. By optimizing our survey strategy for comets, we are complementary to, rather than competitive with other survey programs.

We are also taking a new approach to surveying, utilizing both tried and true survey methods, as well as innovative new ones. The primary emphasis is on applying new technology to small (less than 1 meter aperture), wide field telescopes to survey large areas of sky to faint limiting magnitudes.

By using the links to the left, you can access more details on the various aspects of the Jarnac Comet Survey.

Prototype System Observing

The implementation of new automated scripting software has finally allowed us completely hands-off use of our 0.2-m prototype survey system. The 0.2-m, while not adequate for survey operations, has been a key testbed for the future automation remote operation of larger instruments for the planned survey.

Observations are being conducted each clear night from Jarnac Observatory, and many nights have been completed entirely unattanded. The present success with the automation of the 0.2-m bodes well for the future of electronic surveying as part of JCS.

Introduction to the Jarnac Comet Survey

The Jarnac Comet Survey (JCS) is the result of a fruitful collaboration between the extremely successful traditional comet discoverers David and Wendee Levy and Carolyn Shoemaker, and new automation and detector technology and techniques as well as scientific insight provided by Carol Neese and Gilbert Esquerdo of the Planetary Science Institute.

The population of comets that inhabit the solar system, particularly the smaller members, is poorly understood. By optimizing our survey for the detection of small, faint comets, we hope to extend our knowledge of the comet population to smaller sizes. Details on our science goals may be found in a link under that name on the main page.

While the current workhorse of the Jarnac Comet Survey is the 0.3-m f/2.2 Schmidt camera, we are beginning to transition to a fully electronic, fully automated survey. We have chosen to incorporate commercially produced components to reduce costs as well as development time. Currently, a 0.2-m system operating at f/4.35 has been the primary automation testbed system. We have successfully operated in automated mode since February of 2001. More advanced scriptwriting has allowed the system to run without operator intervention throughout the night. This technology will be applied to the next generation of instruments we bring on line.

Moving object detection is accomplished through a commercially produced software package that scans the three images taken of each field and looks for objects that are displaced from one image to the next. Accurate positions are derived for each detection and these positions are then compiled into a format suitable for submission to the Minor Planet Center.

The only human intervention for the automated survey will be the writing of each nights script of observations, transfer of this file to the telescope via the internet. At the end of each night, the raw data will be processed in a batch mode and then analyzed by the moving object detection code. The candidate detecions are then manually inspected by an operator to check for any false detections that may have fooled the detection code, as well as to provide a means by which to determine what objects show cometary properties.

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Scientific Goals of JCS

The Jarnac Comet Survey is a unique approach to the detection and discovery of small solar system bodies. While superficially similar to other NEO surveys, it emphasizes comets, combining deep CCD imaging, automated operation, and a near-sun survey strategy optimized for comet detection.

We expect to discover a statistically significant sample of faint comets in the inner solar system to extend the size-frequency distribution for comets to small sizes where it is now poorly known. Current models of solar system formation differ on whether the comet size distribution continues to higher numbers as size decreases, or turns down due to physical effects resulting in short lifetimes for the smallest cometary bodies in the early solar system (Stern and Weissman 2001). The results of JCS will provide an important constraint to this problem.

In addition, comets play an important role in the near-earth impact hazard (Harris 1999). JCS will better determine the severity of the hazard from comets as impacting bodies. As well, an improved knowledge of the population of small comets passing through the inner solar system is essential for future target selection for NASA missions (Davis et al. 1997).

Technologically, the survey will bring established hardware and software options together into one integrated system for automated and remote observations. While automated and remote observatories are established in the astronomical communtity, they have historically relied on expensive custom hardware and software to complete the task. Many of these components are beginning to be made commercially available in the form of sub-meter class telescopes, large format CCD camera systems (up to 4000 pixel square arrays) and software that will integrate with this hardware to allow fully automated operations and accessibility via the internet. We have already begun to demonstrate these operations at the Jarnac Observatory with the automation of a 0.2-m telescope and CCD camera.

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CN3u Hyperion.

Comet hunting electronically, narrower but deeper.

Comet van Gent-Peltier

(Drawing from a photograph taken December 24 with the 24-inch reflector of

LITERARY SLEUTH

By MICHAEL COBDEN

In his relentless search for knowledge, Queen's University Professor Norman MacKenzie, the world's leading authority on English poet Gerard Manley Hopkins, uses techniques not unfamiliar to a Scotland Yard detective

. . . what we have loved,
Others will love, and we will teach them how;
Instruct them how the mind of man becomes
A thousand times more beautiful than the earth
On which it dwells . . .

Wordsworth, The Prelude

Criticism: a disinterested endeavour to learn and propagate the best that is known and thought in the world.

Matthew Arnold

IN THE SOUTHERN hemisphere's summer of 1963, Professor Norman MacKenzie, then of the multiracial University College of Rhodesia, now of Queen's University, was on his way from Cape Town to Salisbury. He had in his car a suitcase containing 15 years of research on Gerard Manley Hopkins, the late-Victorian English poet of joyful and painful genius, together with his annotated first editions of Hopkins's works, and the handwritten manuscript of all but the last chapter of a book on Hopkins which he had been invited to write.

"I had the suitcase immediately behind the driver's seat," he says, "because I thought, if there's an accident and the car catches fire I must be able to snatch it out. You see, I don't type unfortunately; and this was the only copy of the manuscript I had.

"A lawyer friend was with me, and when we reached Johannesburg (about half-way) we decided we'd better stop overnight. I locked the car, and we were away from it for only seven minutes booking hotel rooms and a lock-up garage, and in that time it was broken into. It was a station wagon full of our possessions. The only thing they took was the suitcase containing my Hopkins research. The car still had international licence plates — no doubt the thieves hoped for passports and money.

"I searched all the areas round about. I thought, when they find this useless stuff they'll just throw it into a garbage can, so I examined all the bins in the vicinity. During the next few days I spent time 'window shopping,' actually just watching the reflections in the windows, looking out for the gang. I thought, if I can get onto these blighters I'll find out what's happened to my material. And I visited all the second-hand bookshops, hoping that someone would come in offering those annotated first editions. I gave the booksellers a police emergency number to call.

"In the end, I found the suitcase in a railway left-luggage office with,

Prof. Norman MacKenzie: A scholar of the highest international standing

oh, a couple of bookmarkers in it, a shirt of mine, a pen. But the rest — I think all my research had been thrown out of a railway train, and I didn't get a thing back.

"So I had to start all over again. On the way up to Rhodesia, driving alone from Johannesburg to Salisbury — my lawyer friend had had to go on ahead — for every hundred miles I concentrated on thinking of a section of that book. I had a piece of paper pinned up on the dashboard, and as soon as an idea occurred to me I just jotted it down.

"When I got to Salisbury I had a little deputation from the faculty to tell me that I had to become dean again, and I must take on all the administration. [He was also head of English, and was busy helping the college build up its library from zero to 100,000 volumes.] But over the weekends I used to lock myself up in a deserted arts building, in a seminar room, and just rewrite from memory everything I could dredge up. Fifteen years work. And seven months of intensive research in the British Museum."

What a loss. I said he told the story with barely a hint of wretchedness. He smiled. He is a man who smiles often, warmly, sympathetically and with enlightenment. Now, however, there was a moment of darkness in his eyes. "Well," he said, "it was like losing a child, it was like a bereavement. And it took me years and years to get over it. It affected my self-confidence in curious ways."

MacKenzie, who has been at Queen's for 16 years, rewrote the book (*Hopkins*, in the Writers and Critics series published by Oliver and Boyd: Northrop Frye did the Eliot) and went on to become the world's leading literary authority on Hopkins's work. He is co-editor of the widely acclaimed Fourth Edition of *The Poems of Gerard Manley Hopkins* (Oxford University Press), has recently had published, by Thames and Hudson, in that house's highly esteemed critical series, *A Reader's Guide to Gerard Manley Hopkins*, and is now preparing the definitive, variorum edition of Hopkins's poetry in the *Oxford English Texts* series. What a comeback.

MacKenzie is a scholar, then, of the highest international standing, a man whose mind, so much like Hopkins's, encompasses a wide range of subjects, from art to astronomy, from economic history to ornithology, and delves with infinite curiosity into each of them, making them his own and — so refreshingly — making them accessible to all. "The world has become very complex," he remarks. "I'm continually finding out how difficult the jobs are that other people do, and what expert knowledge they need for them. And that's very salutary for a university man, because we tend to become engrossed in our own narrow discipline and to think that the world revolves around it." He has been aptly described, by Peter Milner, in *Perspectives: Profiles of Research at Queen's University*, as "a man who goes behind stage in life and scrutinizes the intricate ropes and riggings, pulleys and winches, that bring it all off."

MacKenzie is one of a handful of English professors at Queen's in recent years who have achieved this international standing. Among the others I know of are George Whalley, at present editing Coleridge's *Marginalia* and *Poems* in five volumes, a project of immensely ambitious proportions requiring of Whalley an intimate knowledge not only of Coleridge's work but of all the works in whose margins he made notes; A.C. Hamilton, author of books on Spenser and Sidney and general editor of the massive *Spenser Encyclopaedia*, signifying his position as one of the world's leading authorities on the whole, rich Renaissance period in English literature; Antony Alpers, who wrote the definitive *Life of Katherine Mansfield* (and is also a world authority on dolphins and on Maori legends); and John Matthews, a specialist in Commonwealth literature who has also established Queen's as *the* centre for the study of Disraeli.

I focus on MacKenzie for three reasons: firstly, because I love what I know of Hopkins's poetry; secondly, because I have read his *Reader's Guide* with immense enjoyment; and thirdly because he hails from the same part of the world as I do, which, together with the fact that I profited from his book, suggested that I would enjoy talking to him, as indeed I did — to him and to his wife Rita, a painter and singer of stature. I discovered that MacKenzie had attended university in the city where I went to boarding school for nine years — a city much like Kingston in many ways — and that he had, in fact, applied for a teaching post at my school. Had he been accepted, he might have stayed long enough to have been my English teacher. Instead, he became a distinguished scholar. But as it turns out, he has become my teacher after all. I envy those generations of Queen's students who have had this advantage, and who have had the benefit of a very fine establishment of English literature scholars.

WHILE MacKENZIE was rewriting his first book on Hopkins, he was also designing an arts building (because the university had become fed up with the architects' plans), as well as making proposals for future building developments for the next 20 years. And at the same time he was working with the late W.H. Gardner, his predecessor as the world's leading editor of Hopkins's poetry and also, as it happens, a native of southern Africa, on the Hopkins Fourth Edition, which has sold 45,000 copies, remarkable in a work of this nature, and which, since its publication in 1967, has been the standard text of Hopkins's poetry.

"And in the middle of that I heard that U.D.I. [Rhodesia's unilateral declaration of independence] was coming. We decided that we must get out of Rhodesia before that occurred. Fortunately, I was invited to Laurentian [in Sudbury, to head that new university's English department], and so we had the upheaval of selling our house, packing everything up."

MacKenzie stayed only a year at Laurentian, because he couldn't survive without a good university library. George Whalley had invited him to Queen's, whose library has been a joy to him. Listen to him enthuse about it — he is such an enthusiastic man: "It's a tremendous privilege to have an old library, and a large, multidisciplinary one. It's a wonderful research instrument, and I use the whole of it, just about — except for mathematics and chemistry. Time and again I find that the Douglas Library a century ago bought some now obscure book which influenced Hopkins — an abstruse philosophical study, or Glaisher's account of his scientific investigations of the atmosphere during ascents in a balloon. But I have also been delighted at the steady improvement of our collections. When I arrived we had very few art history volumes with good illustrations of the British paintings Hopkins commented on when he visited exhibitions. Now we have superb holdings."

His enthusiasm about Hopkins abides, after all these years. He probably knows more about Hopkins's work than anyone else, and yet he is happy to talk about it with someone who knows little, to reveal no end of delight in Hopkins's genius and to read his verse aloud — as it should be read, and as MacKenzie does it so well: quietly, unaffectedly but melodiously, in his British Rhodesian accent, with the rhythm springing as it should, and with understanding.

Hopkins, you will recall if you "took" him at school, was a Jesuit priest who wrote poetry with a vigorous (though sometimes obscure) vocabulary, an unusual and often

'MacKenzie's book is a masterpiece of good, and comprehensible, sense. It guides the reader through Hopkins's dense but dazzling syntax. It makes the poetry more accessible'

crowded syntax, and a distinctive "sprung rhythm." His work reflects the tension — but also the reconciliation — between the esthetic and ascetic forces within him, his profound belief in God's omnipresence, his knowledge and love of nature, his artistic zest and, at times, his terrible melancholia. His poetry, in Gardner's words, was the outcome of a "tension between the free creative *personality* of the artist and the acquired, dedicated *character* of the Jesuit priest." Hardly published in his lifetime, Hopkins is now recognized as one of the giants of English literature, and unexcelled in sheer poetic gift.

He was born in 1844 at Stratford in Essex, the eldest and most artistic child of a gifted family. His father, MacKenzie tells us in the *Reader's Guide*, was "an earnest Anglican, . . . a successful marine insurance adjustor, author of well-known practical handbooks for owners and masters of ships (yet with unexpectedly learned references to Greek and Latin), who also produced some volumes of verse in which piety, sentiment and humour jostled each other." Like two of his brothers who became professional artists, Hopkins hoped at first to be a painter. He abandoned it as a possible career, MacKenzie tells us, "partly because he foresaw moral dangers in its pursuit: 'The fact is that the higher and more attractive parts of the art put a strain upon the passions which I shd. think it unsafe to encounter.' "

He attended Highgate Grammar School, where he won poetry prizes and an Exhibition. He read Latin and Greek at Oxford, and though he wrote a number of poems, his first duty seemed to him to obtain the best possible degree — which he did. At 22, he was finally convinced of the Catholic position, and was received into the Church by John Henry Newman, who later became a distinguished cardinal, theologian and educationist, as well as a poet and novelist.

Having decided to enter a religious order, Hopkins burned some copies of his poems as a symbolic gesture, but sent corrected copies of his best work to his friend Robert Bridges for safekeeping, resolving "to write no more, as not belonging to my profession, unless it were by the wish of my superiors." "The threat to his religious vocation," MacKenzie has observed, "lay not in the poems themselves but in the risk of his attachment to them." Later, after seven years' silence, he found that poetry could help him achieve his vocation.

HOPKINS'S TRAINING as a Jesuit, including periods as a teacher and a parish priest, took him to many parts of England, Wales and Ireland. In 1884, he was appointed professor of Greek and Latin literature at Royal University of Ireland and fellow in classics at University College, Dublin. Here, in a strongly anti-English atmosphere, he was obliged to examine the scripts of candidates from other colleges, "at all levels," MacKenzie says, "from hordes of would-be matriculants up to MAs. These examinations (which occurred five or six times a year and could produce as many as five hundred papers) proved a nightmare to him, combining with his sense of exile to produce serious depression in health and spirits. Yet," MacKenzie adds, "the poems of desperation he composed . . . have appealed strongly to readers in our own age familiar with modern existential anguish and the energy of despair."

Hopkins died of typhoid fever in June 1889, in his 45th year. "If Hopkins had composed his own epitaph," MacKenzie has said, "he would probably have omitted all reference to his poetry, which in later years he had taken pains to conceal from all but a few of his closest friends. Using the Ignatian military metaphor, he might merely have written in unprophetic modesty: 'Though he brought the Society of Jesus no glory, he never wavered in his allegiance.' "

□

Of all the cants which are canted in this canting world, — though the cant of hypocrites may be the worst, — the cant of criticism is the most tormenting.

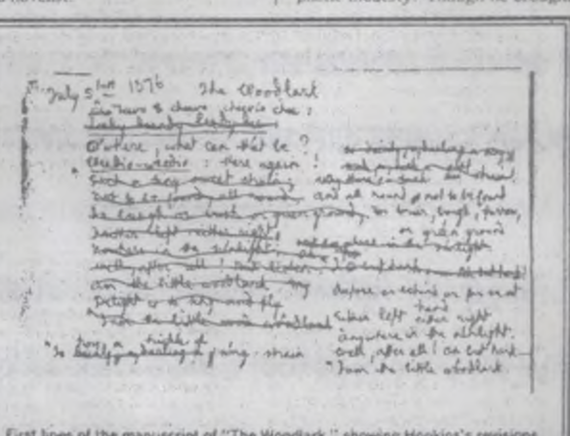
Laurence Sterne (1713-1768)

Talking to Professor MacKenzie, and reading his books, leaves one convinced that Hopkins's work is in the hands of someone quite without cant. I met MacKenzie at his suburban home in Kingston Township a few weeks ago. I'd read his new book at a time when I was at a peak of anger, caused by certain lectures I'd attended and articles I'd read, at scholars who deny all but those in their own specialized fields the fruits of their research and analysis. They confiscate knowledge. They hide it away from my understanding in a cloak of jargon and technical vocabulary that is incomprehensible to all but their own little sodality. And when it is knowledge about literature, which matters to me, about works I love, then I become resentful and bitter.

MacKenzie's guide to Hopkins is a masterpiece of good, and comprehensible, sense. It does precisely what it sets out to do. It provides the historical background necessary to fully appreciate the poems. It guides the reader through Hopkins's dense but dazzling syntax and language. It makes the poetry more accessible. And in all these ways, it enhances the reader's appreciation of every poem, enlarges his world, sharpens his sensitivities, enriches his soul. It strikes me as the very best kind of literary criticism, that which is a pleasure to read and also a means towards pleasure in the text.

And it is based on the very best kind of literary scholarship: detailed study of the poetry itself — the words, the allusions, the imagery, the poetic techniques — together with original study of the manuscripts and of the circumstances in which the poetry was written. There is about MacKenzie's work, to put it plainly, no nonsense. And though, with characteristic modesty, he acknowledges his indebtedness to the pioneer expositors of Hopkins (they "so shaped my attitudes that although I have tried to assess each poem freshly some of their ideas probably figure in my mind as my own"), there is none of the parasitism one finds in some other critics, whose whole existence depends on their being able to correct their predecessors. His work is based not on other people's reactions to the poems, but on a study of contemporary sources, of the poems themselves and on his willingness to explore the springs of Hopkins's inspiration.

As a teacher, MacKenzie has always urged students to approach their studies in this direct way, and not to allow others' criticism to come between them and the text. At Queen's he spent five years building up and directing the doctoral program in English and two further years as chairman of the Council for Graduate Studies and Research. In 1979 he was one of two professors — the other was Dr. R.A. Price of Geology — to be awarded Killam Fellowships (which provide scholars engaged in major works with the time to concentrate on their research). "When I'm supervising a thesis, I



First lines of the manuscript of "The Woodlark," showing Hopkins's revisions
"Teevo cheevo cheevio chee: / O where, what can that be? / Weedio-weedio: there again! / So tiny a trickle of song-strain"

of a windhover — "oh, they're glorious birds" — and told me the story of his first visit to St. Beuno's college in north Wales, where Hopkins wrote the poem in 1877. "The college is beautifully situated on the side of a hill. I said to father rector, 'Father, do you ever see windhovers round here these days?' 'Oh no,' he says, 'it's such a pity. I suppose DDT and other things have driven the windhovers away or killed them off.' But when I walked out of the grounds just to the end of the drive and looked up to the top of the hill, I could see four windhovers busy collecting their daily sustenance on the hillside. They simply hadn't been recognized, in spite of their very characteristic flight.

"SO I CLIMBED the hill with my binoculars. We're birdwatchers: I've done birdwatching in four different continents: enjoy it immensely. After I'd watched them for half an hour, one came and sat on a fence post thirty feet away. Magnificent colors.

"Hopkins loved birds. The first part of the poem is really about how the windhover flies, and then the way in which every creature expressing its own special qualities — with a windhover, that's the ability to hover — is also expressing the glories of God and the range of God's gifts and qualities."

One learns in talking to MacKenzie that the amount of work behind a simple illuminating statement may be quite immense. He doesn't mind the work, and doesn't resent the laborious side of scholarship. "Somebody has to do it. For example, if nobody authoritatively establishes the date of a poem, scholars will be quarrelling over it for years. I find it exciting, really: I don't have to drive myself along. In fact I have to be careful I don't diffract my efforts in too many different directions. Anything that's put in front of me immediately begins to ring bells, it makes connections in my mind with something I've come across in one country or another, and before I know where I am I'm deep into it."

I asked if it was usual for scholars to explore as widely as he has.

"Of course," he said, "there are certain professors who feel that if you're interested in anything outside your own particular discipline, there's something wrong with your standing in that discipline. That's an attitude I found more in Britain than elsewhere. Here, people do encourage interdisciplinary work, and I find it extremely fruitful. I think it's very dangerous to limit oneself to a narrow field. No one can learn to interpret poems simply by sitting in a room all day poring over poetry. The student of literature has to be knowledgeable about nature, about people and places."

MacKenzie was at another university recently examining a thesis on a rural English poet. The thesis depended at one point upon a knowledge of agriculture in England at the time of the enclosures, because the poems were about the frustrations of the peasant farmers as land was enclosed by the big landowners.

"I went to the Queen's library to brush up on my economic history. Economic historians must be not only economists and historians, but must also have a knowledge of agriculture. You have to be able to apply those three other disciplines to the literary judgments of this man's poetry."

I said it sounded as though he'd spent an awful lot of time preparing to examine a thesis.

"I spent far too much time on it because I became so absorbed in the recent developments in economic history — as a matter of fact, right up to 1980; and this student was relying upon work which we had been warned about in 1932, when I was studying economic history, as being somewhat questionable, because its statistical methods were unsound."

MacKenzie approved the thesis but urged changes if it were published. Poor student, I thought, coming up against MacKenzie as examiner — but what a delight it would be to have him as a thesis adviser. I said he really seemed to enjoy learning.

"This is the point," he said, "that I make time and again with graduate students, that they must enjoy the process of reaching a destination. Because, I say, you will find over and over again that when you get to a destination, that's not really the climax; the excitement should come at many stages on the way there."

When he was studying for his PhD at the University of London, he was sharing a house with bright graduate students from Oxford and Cambridge who had been absorbing European culture all their lives. "Although I had been lecturing at university and had had six years of college life," he said in the *Perspectives* article, "I felt as if I knew nothing. I couldn't indulge in conversation on art and music and places in Europe with these people who had grown up in a very rich cultural environment." He decided to educate himself by travelling through France, Switzerland and Italy, by working in the archives of Holland, and by attending concerts, operas and art lectures in London. "I took an extravagant amount of time off," he said, "but I was resolved: I would rather go back without a PhD than with *only* a PhD."

'When the Japanese invaded Hong Kong, MacKenzie was taken prisoner. He was sent to a camp 24 miles from Hiroshima and was there when the atom bomb was dropped'

IN 1940, AFTER finishing his PhD, he found a position at the University of Hong Kong which combined lecturing with military duty as a member of the Hong Kong Volunteers. When the Japanese invaded, MacKenzie was taken prisoner. He was asked to take charge of English classes for his fellow prisoners. But the Japanese stopped the classes when they discovered an escape tunnel and decided that the classes were being used to plan escapes. After a year, MacKenzie was transferred to Hiroshima V, a prisoner of war camp 24 miles from the ill-fated city. He was put to work for three years carrying steel in a dockyard. He was there when the atom bomb was dropped. But he survived, and soon afterwards found himself in Australia. Rather than taking time to recover, he immediately applied for and got a post as assistant professor in the University of Melbourne, where he met and married his Australian wife in 1948.

MacKenzie: He doesn't resent the laborious side of scholarship

I asked MacKenzie whether he was a Catholic, or in any event a religious man, and whether one needed to be to fully appreciate Hopkins's poetry. "I think you have to have a pretty deep basis of religious experience yourself, and although I'm not at present attached to a church, it was a major part of my life before the war. I've a good grounding in theology through years of private study. I was intending, as a matter of fact, to enter the ministry, Presbyterian, not Catholic. My folk came from the north of Ireland, and some of them were bitterly anti-Catholic. But I have no patience with such narrowness. When I go to Oxford I'm given the privilege of a room in the Jesuit college there, and sometimes stay for weeks on end. The fact that I have a good theological background, and I'm not left out of conversation if they throw Latin about (as they tend to do, because they're very familiar with Latin), means that I can fit in with those scholars.

"Hopkins appeals to a very wide range of people, some of whom are basically anti-religious. I would say that they don't reach the essence of Hopkins, because he was a profoundly religious man. But if they're interested in language they can enjoy the excitement of finding phrases which capture in a unique way an experience he's been through. They may not equally appreciate the part of the poem in which Hopkins applies what he has seen to his belief in God, his belief that nature is an expression of God."

But these references to God were seldom made crudely, were they?

"Oh no. They're not morals attached like a sort of tag at the end of a tale. Religion is part of his life, the whole way of viewing things. When he's watching the windhover, he's also seeing the Creator."

Hopkins's verse is difficult. Did it matter if people made of it something that Hopkins hadn't intended it to be?

"As a commentator, after examining the evidence, I try to come as close as I possibly can to the ideas — or some of them — that Hopkins had in mind. I remember once meeting T.S. Eliot and discussing with him an interpretation of one of his poems, which I felt was widely misunderstood. He wouldn't decide between two interpretations. He said, 'I think both meanings reside in the poem. And the poet is not always conscious of why certain words come to him.' I think psychologically that's probably true. But I would reject some interpretations out of hand. In 'The Windhover,' for example, Hopkins speaks of the bird's 'riding / Of the rolling level underneath him steady air, and striding / High there . . .' You wouldn't believe it, but somebody has said, 'That's his greeting to the bird — "Hi there!"' Fancy trying to impose that on 'The Windhover.'"

But if one didn't know any better, if one assumed that "Hi there!" was a universal greeting, it would be possible to make that kind of mistake. It was a very gross mistake, but presumably all sorts of subtler errors were made for the same reason, out of ignorance?

"Yes. I have to be careful, when I'm studying any author, to use the fifteen-volume Oxford English Dictionary, observing the date at which a particular meaning began to have currency. The dates are not always absolutely accurate, mind you. I've often found anticipations, especially in Hopkins. And I've also found him using words centuries after they've dropped out of common usage. Besides, he didn't always spell a dialect word correctly, because he'd only heard it, and so it's sometimes quite difficult to guess what term he had in mind."

Here are some examples, from his *Reader's Guide*, of the minute and detailed examination to which MacKenzie subjects many of Hopkins's words:

☐ From his comment on *"I wake and feel the fell of dark, not day"*:

"To the modern reader that strangely effective phrase, 'the fell of dark,' might suggest the *fell* of a mountain, a high moorland waste on which he has wandered, torn with self-disgust, or the miseries of the *fell* (terrible, unsparing) night when a man is feverish with worry .... He may also vaguely (and correctly) connect *fell* with *fall*; a *fell* is a prostrating blow. To Hopkins's classical ear it would also anticipate the keyword in the sestet, for another *fell* comes from the Latin for gall. But most important, to a Catholic theologian who knew the Vulgate Bible and St. Augustine, yet another *fell*, a skin or hide (from the Greek word *pellis*) would take him back to the ejection of Adam and Eve from Paradise. Psalm 103: 2 (A.V., 104) speaks of the heavens being stretched out like a curtain or tent or pavilion; the Latin Vulgate uses the word *pellis*. St. Augustine connects this with the skins with which God clothed fallen Man: their sin had brought death into the world, symbolized by the skins of animals sacrificed in atonement. The heavens, says Augustine, conceal the light of God from sinful mankind (*Confessions*, Bk. 7 xix, Bk. 23 xv). Hopkins certainly makes us feel as though an oppressive weight has been thrown on him, as in the plague of Egypt — a darkness that could be *felt* (Exodus 10: 21)."

☐ From his comment on "Harry Ploughman": *Hard as hurdle arms, with a broth of goldish flue / Breathed round....*

"A further source of obscurity is the deployment of words at whose meaning one can still only guess after the resources of scholarship have been exercised .... In line 1, the ploughman's arms are shown as 'breathed round' with a 'broth of goldish flue' — the fine blond hairs are like fur. The word *flue*, marked by contemporary dictionaries as obsolete, was still used in dialect for soft down, fur or hair. But *broth* is a puzzle. A 'broth of boy' may be an Irish form of commendation; the context, however, calls for something visual. The *Imperial Dictionary*, 1859, notes under *broth* that 'In America, the word is often applied to foaming water.' But does foam *breathe*, or remind us of light hair on an arm? Could Hopkins have assimilated the word with a dialect *brough* (rhyming with Scottish *loch*) defined by the *Whitby Glossary* of 1855 as 'the halo round the moon, when it shines through a mist or haze'? This would be quite good for a misty down on a sunlit arm. But Wedgwood's *Dictionary of English Etymology*, 1859 ... under *broth* quotes as cognate the Irish *bruth*, strength, heat. Significantly, that word is also applied to the nap or down of cloth."

☐ From: "Thou art indeed just, Lord": *Thou art indeed just, Lord, if I contend / With thee; but, sir, so what I plead is just. / Why do sinners' ways prosper? and why must / Disappointment all I endeavour end?*

"In this sonnet the Jesuit's opening sentence is a little obscure. How are we to paraphrase 'but, sir, so what I plead is just?' The earliest version was forthright: 'but, sir, what I shall speak is just'; after changing this in favour of the final version as we print it he went back to 'these words I speak are just'. The enigmatic phrase 'so what I' figures in several drafts. The usage might seem to be best covered by definition 26 under 'so' in the [*Oxford English Dictionary*]: '*so (that)*, in limiting sense: On condition that, provided that, so long as, if only'. Sir Thomas Browne, for example, wrote: 'Ulysses cared not how meanly he lived, so he might find a noble Tomb after Death'. Hopkins would then be asserting that God will be just in his arguments but only if the poet's pleas are just also. This might be in line with Psalm 17: 35-6 (Douay), 'the Lord wil reward me according to my justice: ... With the holy, thou wilt be holy; and with the perverse thou wilt be perverted'; or as Moffat translates it (18: 25-6), 'To the kind thou provest kind, and true to the true, to the pure thou provest pure, and treacherous to the treacherous'. However, an alternative reading of 'but, sir, so what I plead is just' would rearrange the words to run 'but, sir, so is what I plead (just)', or 'so too what I plead is just'."

With such intensive study for so many years, did MacKenzie sometimes feel that he was losing himself in Hopkins, becoming Hopkins the way some actors become their parts?

"I BELIEVE THAT you never are really able to put yourself into anybody else's place. There's a very strict limitation to our ability to project ourselves into another mind, because we're all so individual, and faced with exactly the same scene, even if we discuss it between ourselves, our reactions are subtly different. And when you have a man of genius, such as Hopkins — so individual, so original in his way of thinking — I have time and again to remind myself that even after very careful study I can't guarantee that my responses are going to be the same as his were. Could he always understand himself?"

Did Hopkins keep surprising him?

"Less and less, though I've recently been working on the very early poems written when he was an undergraduate, and I am still astounded. For example, I am astonished at his precocity, his originality, in a chorus he translated from a Greek play in his last year at high school or first year at Oxford. It's a translation from Aeschylus. I compared this with fourteen other versions, and found that Hopkins hadn't used any of the standard translation words. He did a completely original piece of work."

I asked MacKenzie whether he sometimes became impatient with Hopkins?

"Well, sometimes. 'Harry Ploughman,' for example, is a conundrum. I think Robert Bridges [the poet who was Hopkins's friend and first editor] was a great restraining force, telling him when he became over-compressed, 'Steady now; you're developing such obscurity that nobody will read you.' In fact, few of Hopkins's poems were published in his lifetime. Not having a public was a handicap, because he was deprived of feedback. Readers would have remonstrated with him, letting him know they couldn't fathom what he was saying."

If MacKenzie had his time over again, would he choose Hopkins to devote so much of his time to? (He has, of course, done research on many other authors.)

"My choice of Hopkins was curious. We had a very distinguished professor of English staying with us, and it so happened that all our bedrooms were occupied and I had to give him a bed in my study, under the bookshelves where I had all my material on Hopkins, Yeats and Eliot. In the morning he greeted me: 'Norman, I'm starting a new series of critical works on modern poets, and I haven't placed Eliot, Yeats or Hopkins. If you had a choice, which of the three would you work on?' I had really been interested in Yeats longer than in Hopkins, but I said, 'I think Hopkins, because I feel least is known about him and most work needs to be done on him.'"

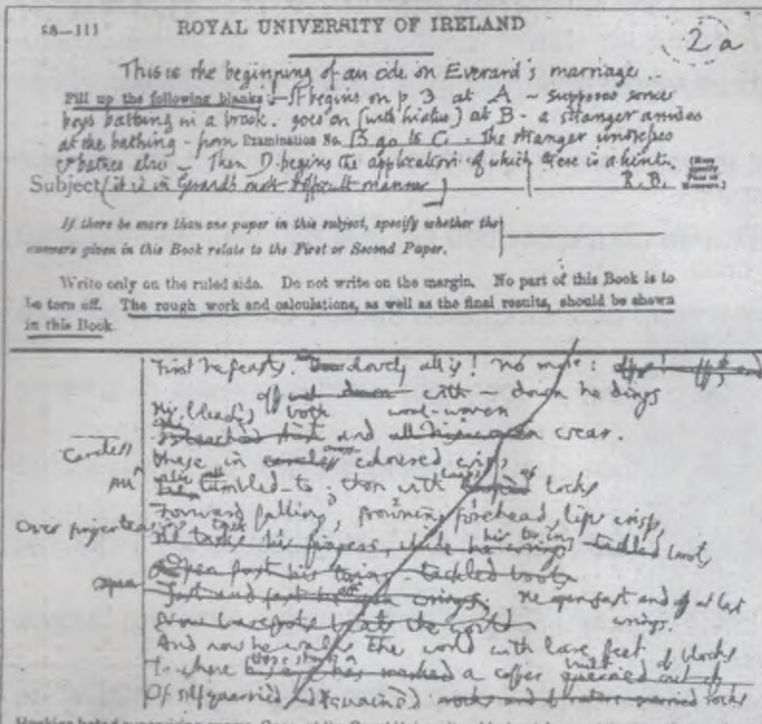
MacKenzie got the job, and that was the book whose manuscript was stolen from his car.

When he completes the *Oxford English Texts* edition of Hopkins's poetry, he plans to concentrate on Anglo-Irish writers. The Douglas Library at Queen's, he says, has a marvellous collection, which he has developed by helping to obtain grants and by being largely responsible for the selection. It was through his connections and his initiative and enthusiasm that Queen's was able to purchase the family's personal set of all the principal volumes of Yeats's poetry, prose and drama from 1903 onwards. The rare 77-volume set, privately printed, includes numerous other original works by distinguished Irish writers.

Would he go back to Yeats?

"Probably not," he said. "Of course I'm very, very fond of Yeats, but there are already numerous studies of his work. He has been pretty well served. I've got my own interpretation of a number of the poems, built up over the years, but the groundwork has been done very thoroughly by some excellent scholars. Other Anglo-Irish writers, earlier than Yeats, and even later, have not been so fortunate. They deserve attention."

They couldn't get better attention than from Norman MacKenzie. ☐


58—111 ROYAL UNIVERSITY OF IRELAND

2a

This is the beginning of an ode on Everard's marriage ..

Fill up the following blanks:— It begins on p 3 at A — supposes some boys bathing in a brook. goes on (with hiatus) at B - a stranger arrives at the bathing - from Examination No. B go to C. - the stranger undresses & bathes also — Then D begins the application of which there is a hint.

Subject (it is in Gerard's most difficult manner) R.B.

If there be more than one paper in this subject, specify whether the answers given in this Book relate to the First or Second Paper.

Write only on the ruled side. Do not write on the margin. No part of this Book is to be torn off. The rough work and calculations, as well as the final results, should be shown in this Book.

Hopkins hated supervising exams. Once, at the Royal University of Ireland, he used the occasion, and an exam booklet, to draft the beginning of an ode. The comments above the text are those of Hopkins's first editor and great friend, the poet Robert Bridges.

May 24, 1998

Heads Up!

There is nothing we can do to prevent a comet from striking Earth.

Related Link

- First Chapter: 'Comets'

By MARCIA BARTUSIAK

It will be this summer's cinematic disaster du jour. Hollywood is now launching a barrage of comets and asteroids on movie theater screens across the country. If viewers' interests are piqued (or if their nerves need soothing), "Comets" is a handy digest to put these celestial visitors into perspective.

It would be hard to find a writer better suited to the task. David H. Levy has been the discoverer or co-discoverer of 21 of them, including Comet Shoemaker-Levy 9, the series of icy chunks that crashed into Jupiter so spectacularly four years ago. But as a former graduate student in English literature, Levy is also able to transform his scientific facts into a charming and accessible story. His book is liberally sprinkled with personal accounts, historical anecdotes and literary references from John Keats to J. D. Salinger. His telescope, a 16-inch reflector, is named Miranda, for the Shakespeare character who spoke of a "brave new world."

COMETS
Creators and Destroyers.
By David H. Levy.
Illustrated. 256 pp. New York: Touchstone/Simon & Schuster. Paper, $12.

Comets have been an obsession for Levy since childhood, starting with a sixth-grade assignment. That's when he learned a comet was a miles-wide blackened snowball, a conglomeration of ices mixed with dustlike particles. Some have short periods, like Comet Encke, which returns every three and a third years. Others have a looser tether to the Sun, like Comet Hale-Bopp, which appeared last year and will travel entirely out of the solar system before returning in a few thousand years to glow once again as it is bathed by the Sun's radiation.

Levy has lost none of his childhood wonder; he describes his vocation as "the world's slowest sport, in which scores are measured not in afternoons but in lifetimes." He began searching in 1965 and spent more than 900 hours at his telescope before finding his first comet 19 years later. So what keeps him and others coming back, to what seems like a wearying endeavor? For some it is the chance to inscribe their name on a sliver of the universe. "For me," Levy answers, "comet hunting is a field of dreams." But "it helps," he adds, "to have the perseverance of an Arctic explorer, the heart of a poet and the patience of Job" when facing the nighttime wind and cold.

Over the centuries, humanity has experienced a love-hate relationship with comets. At first, comets were feared as omens of doom -- it was counted significant that one showed up in 44 B.C., the year Julius Caesar was assassinated. The British astronomer Edmond Halley at last demystified them when, calculating from Newton's laws of gravity, he confidently predicted that a comet he had seen in 1682 would reappear in 1758. It did. Comets, he showed us, are simply planetoids in constant, if eccentric, orbit around the Sun.

More recently, though, comets have been reclaiming their old reputation, ever since evidence emerged that 65 million years ago some form of monstrous meteor slammed into Earth off the coast of Yucatan with the force of 100 million hydrogen bombs. Whatever it was, it gouged out a crater 100 miles wide and 25 miles deep, spewing out enough debris to darken the planet for decades and kill the dinosaurs. No wonder Hollywood is taking note. Yet there was a silver lining to the devastation. It gave mammals the opportunity to rule the world.

Comets and asteroids may be mere specks -- solar system trash. But Levy aptly demonstrates that this debris has decidedly affected our lives, starting five billion years ago. Earth's tilt is probably due to the impact of a large object at its birth, giving us the seasons. Another collision by a Mars-sized planetesimal tore enough material out of our planet to forge the Moon. Meanwhile, a continual hail of smaller comets provided Earth with both water and organic building blocks. Hubble telescope observations of Hale-Bopp showed the comet shedding nine tons of water each second.

Comets were multitudinous eons ago. Now they lurk either in a disk beyond the orbit of Pluto (which is actually an oversize comet) or in a halo farther out called the Oort cloud. Jupiter was the housekeeper: it acted as a gravitational vacuum cleaner, either sweeping the comets outward or consuming them. Comet Shoemaker-Levy was just the latest example, and Levy explains how it was discovered almost by accident, during a fitful survey on a bad-weather night. What resulted "was a scramble to put together the largest telescope armada ever assembled in the history of astronomy to observe a single event," he writes.

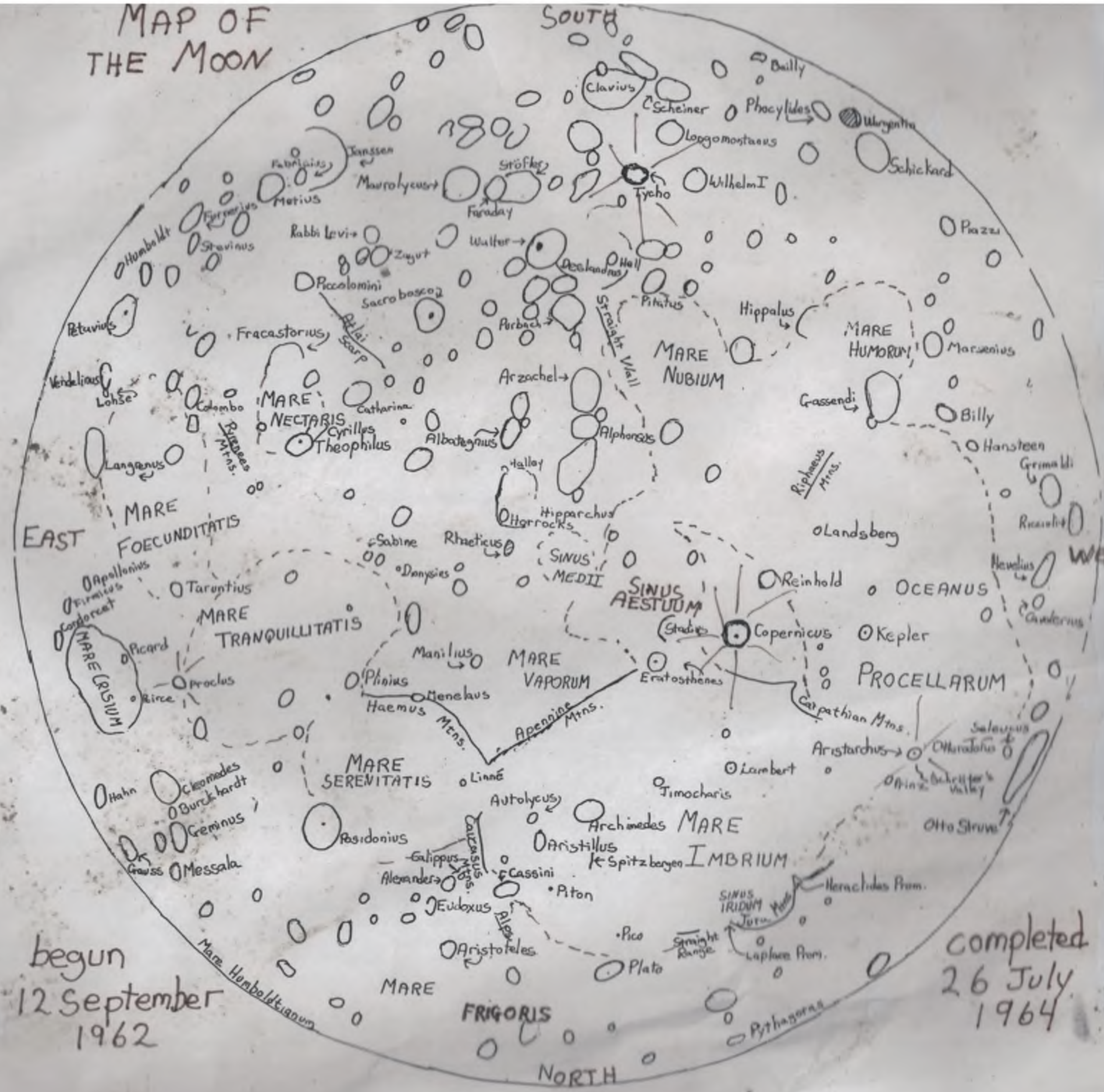
HERE was the dress rehearsal for what will (not may) happen to Earth in the future. Levy weaves a haunting tale of what would occur if a comet like Shoemaker-Levy, with its 21 separate pieces, made a direct hit. What's most disturbing is reading that comets are rarely found more than a year before they enter our terrestrial neighborhood. We'd have little warning. Given our current level of technology, there would be nothing we could do to prevent an impact. "Changing the orbit of a 10-mile-wide comet hurtling toward us at a high velocity is, one scientist insists, like trying to move a tank with a popgun." Levy notes. We have a better chance of keeping tabs on (and maybe even altering) the paths of asteroids, a failed planet's rocky remains that continually crisscross the inner solar system.

"Comets" was obviously not written to be a definitive reference work. Its level and pace are most appropriate to interested newcomers who want a quick overview on topics ranging from Mars rocks to shooting stars. Shooting stars, by the way, are really pieces of comet dust, each no bigger than a grain of beach sand, left behind in a comet's trail. When Earth crosses that wake, these particles vaporize in a streak of light. Levy reports that a spectacular show, as many as 150,000 meteors per hour, will take place on Nov. 17, 1999, when Earth travels through the litter left by Comet Tempel-Tuttle this year. "Those who are lucky enough to witness the spectacle," he writes, "will get a glimpse of what the earth was like during its primordial age. As cometary debris rains out of the sky, the remnants of destruction and creation of life will light up the sky just as they did at the dawn of life on Earth."

Readers will be convinced that comets are far more than illuminated shuttlecocks that occasionally cross the heavens. Homo sapiens might not have evolved without them.

Marcia Bartusiak is the author of "Thursday's Universe" and "Through a Universe Darkly."

MAP OF THE MOON



begun
12 September
1962

completed
26 July
1964

52%

CN3iv: CN3v

Comets, importing change in times and states, Brandish your crystal tresses in the sky.

The Beijing De Tao Masters Academy.

Summer of 2013 onwards.
Dorset.

(86) 108076 33

To: Manuel Veiga Altemira

Copy of DeTao contract

From: David H Levy

Dear Manuel,

In accordance with our many conversations and emails messages, I enclose herewith my contract. We are now ready to proceed to the next step!

Sincerely
David H Levy

德稻宣言

智慧是人类文明发展的源动力。对智慧不断进行科学化、系统化的采集、传承和应用，我们德稻愿作为一分子，把它当作自己的使命。各种科学方法，宽阔的视野，广大的创新灵感来帮助我们，成就德稻解决方案。

社会发展而产生的行业是智慧的细分，作为生产力的代表，行业专家（大师）凝聚了大量智慧。德稻通过汇聚部分世界行业大师，以师徒传承方式开展高端非学历教育，我们重视对隐性知识的采集，培养独具特色的行业精英，助力企业发展。

德稻大师、学生、科技、资本将来自世界各地，我们缘起中国，融入全球，采用半社会化、半商业化的开放运营模式，为企业和机构提供服务，为社会和谐发展尽一份力。

DeTao Vision

Wisdom is the power that develops civilizations. At DeTao we contribute to human progress by gathering important elements of the world's developing wisdom in a systematic and scientific way. We aim to preserve important parts of this heritage and use it to enrich lives. The essence of the heritage is to empower us to use an appropriate variety of scientific methods, perspectives, and creative inspiration to solve real problems.

The wisdom that society has developed in order to expand industry is especially important. DeTao believes that the experts (masters) who drive a wide variety of industries and professions have accumulated enormous wisdom. We are bringing together leading masters from around the world representing many fields. These masters will share their advanced knowledge with apprentices in a sophisticated learning system that goes beyond conventional degree studies. Putting special emphasis on the sharing of tacit knowledge, we seek to nurture professional elites with unique specialties and thus help the development of enterprises that depend on such expertise.

The masters, students, technologies, and capital to build up DeTao will come from all over the world. The concept of the Masters Academy originated in China but aims to have worldwide influence with its unique semi-public, semi-commercial and open business approach. The DeTao Masters Academy is dedicated to improving enterprises and institutions and thus contributing to the harmonious development of the society.

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Cooperation Framework Agreement for Visiting Masters

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Address: Suite 809, No.8, North Second Street, Haidian District, Beijing

电话： (8610) 6070-3333

Telephone: (8610) 6070-3333

乙方：

Party B: = DAVID H. LEVY

地址：

Address: 2500 E. WETSTONES ROAD

证件： VAIL, ARIZONA 85641

ID: U.S.A

电话：

Telephone: 520-762-5685

本协议由甲乙双方（以下合称"双方"）于 2013 年 7 月 17 日签订。

This agreement is entered into by and between Party A and Party B (hereinafter referred to as the Parties) on July / 17 / 2013 (date) in Beijing.

甲方以多年的商业成功为基础，致力于人类优秀的行业技术和文化传承，以国际大师工作室为机制，为帮助国际行业大师进入中国，传承自己知识和技能，发展个人事业提供发展平台，创造商业和文化双赢结果。双方友好协商一致，达成如下合作内容：

Party A is committed to the cultural inheritance of humanity and better living via practical

I had forgotten the photograph. It is very good in spite of the misty weather.

I hope very much that I shall meet you all again some day.

With many thanks.

Sincerely yours,

KATHARINE PARSONS.

THE LATE H. E. S. ASBURY

Many friends of the late Mr. H. E. S. Asbury will regret to hear of his death on October 23, 1933, in Montreal after two years of ill health, for Mr. Asbury had taken an interest in the furtherance of astronomical knowledge for the greater part of his life and particularly during the past twenty years as an active member of the Royal Astronomical Society of Canada.

In 1910 Mr. Asbury and Mr. Westoby founded a Centre of the R.A.S.C. in Guelph, and subsequently on his coming to reside in Montreal, Mr. Asbury was one of those principally responsible for the founding of the Montreal Centre, of which he served as Secretary and later as President for some time. He purchased a good 6-inch telescope and gave generously of his time and energy spreading interest in astronomy. He has been a member of the Council of the Montreal Centre for many years.

His friends in astronomical circles in Montreal are glad to have this opportunity of paying a tribute to his memory.

A. VIBERT DOUGLAS.

A NEW SUN SPOT CYCLE

It has been found that about sixty per cent. of the spots on the sun come in pairs, with the line joining them approximately parallel to the sun's equator. One spot shows the characteristics of a north magnetic pole; the other, those of a south magnetic pole. Also, if the preceding spots of one cycle in the northern hemisphere show north polarity those in the southern hemisphere show south polarity. In the next cycle the polarity of the spots in the two hemispheres is reversed.

This reversal of polarity has just been observed at the Mount Wilson Observatory and the spots are appearing in high latitudes. Hence it can be said with certainty that a new cycle has begun.

THE CONVERSATION

Beijing DeTao Masters Academy

Wisdom is the power that develops civilization. At DeTao we contribute to human progress by gathering important elements of the world's developing wisdom in a systematic and scientific way. We aim to preserve important parts of this heritage and use it to enrich lives. The essence of the heritage is to empower us to use an appropriate variety of scientific methods, perspectives and creative inspiration to solve real problems.

The wisdom that society has developed in order to expand industry is especially important. DeTao believes that the experts (masters) who drive a wide variety of industries and professions have accumulated enormous wisdom. We are bringing together leading masters from around the world representing many fields. These masters will share their advanced knowledge with apprentices in a sophisticated learning system that goes beyond conventional degree studies. Putting special emphasis on the sharing of tacit knowledge, we seek to nurture professional elites with unique specialties and thus help the development of enterprises that depend on such expertise.

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"When Beggars die, there are no comets seen": Comets, Meteors, and Telescopes in Shakespeare's Writings

David H. Levy

University of Tampa

CN3XYZ

"When Beggars die, there are no comets seen": Comets, Meteors, and Telescopes in Shakespeare's Writings

David H. Levy

On 18 September 1965, four hundred years after the Shakespeare family celebrated William's first birthday in England, Kaoru Ikeya peered through the eyepiece of his home-made eight-inch diameter reflector. A worker in a piano factory in Japan, he had taken a moment to enjoy some free time with his telescope when he noticed a little spot of haze in its field of view. Ikeya knew the sky, and he was fairly certain that the object was an anomaly, that it was not permanently in that position. His star atlas showed nothing, and a look through the eyepiece a short while later convinced him that he really was looking at something new, for the fuzzy patch of light had moved slightly. Ikeya identified this new object as a comet, and he lost little time in sending a telegram to Japan's Tokyo Observatory. Just one hour later, Tsutomu Seki, a guitar instructor at the time, found the same object, and the discovery of a new comet, Ikeya-Seki, was made known to the world. When this comet was first detected, its brightness was about six times fainter than the faintest star one can normally see without a telescope. Its motion gave the first clue of what was to come; it was moving almost directly toward the Sun. Within a few weeks,

From: "JUDY A. HAYDEN" <JHAYDEN@UT.EDU>
To: David Levy <david@jarnac.org>
Subject: RE: Your Research

Dear Dr. Levy,

Please feel free to address me as Judy. I have attached a call for papers so you have some idea of what I am looking for. So far I have some interesting proposals on

Anton Doni and Giordano Bruno
Ben Jonson's News from the New World Discovered in the Moon and The Staple of the News
Godwin's Man in the Moone as the foundation for modern science fiction
Associations between lunar discoveries (of Kepler, Godwin's Man in the Moone, etc) and voyages to the New World of America
Hester Pulter's astronomical poetry
Restoration/18th century drama and lunar discoveries/theories
Herschel and Poetry

This should give you an idea of what sort of material I have to date. Please don't worry about a "formal" proposal at this point. All I need is some idea of what you think you will be writing about.

I am thrilled that you are interested in contributing to this volume.

Judy Hayden

>From: David Levy [mailto:david@jarnac.org]
>Sent: Monday, September 10, 2012 5:58 PM
>To: JUDY A. HAYDEN
>Subject: Re: Your Research
...snip...
>>Professor of English
>>University of Tampa
>>401 West Kennedy Boulevard
>>Tampa, Florida 33606-1490
>>813-257-3535
>>jhayden@ut.edu

CALL FOR PAPERS - Astronomy and Lit.docx

Details of the Recommendation: "His deep know knowledge of celestial phenomena enabled him to write a ground-breaking ph.d. thesis on 'The Sky' in Shakespeare and other 16th and 17th century writers. The thesis served as the basis of a book on the same topic. David innovated in a field--Shakespeare and his contemporaries--where scholars have worked literally for centuries . . . but David contributed something new and important, and has thereby earned his immortality. Professor Lawrence Besserman"

THE
IRISH ASTRONOMICAL
JOURNAL

Vol. 6 June 1964 No. 6

THE ASTRONOMY OF SHAKESPEARE

W. G. Guthrie

In the year that marks the fourhundredth anniversary of the birth of William Shakespeare, it is a matter of interest to astronomers to look at their subject through the eyes of the great dramatic genius of the Elizabethan era. Contemporary with such men as Bruno, Tycho Brahe, Galileo, and Kepler, Shakespeare stood at the dawning of the new age of modern astronomy, and, gifted as he was with a peculiar sensitivity to the intellectual climate of his changing world, he did not hesitate to use for his dramatic and poetic purposes such allusions to the cosmic scene as would lend power to his pen. Many other writers of all ages and tongues have narrated in prose, poem, and drama, the mystery and splendour of heavenly events. Nowhere, however, is there to be found such an abundance of astronomical allusions as occurs in the writings of Shakespeare. Out of some hundreds, frequently of the highest literary worth, only a few which seemed specially typical or significant have been chosen to illustrate the subject of this article.

The lifetime of Shakespeare, 1564-1616, fell at a period in which the geocentric theory of the universe, propounded by Ptolemy in his Almagest, was beginning to decline, and the heliocentric theory of Copernicus was gradually gaining more general acceptance. The Italian pantheistic philosopher Bruno, 1548-1600, who had adopted the Copernican doctrine, visited England between 1583 and 1586 and delivered the first lectures on it in this country. Bruno is known to have had contacts with members of the court of Queen Elizabeth, and through these it is possible that Shakespeare derived some knowledge of the new doctrine. The Copernican theory, however, was slow in gaining currency and credence. Until the time when Galileo began to make telescopic observations, about 1610, the theory seemed to be mere speculation, contrary to common sense, and entirely unsupported by any solid factual evidence. The Ptolemaic theory still held strongly on a basis of religious dogma and common sense, while the Copernican doctrine, acceptable only to a few of the more daring intellectuals, had yet to prove its power and its worth.

It is not surprising, then, that in his writings Shakespeare adheres to the Ptolemaic doctrine and refers to a fixed earth as the centre of the universe. Indeed in several passages in the plays the word " centre " is used as if it were synonymous with the earth. For example, in " Midsummer Night's Dream " occur the lines—

" I'll believe as soon this whole earth may be bored; and that the moon may through the centre creep, and so displease her brother's noontide with th'Antipodes ".

Here the implication is that the moon and " her brother ", the sun, both revolve about the earth as centre.

In " Troilus and Cressida " we have the simile " as true as earth to th'centre ", and also in the same play lines which suggest that the sun, although pre-eminent, is merely planetary—

" The heavens themselves, the planets, and this centre,
Observe degree, priority and place,
Insisture, course, proportion, season, form,
Office, and custom, in all line of order:
And therefore is the glorious planet Sol
In noble eminence enthroned and sphered
Amidst the other . . ."

Equally suggestive of the geocentric theory are the references to the stable and steadfast position of the earth—

" For my grief's so great that no supporter but the huge firm earth can hold it up ".

" For it is positive as the earth is firm that Falstaff is there ".

" Thou sure and firmest earth, hear not my steps, which way they walk . . ."

Even more suggestive is the line found in Troilus and Cressida—

" Strong as the axletree on which heaven rides ",

a simile which clearly refers to a motion of the whole heavens around a stationary earth.

The apparent rotation of the heavens about a stationary earth is a fact at once familiar and obvious; indeed it formed one of the commonsense bulwarks upon which opposition was based against the attacks of the new Copernican theory. The position of the north celestial pole is marked within about one degree by the star Polaris, easily found from the pointers of the Plough constellation. Casual observation fails to detect any variation in the position of this star, which always seems to occupy the same place at any time of the night or year. This fact was familiar to Shakespeare when he wrote the lines—

" But I am constant as the northern star,
Of whose true-fixt and resting quality
There is no fellow in the firmament.
The skies are painted with unnumbered sparks,
They are all fire, and every one doth shine;
But there's but one in all doth hold his place."

The polestar serves the useful practical purpose of indicating the position of true north, and thus acts as a guide to the traveller on sea or land. In one of his sonnets Shakespeare has written these lines—

"It is an ever-fixed mark,
That looks on tempests and is never shaken,
It is the star to every wandering bark,
Whose worth's unknown, although his height be taken."

Another reference to the polestar is found in the play "Othello", where a character describes how in a storm at sea—

"The wind-shaked surge, with high and monstrous mane,
Seems to cast water on the burning bear,
And quench the guards of the ever-fixed pole."

In this quotation the "burning bear" is the Great Bear constellation, presumably lying near the horizon; while the "guards of the ever-fixed pole" are the two stars Beta and Gamma of the Little Bear, commonly known as the Guards

Before leaving these circumpolar constellations we may note that it was no uncommon practice in Shakespeare's time to tell the time by means of the positions of stars. This explains the remark of the Carrier in "Henry IV"—

"Heigh-ho! An't be not four by the day I'll be hanged:
Charles's Wain is over the new chimney, and yet our horse not packed."

Here "Charles's Wain" is another popular name for the principal stars of the Great Bear constellation, familiarly known also as the Plough. Incidentally it may be noted that Shakespeare has one or two references to "the seven stars". Commentators differ as to whether he is referring to the stars of the Plough, or to those of the Pleiades known as the "seven sisters". On the whole it seems more likely to have been the latter.

"We that take purses go by the moon and the seven stars, and not by Phoebus". This line from "Henry IV" refers to the fact that thieves prefer moonlight, rather than the light of Phoebus, the sun, for their activities. If "the seven stars" are the stars of the Plough, they may have been used to tell the time of night; but if they are the Seven Sisters, the thieves may have been superstitiously relying upon the well-known beneficent influence of the Pleiades to favour their activities.

The sun is frequently and variously mentioned in the writings of Shakespeare. In numerous passages the poet refers to its rising and setting, its daily motion in the sky, and its annual passage through the twelve constellations of the Zodiac. There was at that time a poetic convention that the sun galloped daily through the Zodiac in a chariot drawn by fiery horses. This explains such passages as the following:—

"The weary sun hath made a golden set,
And by the bright track of his fiery car
Gives token of a goodly day tomorrow".

"And flecked darkness like a drunkard reels
From forth day's path and Titan's fiery wheels."

Shakespeare depicts an unusual daytime darkness in his lines—

"It is the very error of the moon;
She comes more near the earth than she was wont
And makes men mad."

With regard to the last line, it may be recalled that madness, in the old astrology, was believed to be influenced by the moon, as the word "lunacy" itself implies; a circumstance which explains, too, why the moon is addressed in the play "Antony and Cleopatra" as—

"the sovereign mistress of true melancholy".

Let us turn now to the subject of comets. For centuries up to the time of Shakespeare and beyond they were complete mysteries. No one knew whence they came nor whither they went; and no one knew when they might be expected to appear. All other heavenly bodies seemed to obey some kind of natural law by means of which their behaviour could be foretold. No law, however, was known for comets. They seemed to shun the Zodiac in which all other wanderers moved. They appeared, approached the sun, shone in the sky for a time, and then disappeared again into the unknown. Awe-inspiring in appearance, they naturally came to be accepted as omens of disaster or signs of divine displeasure. It is this ominous character of comets that is usually reflected in the plays of Shakespeare; as, for example, in "Henry VI"—

"Comets, importing change of times and states,
Brandish your crystal tresses in the sky,
And with them scourge the bad revolting stars
That have consented unto Henry's death!"

Later in the same play there are, too, the lines—

"Now shine it like a comet of revenge,
A prophet to the fall of all our foes!"

Best known of all the lines on comets are perhaps those which occur in "Julius Caesar"—

"When beggars die there are no comets seen;
The heavens themselves blaze forth the death of princes."

It was not until about a century later that this superstitious fear of comets was replaced by a more enlightened understanding of their nature. In 1682 Edmund Halley, who lived from 1656 to 1742, observed a comet which now bears his name. From the observations he calculated the orbit, and predicted its reappearance in 1759, this being the first prediction of a comet's return ever made. The comet did in fact appear after Halley's death about the time predicted, thus establishing that it moved with regularity, reappearing every 75 or 76 years. When the historical records were examined it was found that the comet had made some spectacular appearances in earlier times; for example at the battle of Hastings in 1066, when it was viewed with dread and taken to be a divine visitation associated with the death of the English King. Shakespeare saw Halley's comet in 1607, and as it must have presented a very striking appearance to all who beheld it, the references to the ominous nature of comets in the plays must have created a powerful dramatic impression in the minds of audiences at that time. The plays "Henry IV" and "Henry VI" in particular contain several references to comets.

Meteors, or shooting stars, are also frequently mentioned in the writings of Shakespeare, but as there was again no proper understanding of their true nature at that time, the references reflect the prevailing superstition with which such appearances were regarded. One common idea was that a shooting star was one which had somehow escaped from its proper sphere or orbit. This is illustrated in the following quotations—

> "Little stars shot from their fixed places".
>
> "Earth-treading stars that make the dark heaven light".
>
> "Though you would speak t'unsphere the stars with oaths . . ."
>
> "He makes me angry,
> And at this time most easy 'tis to do't,
> When my good stars, that were my former guides,
> Have empty left their orbs, and shot their fires
> Into th'abyss of hell."
>
> "Fly like chidden Mercury from Jove,
> Or like a star disorbed."
>
> "Ah, Richard, with the eyes of heavy mind,
> I see thy glory like a shooting star,
> Fall to the base earth from the firmament!"

In a simile which occurs in "Henry IV"—

> ". . . like the meteors of a troubled heaven,
> All of one nature, of one substance bred . . ."

there is at least the suggestion that meteors spring from a common cause, an idea which cannot be regarded as discordant with modern science.

In most cases, however, meteors, like comets, were to be regarded as fearsome and ominous—

> "My lord, do you see these meteors? do you behold these exhalations?
> What think you they portend?"
>
> ". . . an exhaled meteor,
> A prodigy of fear, and a portent
> Of broached mischief to the unborn times."
>
> "'Tis thought the king is dead; we will not stay.
> The baytrees in our country all are withered,
> And meteors fright the fixed stars of heaven . . ."

" And makes me more amazed
Than had I seen the vaulty top of heaven
Figured quite o'er with burning meteors."

Shakespeare's references to the planets are nearly all astrological in character. According to astrology each planet had its own peculiar qualities, Mercury being associated with elusiveness and trickery, Venus with love, Mars with war, and Saturn with evil. The irregular movements of the planets, their conjunctions and oppositions, all were supposed to have their influence upon human affairs, and to account for the vicissitudes of the human lot. Thus in "All's Well That Ends Well" there is the statement—

" The wars have so kept you under that you must needs be born under Mars."

Although popular notions on the planets were mainly of this type, astronomical research was proceeding on scientific lines. Shakespeare seems to have known of the attempts that were being made to solve the problem of the motion of Mars, for he writes in " Henry VI " the lines—

" Mars his true moving, even as in the heavens,
So in the earth, to this day is not known."

It was the problem of the "true moving " of Mars that puzzled Kepler and helped to lead him to the discovery of the three laws of planetary motion which bear his name. They were published by Kepler in 1609, seven years before Shakespeare died, in a work called " De Motibus Stellae Martis ".

Shakespeare frequently uses the terms conjunction and opposition with reference to the planets, as in his line from " Henry IV "—

" Saturn and Venus this year in conjuction !
What says the almanac to that ? "

That the sun is the source of the light by which the planets shine is indicated in the poem " Venus and Adonis " when Venus salutes the sun with the words—

" O thou clear god, and patron of all light,
From whom each lamp and shining star doth borrow
The beauteous influence that makes him bright . . ."

Perhaps nowhere else in the whole of literature is the sheer beauty of the night sky more perfectly matched in words than in a passage to be found in " The Merchant of Venice "—

" How sweet the moonlight sleeps upon this bank !
Here we will sit, and let the sound of music
Creep in our ears : soft stillness and the night
Become the touches of sweet harmony.
Look, how the floor of heaven
Is thick inlaid with patines of bright gold :
There's not the smallest orb which thou behold'st
But in his motion like an angel sings . . ."

Here, as elsewhere in Shakespeare's writings, there is a reference to celestial music, the music of the spheres. The spheres of Ptolemy's theory have long since been discredited, but the celestial music may be said to survive to this day in the wonderful harmonies of the physical universe as perceived by the modern astronomer.

The idea that the destiny of man is being fulfilled against the background of the stars is never far absent from Shakespeare's thoughts. As we read his works we realize that not once, but many times, must he have stood like Hamlet gazing up into "this brave o'erhanging firmament, this majestical roof, fretted with golden fire", and pondering the questions that came into his mind out of the night. His lifetime fell at the beginning of the new age of modern astronomy, for as it drew to a close the telescope was being used for the first time upon the heavens, and men were turning their instruments and their minds farther and farther into the depths of space. There is, I think, no surer sign of the massive nature of Shakespeare's genius than this, that again and again in his writings we find him speaking not only for his own day, but also for succeeding generations.

> "Doubt thou the stars are fire,
> Doubt thou the sun doth move,
> Doubt truth to be a liar,
> But never doubt I love."

Here Shakespeare clearly expresses the idea now familiar to astronomy, that the stars are vast reservoirs of heat and light. "They are all fire, and everyone doth shine," he writes again in "Julius Caesar". "Doubt thou the stars are fire"—we find the great astronomer Sir William Herschel saying the same thing in a scientific paper written in 1795, nearly 200 years later. "That stars are suns" wrote Herschel, "can hardly admit of a doubt".

It may be, too, that Shakespeare, with prophetic insight, wrote the last word on the ultimate fate of the earth in his lines in "The Taming of the Shrew"—

> "The cloud-capped towers, the gorgeous palaces,
> The solemn temples, the great globe itself,
> Yea, all which it inherit, shall dissolve
> And like this insubstantial pageant faded,
> Leave not a rack behind."

The same possibility has been suggested by the present-day astronomer, Fred Hoyle, when he envisaged after aeons of time an intensely hot sun engulfing the planets one by one in its spreading fire.

Within the framework of his poetic and dramatic art Shakespeare has enshrined for us in immortal words many of the basic facts of the cosmos in which humanity finds itself. It is with particularly happy inspiration that the poet Matthew Arnold addressed him in a sonnet as "Thou who didst the stars and sunbeams know". For Shakespeare moved familiarly amongst the matters of astronomy, displaying himself as an observer with some discernment, and speaking with understanding the language of the science as it was known in his day. Even in the twentieth century only a minority of people can rival his familiar knowledge of the sun and moon, their motion and eclipses, the planets and their movements, conjunctions, oppositions, and regressions, the stars and their constellations, meteors, comets, and other matters. Although astrology is prominent in his writings, two things must be kept in view, (i) that his works cover nearly 2000 years of human history, and therefore properly reflect the beliefs of more primitive times, and (ii) that arguments against astrology are frequently presented from his pen. For example in " Julius Caesar " are to be found the well-known lines—

> " The fault, dear Brutus, is not in our stars,
> But in ourselves, that we are underlings."

Again Edmund in " King Lear " speaks to the same effect with bitter irony—

" This is the excellent foppery of the world, that, when we are sick in fortune—often in the surfeit of our own behaviour—we make guilty of our disasters the sun, the moon, and the stars; as if we were villains by necessity, fools by heavenly compulsion, knaves, thieves and treachers by spherical predominance, drunkards, liars and adulterers by an enforced obedience of planetary influence; and all that we are evil in, by a divine thrusting on."

Astrology may be a discredited science, though perhaps not even yet a completely spent force. The inescapable fact remains, however, that the fate of humanity is bound up with the process of the stars, and the " promontory " upon which, for good or ill, man struts for his brief hour is set in emptiness against the background of the mysterious heavens. The thought that man is a cosmic being, a fragment of a fragment of a star, is one that never seems to be far absent from the mind of Shakespeare. Will there ever be another to clothe in words of greater dignity and nobler beauty the mystery of human destiny ?

CN3x11:

Comet hunt with mighty Rigel --and with Tim Hunter.

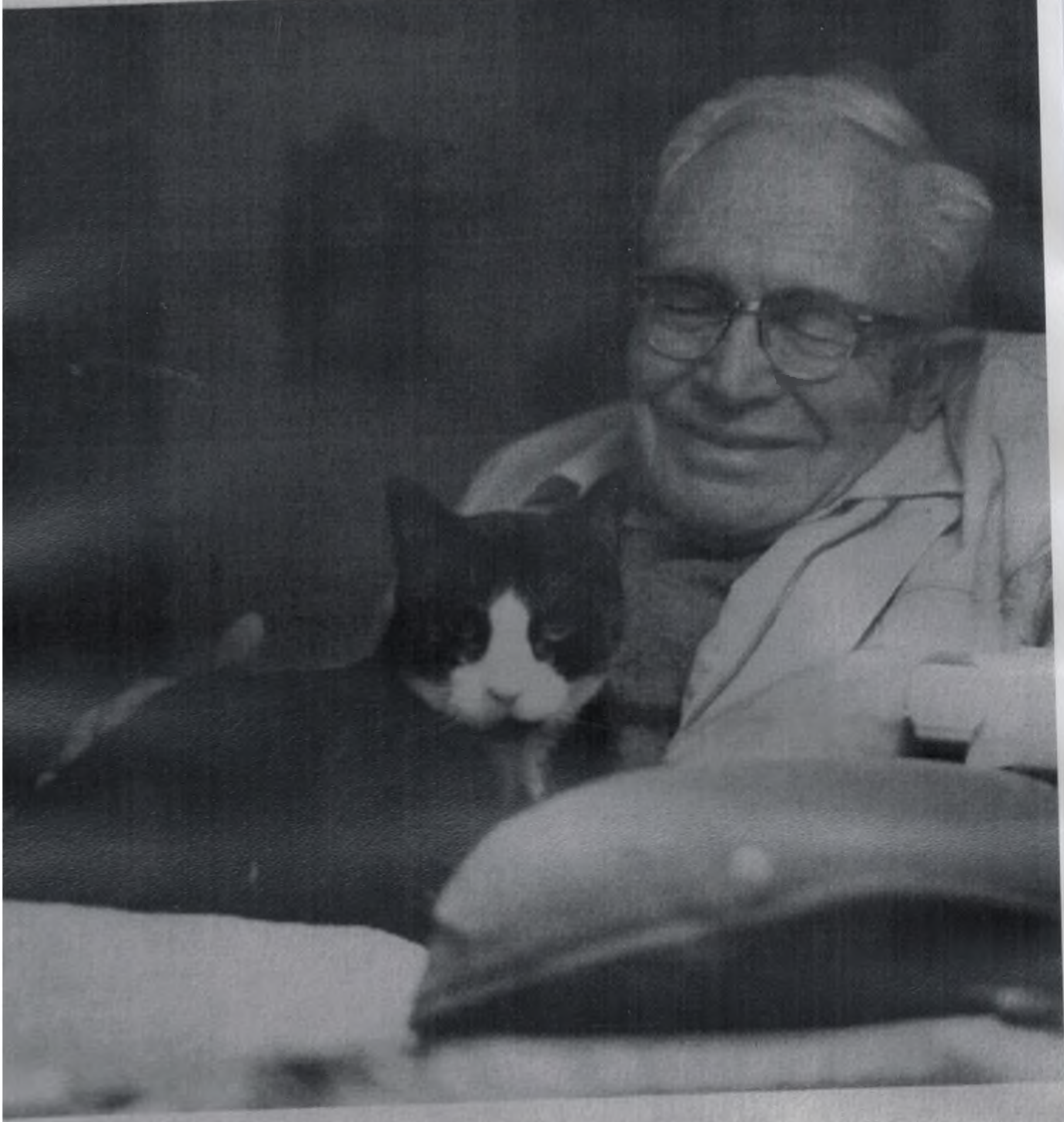
CN3~~h-11~~4

Digital Comet Hunting with POTUS.

Begun early in 2010

Using POTUS, the telescope that Dean Koenig set up at the White House, as a part of what might have been the first star party held with the President of the United States.


FL 2800mm
F/10
CELESTRON
MULTI-COATED OPTICS
SCHMIDT-CASSEGRAIN
11" (279mm)



Clyde Tombaugh with cat Pluto, 1990.

PHOTO BY THE AUTHOR.

Discovery of Pluto just one tiny debt astronomy owes to Tombaugh

CN3z

Sky Watch

By Don Sheron

The passing of astronomer Clyde Tombaugh on Friday closes a remarkable chapter in the history of astronomy.

Tombaugh, 90, was best-known for discovering the planet Pluto, but his contributions to astronomy span to more than just that distant planet.

Actually, his contributions can be remembered by anyone who met him. He was a friendly, down-to-earth person who enjoyed sharing the wonders of the cosmos.

Several of us from San Antonio have had opportunities during the past few years to meet Tombaugh, whether at the Texas Star Party or one of the annual meetings of the Association of Lunar and Planetary Observers.

Although I was just one of the thousands of faces and handshakes during Tombaugh's public appearances, each one of us who had met him was impressed with his friendly approach and enthusiasm.

He was not the type of person to put on airs. He was the type of man who would walk up to you and ask how things were going, what you thought about observing Pluto, and what people could look forward to in the years ahead.

One of Tombaugh's favorite things to do during a public speech was to present a slide show, including what he called the latest NASA photo taken of Pluto.

Once he saw everyone leaning forward to get a better look at the upcoming slide, Tombaugh clicked on the slide projector to show not the planet, but the Disney canine of the same name.

Tombaugh's humor and down-to-earth approach was part of his upbringing as a Kansas farm boy.

During those days of the 1920s, Tombaugh was like most people.

He didn't have money to buy a telescope as most people do today, so he built his own instrument from farm machinery. He often showed pride in his telescope, explaining where the drive shaft came from or where a hunk of metal once was used on the farm.

When he left the farm at age 22, he embarked on a career in astronomy that two years later brought him worldwide attention with the discovery of Pluto in 1930.

Tombaugh outlined his career in a biography, "Out of the Darkness: The Planet Pluto." The book is out of print, but I was lucky to find a paperback version in a used bookstore several years ago. When Tombaugh was a guest speaker at the Texas Star Party in 1987, I took the book and got his autograph on a 1928 picture of him with his homemade telescope.

A more recent book, "Clyde Tombaugh, Discoverer of Planet Pluto," by David Levy, (1991, The University of Arizona Press) also examines Tombaugh's career.

Although Tombaugh had been in ill health for years, several of us drove by his house in Las Cruces, N.M., to visit him about four years ago, when we were there for a meeting of the Association of Lunar and Planetary Observers. Tombaugh wasn't home at the time, but to the side of his house we saw his homemade telescope sitting under large shade trees. The telescope didn't look like much, but it showed that Tombaugh wasn't the type to be taken in by the fancy doodads of today's amateur telescopes.

Tombaugh was fond of telling an anecdote about that telescope. For years, the Smithsonian Institution had requested that Tombaugh donate it, but Tombaugh kept saying that he was still using it.

Whether that telescope now goes to the Smithsonian or not, Tombaugh's contributions to astronomy and his friendliness with people will be remembered.

■ ■ ■

Grab the binoculars and watch the moon pass close by the bright star Aldebaran on Saturday night.

The moon will pass within one-half degree of the bright star from about midnight through 2 a.m. Sunday.

Aldebaran marks one of the eyes of the constellation Taurus, the bull.

If you were along the U.S.-Canadian border, you would see the edge of the moon cover up the star.

To reach Don Sheron, send e-mail to dsheron@express-news.net or call 250-3243

Sincerely
Clyde W. Tombaugh

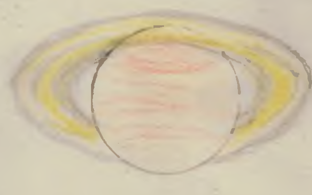
1985 years
A Proud Beginnin

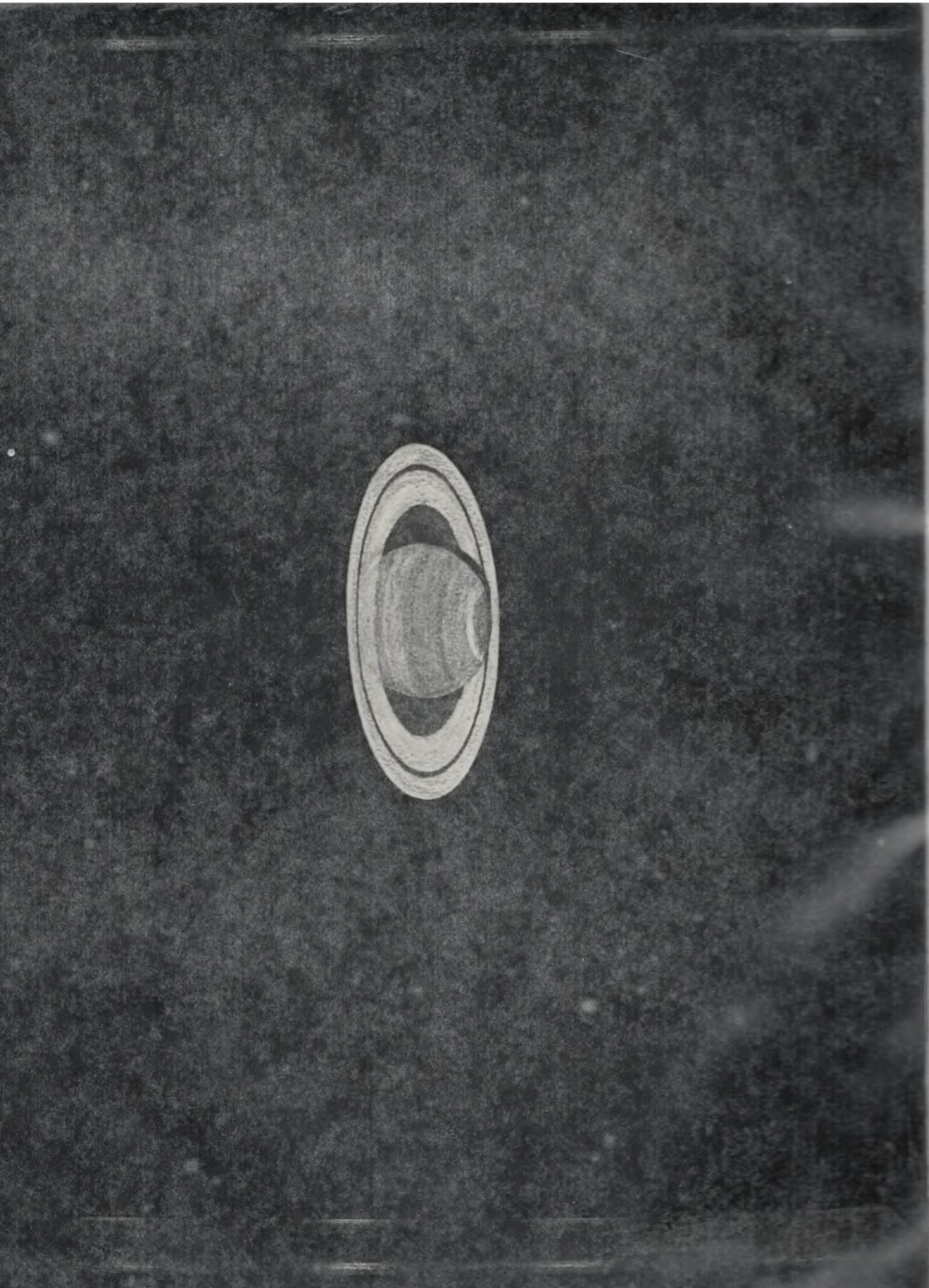
Clyde Tombaugh with cat Pluto, 1990.

PHOTO BY THE AUTHOR.

Jupiter – June 8, 5:00 AM. 1927 A.D.
As seen thru 7-inch reflector,
56½" focus, ¼" eyepiece.
appr. 240 X.

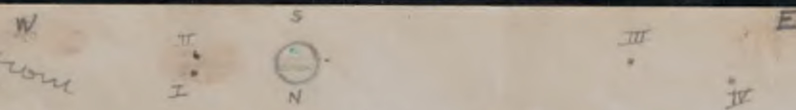
Jupiter – Aug. 4, 1927.
at 4:00 A M
As seen thru 7-inch
reflector, 240 X.





(II)

different belts from last night



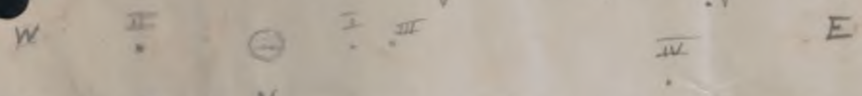
Seeing 3-4 Oct. 23, 1928; 11:00PM IV seems faint

With the $\frac{1}{5}''$ eyepiece (400x) it takes appr. 30 seconds of time for an object to trail across the field of view.

$30 \times 15 = 450$ seconds of arc $= 7\frac{1}{2}$ minutes of arc.

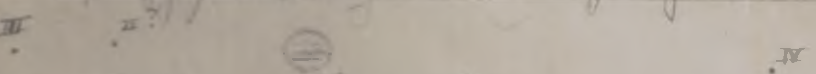
The error of the equatorial = $7\frac{1}{2}$ minutes of arc southward (that is the S disappears first) every 33 minutes of time (polar axis not steep enough)

86
4
344,000
I travelled 344,000 miles in 24 hrs



Oct. 24, 9:00PM
Seeing 1-3
(rather poor)
windy, hazy, partially cloudy

Same belts appr. as on Oct. 22.
S markings lost in poor seeing, not traceable, N. Tropical black area conspicuous and dark, with black spots under the prongs.



I — eclipse?
Seeing = 4
Oct. 27, 10:30PM.
Jupiter rather in[illegible], many white spots, Southern hemisphere markings very faint. N dark conspicuous

$8 \times \frac{?}{?} = \frac{??}{?} = 9\frac{?}{?}$

$50\gamma = \frac{1}{4}$
480
$50\gamma = \frac{480}{4}$
$50\gamma = 120$

Observations (Continued)

The two stars of mags. 12.0 and 12.5 were easily seen and steady. By averted vision I could see the two fainter stars: mags. 13.8 and 13.9 at intervals for a few seconds I could glimpse them directly.

Aug. 20, 1928

Epsilon Lyrae System

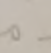
As seen thru my 9 inch Newtonian; 396 X.

No trace of the 15th mag. star could be glimpsed, which is really far beyond the range of a 9 inch. I daresay it would be a good test for a 15 inch aperture.

The globular star-cluster (13 M) of Hercules was well seen. The outlying part was resolved into many stars with the $\frac{1}{5}$ inch eyepi[ece] (400 X), but not the central part.

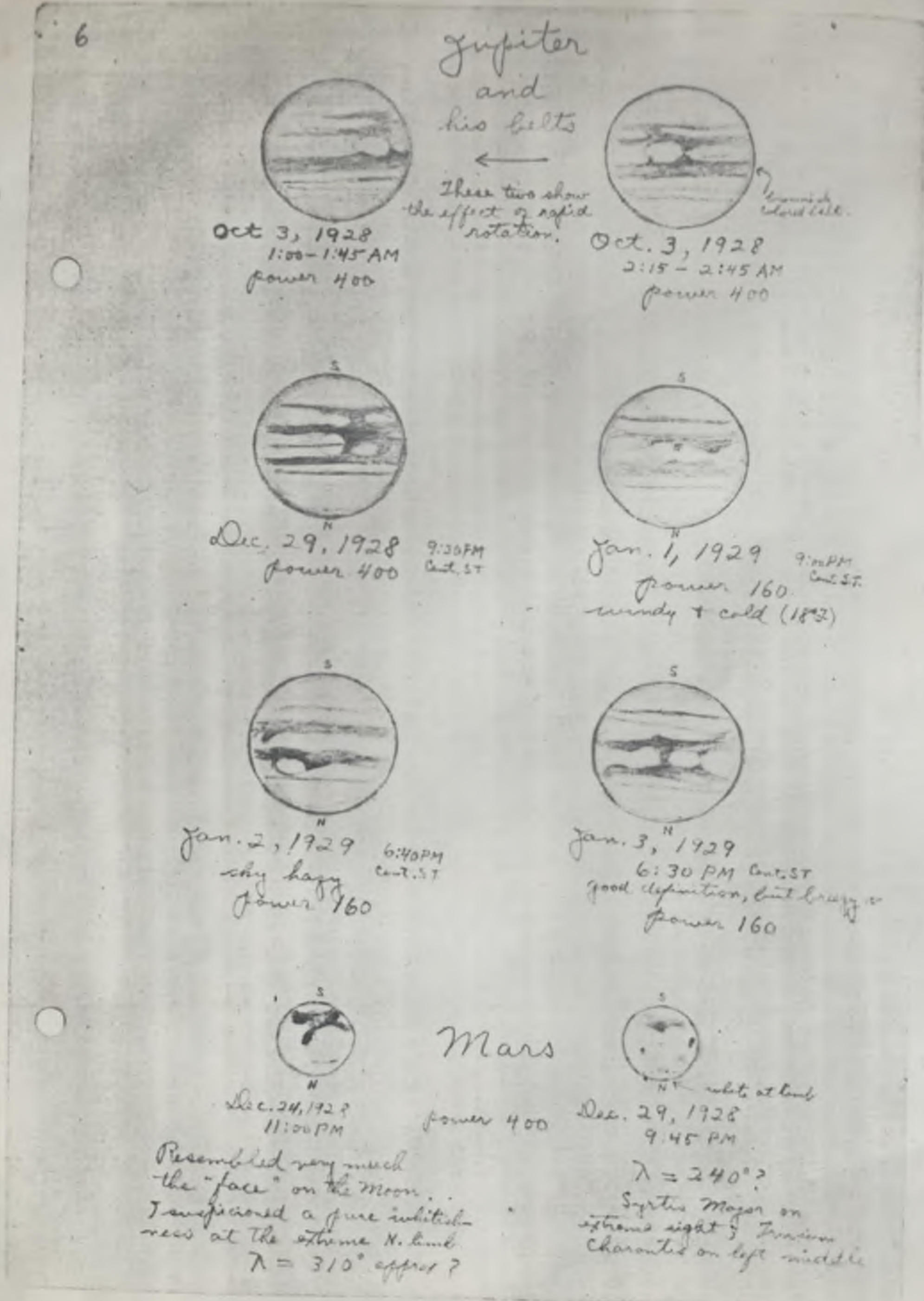
I believe a power of at least 1000 with a 20-inch aperture would be needed to resolve the central part of the cluster into stars.

On the morning of Oct. 3, 1928; the seeing was very good. Oct. 2, PM + Oct. 3, AM, I stayed up all night looking thru my reflector. On this morning I divided η Orionis nicely. Mags: 4, 5; and 1.2" of arc apart between centers. Here is the way I saw it: →
I used the $\frac{1}{5}$ inch eyepiece, power 396 diameters.



η Orionis
Oct. 3, 1928.


JUPITER
JULY 29. 1936.



In December 1928, Clyde received a letter from Dr. V. M. Slipher, chief astronomer and director of the Lowell Observatory. He said that Clyde's drawings were amazingly accurate. Then he asked a few questions.

Was Clyde in good health?

Was he willing to work for many hours in a cold, unheated dome?

Was he interested in becoming an assistant at the Lowell Observatory?

If so, there was a job in photographic observing waiting for him.

Dr. Slipher's letter seemed too good to be true. Clyde read it so many times that he knew it by heart. But what would his parents say? Would they be willing to let him leave the farm?

Clyde read the letter to them and waited eagerly for their answer.

Mr. Tombaugh spoke first. "I think this is a wonderful chance for a career in astronomy, if that's what you want," he said.

"I want it more than anything in the world," said Clyde.

"Then you should try it," said his mother. "Your father and I are very proud of you."

"We wish you the best of luck," added his father.

So Clyde accepted the offer. He made plans to go to Flagstaff after Christmas.

P... [illegible], Kansas,
[illegible] 26, 1926.

Mr. Napoleon Carreau,
266 Butts Building,
Wichita, Kansas.

Dear Sir:

I h[illegible] polish[illegible] figured an eight-inch speculum for a [illegible]. The speculum has a focal length [illegible] eighty [illegible] which I know is longer than [illegible] it should [illegible] that aperture, but I wanted one [illegible] longer [illegible].

I have tried [illegible] silvering [illegible] ones, but not with much success [illegible] silvering directions, I understand the [illegible] little [illegible] practice to get on to the art [illegible]. I am getting busy with other [illegible] will have to wait until the [illegible] done before I can try it ag[illegible]. [illegible] my telescope to [illegible] evenings. The [illegible] I have [illegible] keep the temperature [illegible] the heat, if I did [illegible]

The [illegible] dollars: But if [illegible] speculum is [illegible] let you silver my speculum [illegible] price and how soon could [illegible]

I remain

[illegible] truly, yours,
[illegible]

THIS ACETATE IS COPIED DIRECTLY FROM THE ORIGINAL LETTER, DISCOVERED BY HOWARD LOUTH AMONG SOME MISCELLANEOUS OPTICAL PARTS PURCHASED FROM THE WIDOW OF A WITCHITA OPTICIAN. (DAVE L., I HAVE MORE OF THESE. EDM)

Burdett Kan
Dear Clyde Mar 16 1930

Well, well, you old hea
liner how does it feel to be
a hero in the public eye? ha
You sure took us by surprise
keeping mum about your find
until it was proven a fact,
Friday morning we were sitt
around the house after breakfast
when the phone rang, Tilles and
Toiler calling, "Did you know
your son has discovered a planet
"No," says I, "but I know he wa
hot on the trail of one", They wan
to send a man out right away fo
an interview for the Kansas City
Times, While he was on the road
The Dodge City Globe called,
wanted pictures and facts about

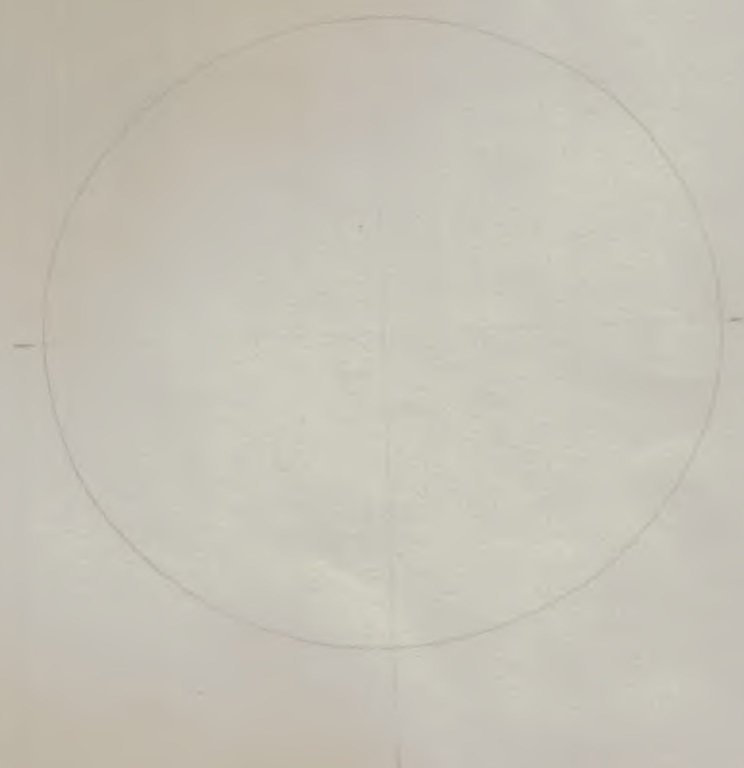
Journal-Post called, and
Just before noon a telegram f
New York Associated Photo
wanting pictures by airmail
special delivery, meanwhile
~~he~~ we got our wits sufficient
collected to send you telegram
congratulations which I suppose
you recieved O.K. Potter from the
T and T. arrived then and want
your history and that of the fam
from A to Z, also took back with
him the pictures of your telescop
some of your star plates and you
studio photograph, It was sur
lucky we had the prints you
made for us, We went to tow
after dinner and while there an
telegram from New York arrived
asking for parents pictures,
Well we only had one left of th
family group taken last July a
a small one of Mamma, I, and

sent them Saturday noon, The boys got wind of it about 1 P. Friday after the mail came, the K.C. Star mentioning that C.W. Tombaugh was the photogra[illegible] at the observatory who called atten[illegible] to the new planet, We took in the Sterling Boys Glee Club conce[illegible] at the High school Friday P.M.

Planted potatoes Sat. AM a[illegible] all went to Larned PM for a little celebration in your hono[illegible] We bought all the papers we could find having articles about you, Including K.C. Star and Tim[illegible] Wichita Beacon and Eagle also ordered Sunday editions of the Sta[illegible] and Journal Post, Have quite a bunch of clippings including th[illegible] 1000 word write-up in the K.C. T[illegible] If you want to see them will send them otherwise I expect y[illegible] are swamped with congratulation[illegible]

JUPITER

taken NOV. 29, 1940. 42" REFLECTOR
10:32 PM. MT. Time
from KODACHROME 115' CASS. FOCUS
DIA. = 8 MM.



Rev. Bob Evans

StarTrails

BOB EVANS is to supernovae what Charles Messier was to comets. More than two centuries ago Messier searched specifically for comets, introducing sport and challenge to the activity. He went on to discover seven comets virtually unchallenged before others joined the race. Similarly, in this decade Evans became the first to show us the rewards of a systematic visual supernova search.

In October, 1983, *Sky & Telescope's* Dennis di Cicco interviewed Evans, a resident of Australia, when he was in the United States to receive the American Association of Variable Star Observers Nova Award for his fourth supernova discovery (*S&T:* January, 1984, page 94). Last fall Evans returned to the United States — this time to receive the Nova Award for his 17th discovery or co-discovery. (His 18th, in M66, would come soon after.) Nova discoverer Peter Collins of Scottsdale, Arizona, and I talked with Evans one bright November day in Socorro, New Mexico.

Evans began a rudimentary supernova patrol in the late 1950's — a response to reading about Fritz Zwicky and Walter Baade, the astronomers who cleverly suggested in the 1930's that the end result of a supernova explosion is a neutron star. They had emphasized the importance of looking for these objects. "I started wondering if I could find one," Evans recalls, "because hardly any had been found."

For most of us, knowing that "hardly any had been found" would make a search seem hopeless or even futile. But the idea of these stars exploding and revealing their secrets captured Evans' fancy. So he started to scan galaxies, first with a 5½-inch Newtonian telescope mounted against his leg, then with a 10-inch reflector he built with odds and ends. He would discover his first 11 supernovae with that telescope before moving on to a 16-inch.

Developing an effective strategy was not easy. A lack of suitable galaxy photographs hampered Evans' early attempts at identifying what might be "new" stars in a galaxy. Without good confirmation charts, most of us would have given up. But instead Evans began *memorizing* the appearance of galaxies and the stars around them. This approach evolved into the highly organized program that today allows Evans to do more than 15,000 galaxy examinations per year.

The early years had some false alarms, caused for instance by the bright stars near the nuclei of Centaurus A and M49. These punctuated two decades of intermittent and fruitless searches. But this was a time of learning. One thing Evans discovered during those years was that a galaxy's core can appear more starlike in the morning sky than in the evening. An unsuspecting observer, perhaps seeing a galaxy oriented differently, could mistake a sharp nucleus for a new star, especially if the sky is clearer.

Australian amateur Rev. Robert O. Evans is credited with 18 supernova finds. A pastor of the Uniting Church, Evans finds harmony in viewing nature as an astronomer and theologian. Photograph courtesy Robert Evans.

Meanwhile two critical events had happened. In 1968 South African amateur Jack C. Bennett discovered a 9th-magnitude supernova visually in M83. And in 1979 Gus E. Johnson of Swanton, Maryland, found a 12th-magnitude supernova visually in M100. Clearly amateurs could discover supernovae!

In December, 1980, Evans found a 12th-magnitude supernova in NGC 1316. It had been recorded by another astronomer a few days earlier, so Evans missed getting official credit for the discovery. He made his first official find two months later, in February, 1981. One month later he chanced upon another supernova — again in NGC 1316! Again, Evans is credited with 18 discoveries or co-discoveries, and there is no end in sight.

BEYOND GALAXIES

Collins and I met two incarnations of Robert Evans that day in Socorro: the discoverer extraordinaire of supernovae, and the pastor of the Uniting Church. Evans the discoverer is as dedicated to his astronomical avocation as Evans the pastor is to his religious profession. Superficially, the two seemed separate. But as we talked, I suspected that some deep, unifying force enables him to have diverse views of nature without conflict.

There are other well-known cases of theologians having a deep interest in astronomy. No doubt you've heard of Rev. Thomas W. Webb, the 19th-century observer and author of *Celestial Objects for Common Telescopes*. You might also have read about Rev. T. H. Espin, who discovered a number of variable stars during his late-19th-century study of red stars. Also, Rev. Thomas D. Anderson discovered Nova Persei 1901 while walking home one evening.

Most of us like to keep astronomy and religion separate. Evans himself does not preach much about the stars. "People ought not to talk about their favorite topics too much," he says. "I do occasionally make references to astronomy to illustrate certain points, but not often."

For many of us, the topic of "theology vs. astronomy" comes up again and again at star parties. "What do the stars say about God?" an eight-year-old girl asked me one starry night. As amateur astronomers we are often asked to explain our beliefs in science and religion. "Physics, chemistry, psychology, and theology each look at certain areas of reality," offers Evans.

"There are different standards of evidence and certainty that are looked for in each of these areas," he continues. "It is a mistake to take the kind of reasoning that's used in physics and try to apply it to other areas.

"Physics and theology require different lines of approach," he says. "What kind of method of investigation is used in each area? What kinds of evidence are going to be acceptable? What kind of certainty of knowledge can you get? A scientific theory about the origin of life is not going to talk about God, because God is not an area of knowledge where the scientific method applies. The difficulty comes when someone insists that the scientific theory is a total description of what happened."

As that eight-year-old girl I met at the star party matures, she might learn that this beautiful world is a complicated place, and that many answers, not just one, are right. "Theology," Evans concludes, "has a right to have an input into the question, as do physics and chemistry. They can all contribute."

Collins ended our meeting with something he remembered from the Bible (*Psalms 19: 1-2*): "Day unto day uttereth speech, and night unto night showeth knowledge." As people who think deeply about nature, we each have to develop our own thoughts about day and night.

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Brian,

StarTrails

LAST July StarTrails applauded amateur astronomers for their contributions in 1987, as recognized by the International Astronomical Union through its *Circulars.** Published by the IAU's Central Bureau for Astronomical Telegrams in Cambridge, Massachusetts, these hand-size cards announce the latest discoveries and noteworthy observations of all manner of celestial objects. Issued several times a week on average, the *Circulars* help us follow the performance of some of astronomy's most serious amateurs.

Here's a taste of what they accomplished in 1988.

Comet discoveries. On January 11th William Liller of Vina del Mar, Chile, found the year's first new comet. Although a professional astronomer, he uses equipment and techniques — an 8-inch Schmidt camera and Kodak 2415 film — that are available to any amateur. He captured the 13th-magnitude interloper on two short exposures taken 30 minutes apart. Liller participates in the Problicom sky patrol, whose members "blink" photographs in search of comets and novae. Comet Liller, 1988a, became a beautiful binocular object for Northern Hemisphere viewers.

I made the year's first visual comet discovery on March 19th. Through my 16-inch reflector Comet Levy, 1988e, appeared as an 11th-magnitude diffuse glow. Amateurs also nabbed two other comets in 1988. On August 6th Donald Machholz at Loma Prieta, California, used 27 x 120 binoculars to find his fourth — Comet Machholz, 1988j. And on December 29th Japanese amateur Tetsuo Yanaka used 6-inch binoculars to capture his first — Comet Yanaka, 1988r. His second discovery, Comet Yanaka 1989a, would occur only three days later (see page 407).

Novae and Supernovae. The year also opened with a "bang!" as a supernova erupted in the 10th-magnitude galaxy M58 in Virgo. The new 14th magnitude star was first sighted visually by famed comet hunter Kaoru Ikeya of Shizuoka, Japan, on January 18th, followed by Australian Robert O. Evans, of Hazelbrook, New South Wales, on the 22nd. Another Japanese amateur, Shingo Horiguchi, had unknowingly photographed the star two days before Ikeya's discovery. He used an 8-inch reflector and Konica SR-V3200 color negative film to record the galaxy.

Brian Marsden directs the International Astronomical Union's Central Bureau for Astronomical Telegrams, the clearinghouse for all celestial discoveries. On January 20th the University of Arizona bestowed the George Van Biesbroeck Award upon Marsden for his services in astronomy. Photograph by Stephen James O'Meara.

D. McAdam of Telford, England, photographed a peculiar 10th-magnitude star in Andromeda on March 21st. It didn't appear on Hans Vehrenberg's *Atlas Stellarum* — a photographic atlas in blue light showing stars to about 14th magnitude — or on nova patrol photographs taken just days before McAdam called attention to the star. Not until July 9th, when the star had faded to about 18th magnitude, did astronomers obtain a spectrum, which revealed it to be a nova.

A few weeks after McAdam's discovery, Minoru Wakuda of Shizuoka, Japan, photographed a 9th-magnitude nova in Ophiuchus with a 200-mm lens, a green filter, and Tri-X film. Wakuda's negatives were also used to obtain an accurate position of the new star.

Mars. Kermit Rhea of Paragould, Arkansas, witnessed the onset of a major Martian dust storm on June 7th. Association of Lunar and Planetary Observers Mars recorders Jeff Beish and Donald Parker independently sighted it a week later. By June 21st the storm had spread across the planet's southern deserts and measured 7,500 km east-west by 2,500 km north-south before gradually dissipating.

The long-awaited global dust storm, expected in August, never materialized. But another episode of dust activity did cloud the planet's southern hemisphere from late November to early December. Mars observer Daniel M. Troiani of Schaumburg, Illinois, noticed it first two days before Thanksgiving (see page 369).

Circular 4645 reports the independent discoveries of a new dark feature on Mars by Parker, Beish, Isao Miyazaki (Okinawa, Japan), and *Sky & Telescope's* Stephen O'Meara. Using the 60-inch telescope at Mount Wilson Observatory O'Meara traced it across more than 100 degrees of Martian longitude; it appeared to be a long lane swept clear of dust. Now called Valhalla, it is not on maps dating back to Schiaparelli's of 1879.

Asteroids. In August *Sky and Telescope's* Roger Sinnott informed the Central Bureau that asteroid 1988 OG, discovered by Carolyn Shoemaker at Palomar in July, is identical with another object recorded three years earlier, asteroid 1985 DO_2 (*Circular* 4639).

Identifying newly found asteroids with known objects rarely results in the recovery of a long-lost asteroid. Yet that's what happened in November when Japanese amateur Syuichi Nakano identified the newly discovered 1988 VG_2 with minor planet 724 Hapag, which was lost after Johann Palisa's original discovery in 1911.

Magnitude estimates. When planning to observe comets, professional astronomers often scan the *Circulars* for recent brightness estimates made by amateurs. These status reports help them judge how a comet is behaving. For example, *Circular* 4579 reported 11 visual observations of Comet Liller, 1988a, made from Europe and the United States, which show the comet rising from 7th magnitude in late March to 5th magnitude in mid-April.

Visual magnitude estimates also help astronomers interpret the behavior of distant novae and supernovae. In fact, many of these stars are classified by the shape of their light curves. Thus prolonged observations of them are very valuable. Throughout 1988 the *Circulars* reported magnitude estimates of the supernova in the Large Magellanic Cloud that blazed to 3rd magnitude in early 1987. A. C. Beresford of Adelaide, South Australia, and his countryman P. Williams of Heathcote, New South Wales, provided many of the observations, which show the supernova gradually fading from 6th magnitude in early January to 10th magnitude in late November.

One final set of observations: Steve Larson and I used a CCD on the University of Arizona's 61-inch reflector atop Mount Bigelow to estimate the brightness of Comet Halley on February 23, 1988. It was 17.2. As a comparison, I estimated its brightness visually using the same telescope and got 16.8. These results are reported on *Circular* 4559. Incidentally, this is the last visual observation of Comet Halley reported thus far on the *Circulars*.

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* The IAU *Circulars* are available from the Central Bureau for Astronomical Telegrams, Smithsonian Astrophysical Observatory, Cambridge, Mass. 02138, for $54 per year (noninvoiced rate). You can also receive the *Circulars* by computer for an additional $54 per year (noninvoiced rate).

StarTrails

"MY GOD, it's a comet!" cried Rodney Austin. It was the early morning of April 26th, and the Space Shuttle *Discovery* was sailing across the dark Tucson sky with the Hubble Space Telescope some 10° east of it. As he, I, and others watched, a bright plume spewed from the shuttle, curving away to form a broad, 3° tail. It was a water dump, one of the many that occur on each mission. When the show was over, Austin turned to me and said, "*Discovery* is a better comet than mine." It was true. Although Comet Austin shined at fifth magnitude and had a respectable 4° tail that morning, "Comet *Discovery*" had beaten it by more than a magnitude.

I happened to be with Austin and fellow New Zealand amateur Mervyn Thomas that April morning because they were visiting Tucson for a few days. They had traveled here to see the comet, which was ill-placed in New Zealand's sky. As is now well known, it fell far short of their hopes (and everyone else's). Nevertheless, the visit gave us the opportunity to share some thoughts.

Although we compete for comet discoveries, Austin and I instantly began sharing hunting strategies and friendly gossip. It quickly became apparent that our approaches to searching are different, but that we share a deep respect for both the hunt and the prey. I also found his comments about the philosophy of comet hunting deeply illuminating.

"The main hazard of comet hunting," Austin reflected, "is not galaxies, not light pollution, but success." Perhaps this comment comes with the benefit of hindsight. Had he known how chaotic his life would become after he found his latest comet, Austin said he "might have just packed up quietly and forgotten about it."

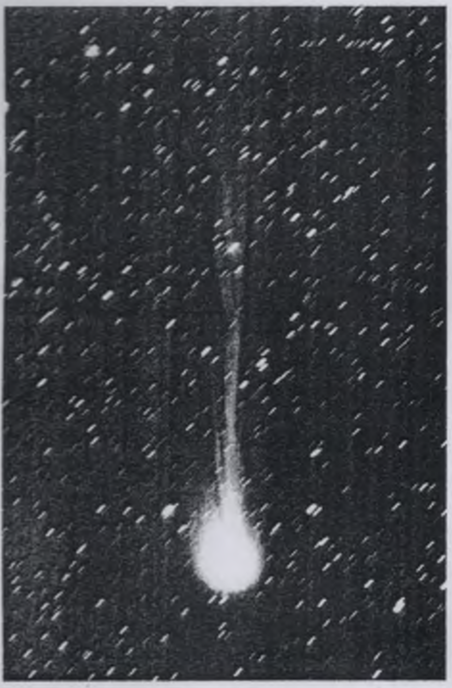
Instead he has had to endure some rough times. Austin was quickly thrust into the limelight when the comet showed indications of becoming very bright. Suddenly he was the subject of international media attention. But Austin's exposure waned as the comet's brightness failed to live up to expectation; although predicted to brighten to magnitude 0, it barely reached 4th magnitude.

Despite the world's eager reaction to his find, Austin complained about how his home country treated him during the affair. Ironically, New Zealand television virtually ignored the event. It seems one is never a hero in one's own house.

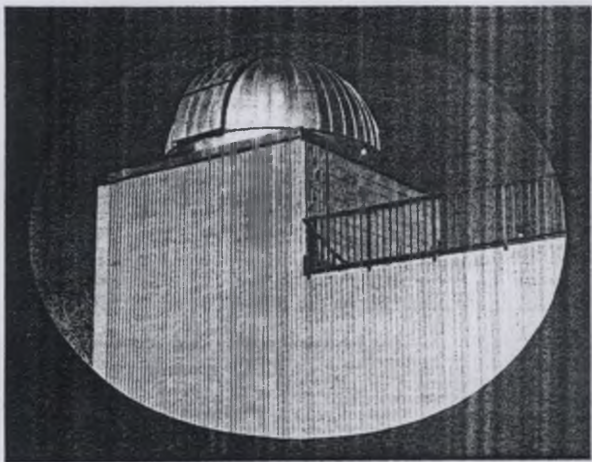
Now that the comet is leaving the inner solar system, some people are treating its behavior like a political fiasco. So who is to blame for "Austingate"? No one really — and certainly not the discoverer himself. Comet Austin, the phenomenon, flopped because an uncertain event was oversold. It's simply hard to predict the behavior of a comet coming in fresh from the Oort Cloud.

A tall, thin man in his mid-forties, Austin got a very early start with comets. He claims comet watching is a long-standing family tradition. His mother showed him the Great Southern comet of 1947 when he was only three years old, and the sight remains one of his earliest memories. As a comet hunter, Austin has had incredible luck. He has managed to make three discoveries in only 243 hours of searching, and each comet bears his name alone.

Austin started hunting for comets in 1956, though he spread his time very thinly. It was not until June 18, 1982, that he found his first — an object that put on



Michael Stecker took this 20-minute exposure of Comet Austin on May 3rd. He used an 8-inch f/4 Takahashi reflector and hypered Kodak 2415 film.



FOCUS ON

Mohns Observatory
Sheridan College
Sheridan, Wyoming

Sheridan College recently completed a fund drive to provide a home for a 12½-inch Ghikas reflecting telescope. The major benefactor provided a facility including the 14-foot dome. During the first few months of operation, several thousand school children and other lay people in northern Wyoming have taken field trips to the observatory. Regular credit students in the college academic program find this facility a valuable addition to their science programs. Hands-on use of the telescope and darkroom facilities are provided to the students.

StarTrails

ALFRED JOY was lucky. He was one of Mount Wilson Observatory's most illustrious astronomers, and he narrowly escaped death in 1946 when he fell more than 20 feet off an observing platform. Even though his assistant got help immediately, there was doubt he would survive his massive injuries. Had he been observing alone, Joy might have died.

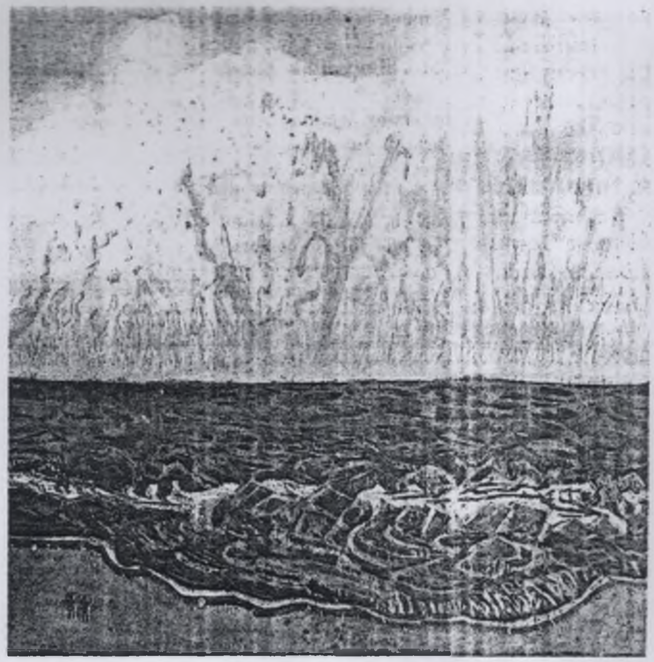
Observing can be dangerous. In fact astronomy has been rated the seventh most hazardous white-collar profession (*S&T:* March, 1989, page 247). The death of Marc Aaronson in 1987 is a cold reminder. He was crushed by the rotating dome of the 4-meter Mayall reflector at Kitt Peak National Observatory. It was the most serious of several accidents in recent years.

Astronomers do take chances whenever they are with a telescope. On Arizona's Mount Lemmon, an observer was busy doing photometry when he heard a knock at the door. It was someone from a neighboring telescope, his face covered with blood. He had walked into a corner of an instrument attached to the telescope. This kind of accident is surprisingly common, since a heavy instrument bolted to a multi-ton telescope will not budge when a 180-pound observer walks into it. Even I have earned a bruise and a headache that way while imaging Comet Halley through a 61-inch reflector. (Later, I could not detect the slightest telescopic shift in the perfectly tracked image.)

Sometimes accidents happen because the observing takes place where it's dark and cold. Long nights under such conditions can be taxing on the body and mind. High elevations may be fine for infrared telescopes but not for humans used to breathing oxygen in abundance at sea level. Furthermore, the drive to and from mountaintop observatories can be dangerous. In 1986 two people perished when they drove off Hawaii's Mauna Kea after observing Comet Halley from 9,000 feet.

Thanks to the need to point telescopes and their equipment at odd angles, observing platforms and dome walkways can become perilous at any time. Such was the experience of one observer at the Anglo-Australian Telescope. Trying to avoid a jutting instrument, he paraded right off a walkway into the center of a hoist intended to lift the mirror cell. He narrowly escaped death. And no, the walkway did not have a rail.

Portable amateur telescopes are a blessing, since they submit somewhat if a user bumps into them. In fact I don't consider a telescope really mine until I have bruised myself on it somehow. The worst such incident happened just a few months ago when I was removing an 8-inch Schmidt camera from its fork mount. During this awkward task, the camera slipped and started to fall. By quickly moving my hand between the camera and the base of the fork, I traded one impact for another: camera safe, finger healing.



As lava shot 200 feet ward from the floor Hawaii's Kilauea vo on September 25, 19 Stephen J. O'Meara of the two silhouette lower left) was just away, scanning the novae with 10 x 50 b lars. Section of a wa color by O'Meara.

A lfred Joy

What about the *fear* of accident? Recently I arrived alone at the 61-inch reflector high in the Catalina Mountains north of Tucson. A message from the site manager was waiting for me: "Keep the radio on loudly, and do not leave the observatory site during your run." Apparently, an environmental group had just vandalized a University of Arizona telescope to protest the construction of a new observatory at nearby Mount Graham. What's more, they had threatened to strike again. "Our facility is less likely to get damaged if someone is there," the note continued, "as the group so far has targeted telescopes, not people." Hardly encouraged, I managed to get though an otherwise uneventful evening anticipating the worst.

Comet observer Stephen Edberg of La Canada, California, had an eerie experience one night when a sheriff's truck passed by his roadside observing site and scanned the lower terrain with a searchlight. "Later, I heard footsteps down slope," says Edberg, "as if someone was trying to walk unseen." Then the sound slowly faded until it was gone. These footsteps were real, but how often have we heard other noises and imagined wild animals or lunatics lurking in the rough, or been startled half to death? (Last October's Amateur Astronomers department considered several ghost stories, some of which were likely born out of loneliness and fatigue.) Indeed, the perception of trouble can be as frightening as real trouble.

How do we minimize risk? The way is never to observe alone. If you go out by yourself, please tell som where you will be and when you return. The University of Arizona vides its observers with a special ne that can alert emergency crews. At l dome offers some protection from outside world; a solitary amateur set a field is an easy target for attack, e the telescope in the dark could bear resemblance to a mortar or other ar piece!

All other precautions aside, telesco weapons system won't help if Nature is the problem. On the evening of Se ber 25, 1982, a mile-long fissure op on the floor of the Kilauea volcan Hawaii's Big Island, through spouted a 200-foot "curtain of fire. hundreds of people viewed the eru safely atop the crater wall, Steph O'Meara was strolling the caldera with his 10x50 binoculars, only 75 from the fountains.

"Sitting two feet from a lava f watched the flow of new land pour the volcano's floor with pops and gles," Steve wrote in his Hawaiian "I decided to walk the perimeter o flow to the fissure, where the p activity of the fountains was dying d At one point I took the opportun nova hunt not three feet from an ad ing wall of lava.

"Lying supine, glasses raised to the I searched star fields in Monoceros. spite purple sky, green stars, and molten rock, I completed the search tered from a chilling breeze by the he the flow."

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Leslie -

StarTrails

STARLIGHT NIGHTS: The A
*tures of a Star-Gazer,** is the a
ography of the late Leslie Copus P
Born in 1900, this renowned Ohio
teur astronomer discovered 12 come
made more than 132,000 observatio
variable stars before his death in
The book depicts his life as almost i
showing a man so entranced with t
that, to him, earthly problems
didn't exist. As a young reader I
thought that such a life was possible
interested in the stars and all w
disappear.

But *Starlight Nights* is not
autobiographical. Peltier intertwine
from his life with lessons about s
ing. The book is a personal hymn
observing and how it affects our li
other book celebrates the virtues o
teur astronomy so successfully.

Starlight Nights exudes magic fr
opening sentence: "There is a chill
autumn air as I walk down the pa
leads along the brow of the hill.
Likewise, a chill went spiraling
down my spine as I read on. Be
with the sighting of two mighty co
1910, Peltier advances to his teenag
and tells a wonderful story of ho
clear, spring night he looked skywa
suddenly realized he did not know
star. He resolved to learn his way
the sky. But before using his gu
of the stars, Peltier began with
slate; he attempted to see the ni
on its own terms, guided only
imagination.

Soon Peltier acquired his first te
We learn that he had to pick 900 q
strawberries (at two cents per q
earn the money for the 2-inch re
After getting it, he was stunned
disappointing views; he didn't re
first that a telescope needed to be

That strawberry spyglass was
telescope Peltier ever had to buy.
two instruments, 6- and 12-inch
tors, were essentially given to h
used the 12-inch mostly to obse
able stars. But the 6-inch was fo
hunting, and he was delighted
that Zaccheus Daniel of Princeton
sity Observatory had used it to
three comets:

> So actually this telescope that was
> me was really a patriarch with a
> honored past. But already its birth
> was lost and the story of its yout
> forgotten. Rather piqued by such
> vowed that some recording of its ear
> as they were known to me, woul
> permanently preserved. . . .

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*Available from Sky Publishing
$8.95, postpaid in the United States.

It seemed to me that if ever human attributes could be invested in a thing of metal, wood, and glass then this ancient instrument now in my keeping must long for one more chance to show what it could do.

Among the book's wide variety of observing experiences, those about his comet discoveries inspired me the most. When I first met Peltier in 1974, I wanted him to share his comet adventures with me. But he was a quiet and modest man, eager to discuss observing in general but not the stories of his own successes. That would be the job of others to tell.

Peltier traveled rarely; a socialite he was not. One time, however, Peltier did go to California to accept the Bruce Blair Medal, offered by the Western Amateur Astronomers for outstanding achievement. Walter Scott Houston recalls how one person there asked Peltier why he took the train to California. "Because," Peltier answered seriously, "the stagecoach no longer operates!"

My second visit took place a few months before his death. By this time I was much more serious about comet hunting and he far more reminiscent. We also spent much time discussing *Starlight Nights.* It was his *magnum opus,* his proudest achievement in writing. There are too many books on theoretical astronomy, he told me, and not enough about the passion of a clear night that can come only from someone who has experienced it firsthand.

I have a special copy of *Starlight Nights,* a rebound second edition with extra pages in front. Like a lucky rabbit's foot I carry it with me whenever I give a talk or lecture and quote extensively from it. The date and subject of the talk subsequently get recorded in the blank front pages. I have now quoted from it nearly 150 times, because it so successfully captures the mood, intensity, and fun of the amateur spirit. If your parent, child, spouse, or friend asks why you are so committed to amateur astronomy, have them read from this book. They might find a passage like the one that follows reason enough.

Time has not lessened the age-old allure of the comets. In some ways their mystery has only deepened with the years. At each return a comet brings with it the questions which were asked when it was here before, and as it rounds the sun and backs away toward the long, slow night of its aphelion it leaves behind with us those questions, still unanswered.

To hunt a speck of moving haze may seem a strange pursuit, but even though we fail the search is still rewarding, for in no better way can we come face to face, night after night, with such a wealth of riches as old Croesus never dreamed of.

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StarTrails

"FIVE, FOUR, three, two, one, close!" The night's first 8-minute exposure is done. Eugene Shoemaker and I race to prepare the venerable 18-inch Schmidt for the next one. I have already loaded a new film into its holder and rushed it upstairs to Gene. We exchange film holders. Gene puts the new one into the telescope and sets the focus. I read him coordinates and move the dome. He slews and sets the telescope. "Five, four, three, two, one, open!" Total elapsed time between exposures: only 2 minutes and 15 seconds.

If tonight remains clear we will have exposed almost 300 films by the end of this 5½-night observing run. But we're apprehensive about the weather. This afternoon clouds hugged the mountaintop, threatening to put an early end to our last observing night. Gene's wife Carolyn, though, was upbeat: "Maybe they'll drop."

Each month the Shoemakers leave their home in Flagstaff, Arizona, and drive some 500 miles across the desert to Palomar Mountain in Southern California. There they scan the skies for planet-crossing asteroids and comets. In fact, tonight Carolyn is downstairs, already busily examining the new films for any tiny speck that shouldn't be there.

Earlier during this run she discovered her 21st comet, and a week later she found her 22nd. That tied her with William R. Brooks as the second most successful comet discoverer in history (see last month's issue, page 470). Now it is only a matter of time before she accomplishes

Carolyn Sho
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Jean-Louis P
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the 18-inch S
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Gene, who i
planet-crossi
and comet s
telescope ab
ago. Photog
Mueller of P
servatory.

Carol

what was once unthinkable — to have more comets named for her than for the great Jean-Louis Pons. Standing on this threshold of astronomical fame must seem dreamlike to Carolyn, who not too long ago led a very different life.

HOMEMAKER TO COMET CHASER

Carolyn Spellmann Shoemaker was born in 1929 in Gallup, New Mexico. Her father was a poultry farmer and her mother a schoolteacher. Carolyn herself taught junior high school, though she never enjoyed it. She married Gene in 1951 and spent the next 25 years raising three children. She also spe
doing field geology with Ge
time he was studying impa
Earth for the U. S. Geologic

Anxious to become more
science, Carolyn joined
planet-crossing asteroid surv
project directed by her husb
tech astronomer Eleanor He
later Eugene and Carolyn st
pendent program with Palo
Schmidt. Their goal was
sufficient number of planet-
oids and comets — those
overlap that of a planet –
how many of these objects
They hoped to refine calcu
cratering rates on the terr
(including those on Earth!),
the Moon and the many sa
outer planets.

To examine the exposed
uses a stereo microscope
photographs of the same
This, she says, gives her a
seeing the solar system i
stereo scanner differs subs
the blink comparator used
baugh to discover Pluto. In
a timing device switches the
film to its mate. Tombaug
for objects that shifted
"blinked." In the Shoema
two identical films taken ab
apart are viewed simultane
ject moving retrograde,
against the stars appears
the general plane of the bac
An object moving rapidly
below the star field. It t
minutes to examine compl

the Schmidt's 6-inch-diameter pieces of circular film.

Carolyn discovered her first near-Earth asteroid in 1983. It was an Amor type (a Mars crosser) later named Nefertiti. She also found another Amor known as 1983 RB. Later that year Carolyn found her first comet. Announced as Comet Shoemaker 1983p, it would be the first of a long series of rapid-fire finds.

NO MINOR TASK

As she closes in on Pons, the 18th-century *concierge* of Paris Observatory who has 26 comets officially named for him, Carolyn reflects on the enormous effort required to find them. A typical observing night's work lasts 13 hours. During this time she and Gene, along with a helper, take more than 27 stereo pairs of overlapping regions of the sky. Often only two weeks separate the end of one run and the start of another. So Carolyn might finish scanning the previous run's films only a day or two before it is time to return and try again.

There is one question that seems to sizzle in every comet hunter's mind: Is a photographic discovery the same as a visual one? Definitely, yes! In fact, it usually requires more work. Scanning films for comets takes about the same amount of diligent searching as a visual observer might spend. And this does not include the hours spent acquiring the photographs. Over the last nine years, Carolyn has examined some 6,000 pairs of films. Since she spends about 20 minutes per pair, her discovery rate is about 100 search hours at the stereo microscope per comet find.

The long periods of scanning tire both the eyes and the mind — a complaint Clyde Tombaugh also had — and a short walk or diversion is needed every hour or so. But Carolyn doesn't find the task particularly tedious. "Finding unusual things, especially comets, gives me the feeling that something lives and breathes out there."

To the scanner of films, the art of searching for comets photographically is every bit as much visual observing as being out with a telescope. Tombaugh felt that way 60 years ago. And Carolyn, a lover of the outdoors, feels that "looking at films is like actually going outside." Always an astute observer, Carolyn has developed an ability to spot faint moving objects, and even fainter cometary halos around them, over many years of searching. "I am enormously proud of her," Gene says. "As long as we have been together, I have known that eagle-eyed Carolyn is a great observer."

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been trying to reduce their effect on Van Vleck Observatory, which resides on its campus. However, he says a compromise has been reached: the school will order 80 new campus lights but all will be fully shielded. Upgren has also recently prevailed on the university's president to help him get shielding for the city's streetlights near the observatory.

Eric Johansson and fellow members of the Amateur Telescope Makers of Boston are working to preserve the club's dark-sky site. Realizing they cannot move a reasonable distance away from the city's light pollution, they have decided to stay put and fight. Johansson is now trying to develop suggested bylaws.

The club's vice president, Mario Motta, had to deal with just such a threat at his home observatory in Lynnfield, Massachusetts. Observing was fine until the local power company replaced a burned-out mercury-vapor lamp near his property, ruining his view of the southern sky. Motta reacted immediately, and by getting only six neighbors to sign a petition he got the local power company to install a fully shielded, high-pressure sodium lamp. More important, Motta says, the power company now plans to replace most of the town's lighting with similar fully shielded fixtures by 1996. "It wasn't a hard battle to win," he adds.

In response to these and other solo efforts, conference attendees voted to form a lobbying group — the New England Light Pollution Advisory Group (NELPAG) — which will be distinct from the nonprofit IDA. To obtain NELPAG's free newsletter, send a self-addressed, stamped envelope to Daniel Green, Smithsonian Astrophysical Observatory, 60 Garden St., Cambridge, MA 02138.

IDA members stress that it *is* possible to slow the rampant growth of light pollution. Just as the installation of one bad light can lead to another, a lighting ordinance in one community can snowball into others. But to make this happen, they say, *we* have to act, because if lovers of the sky don't care, why should anyone else?

STEPHEN JAMES O'MEARA

IDA Membership

If you would like to join the International Dark-Sky Association (IDA) write them at 3545 N. Stewart Ave., Tucson, AZ 85716. The standard membership dues are $20 per year. The IDA has copies of the lighting ordinances mentioned in this article.

STAR TRAILS

Some Thoughts on Pet Na for Minor Bodies

By David H. Levy

David Levy and his late tabby, Lima Bean. Photograph by Bob Summerfie

EVER SINCE ORION insisted on taking his two dogs with him to the heavens, skywatchers have indulged their pets. Almost every astronomer I know has a special cat or dog, and many of these animals go through life with appropriate names like Milky Way, Kitt Peak, and Halley.

Naming your pet Cassiopeia, Umbra, or Copernicus is not a bad way to celebrate your interest in the sky. But some astronomers have gone so far as to name celestial bodies after their pets! Take for example, asteroid 2309, which has been renamed Mr. Spock. The following citation appears in Lutz D. Schmadel's *Dictionary of Minor Planet Names:*

Named for the ginger short-haired tabby cat (1967–) who selected the discoverer [James Gibson] and his soon-to-be wife at a cat show in California and accompanied them to Connecticut, South Africa and Argentina. At El Leoncito he provided endless hours of amusement, brought home his trophies, dead or alive, and was a figure of interest to everyone who knew him. He was named after the character in the television program "Star Trek" who was also imperturbable, logical, intelligent a ed ears.

Although Mr. Spock is matic example of an astero a pet, it is not the first. In astronomer Max Wolf dis minor planets (the astero 483), which he later namec Seppina after his dogs Pete

No one begrudges an right to love an animal, bu priate to name a minor plan Commission 20 of the Inte tronomical Union — the ble for approving asteroid generally opposed to it. Ne the selection of Mr. Spock versial. Some astronomers the name and the whims but others were incensed: honor a poet (the asteroid speare) or a composer (18 naysayers argued, wouldn mean such a choice grou Mr. Spock is now official. 20 has since passed a resolu aging pet names. Howeve outright ban, and the deba

Actually, all cats that agree to pu with astronomers are honored by a gle Earth-crossing asteroid — Ubasti. Jean Mueller, an inveterate lover, discovered it in 1987 from P mar Observatory. Several years la Gareth Williams, associate director the Minor Planet Center in Cambrid Massachusetts, wrote the following ci tion in the *Minor Planet Circulars:*

Ubasti, also called Bastet or Bast, was ancient Egyptian goddess worshipped in form of a cat. Originally a goddess of home, in the New Kingdom Ubasti w equated with the lioness war goddess. T name is being dedicated to observatory c throughout the world.

Then Mueller's own Pepper C passed away. Schmadel's *Dictionary* ad this line: "This name is particular dedicated to the discoverer's belove companion for the past ten years, Pe per Cat (1974–1991)."

Yes, Ubasti honors all cats, includin my own late Bounder and Lima Bean. large Russian Blue, Bounder one nigh decided to help me estimate the bright ness of variable stars in the Orion Nebu la. Leaping onto the middle of the tube Bounder tried to climb to the top. Be fore I had time to react, the telescope surged forward and hit the ground. A my nerves recovered from the shock Bounder sat calmly on the ground, cleansing himself. No doubt he wondered why I would spend time with a telescope that couldn't support the weight of a well-fed cat.

Although Lima Bean, my tabby, wasn't into telescope jumping, we did share many observing nights together. Just a few months ago he joined me to watch the Space Shuttle *Discovery* pass over Tucson on a late-night descent into Florida's Kennedy Space Center. Just after midnight I spotted the shuttle, which appeared as a deep orange ball shining around magnitude –1 — I like to think it was bright enough for Lima Bean to see. I marveled at the 1st-magnitude, orange contrail that stretched from east to west about 5° from the southern horizon. That feature lasted almost five minutes before it started to fade.

That was the last observing session I had with Lima Bean. He died the following week from cancer. Unlike the long-deceased Mr. Spock, he may never be honored as an asteroid. But sometimes when a bright satellite passes by, I remember my night under the orange arch, when I said a silent goodbye to my unforgettable cat.

Levy can usually be found searching the heavens for "hairy stars" with tails.

Fred Lawrence Whipple, the dean of cometary science, at his office at the Harvard-Smithsonian Center for Astrophysics in Cambridge, Massachusetts. In recognition of his valuable contributions to the study of comets and meteors, Whipple was awarded the Smith Medal by the National Academy of Sciences in 1949 and the Bruce Medal by the Astronomical Society of the Pacific in 1986. Asteroid 1940 was named Whipple in his honor.

star trails | *By David H. Levy*

Dr. Comet at 95

IT'S REFERRED TO AS THE CLASS OF 1906 — a small group of astronomers born that year whose accomplishments span the full range of astronomy, from meteors to galaxies. Four of them, Clyde Tombaugh, Bart Bok, Peter Millman, and Pol Swings, left their marks by discovering Pluto and studying the Milky Way, meteors, and comets and stars, respectively. Fred Lawrence Whipple, a.k.a. Dr. Comet, is a fifth, and at age 95 he is still pursuing his passion. Whipple is best known for his theory on the nature of cometary nuclei, which revolutionized the science of cometary astronomy.

But comets weren't his first love. "I was a farm boy till I was 14," says Whipple. Born in Red Oak, Iowa, he never did any serious observing while growing up. "I was busy going to school and earning a few dollars trapping skunks and selling their furs," he recalls. As a youngster he contracted a mild case of polio that prevented him from following his dream of becoming a professional tennis player. In 1920 he moved to Long Beach, California, and eventually enrolled at the University of California, Los Angeles, as a mathematics major. "Mathematics seemed easy and it gave me lots of time to play tennis," Whipple says, laughing. "But then I realized that becoming a math professor could be the most boring life I could imagine." So in his junior year he shifted his focus to astronomy. After graduating in 1927 he accepted a teaching fellowship at the University of California, Berkeley.

At first, Whipple's astronomical research had little to do with comets; in fact, his doctoral thesis dealt with determining the radial velocities of bright Cepheid variable stars, including Delta Cephei and Eta Aquilae. "I used the 36-inch refractor at Lick Observatory," he remembers. "After a few nights of taking the stars' spectra I wanted to go outside the dome and actually see what stars I really was observing! That was the extent of my interest in the constellations."

In 1930 an early hint of the direction of Whipple's career came when Clyde Tombaugh found Pluto. At Berkeley, University of California professor Armin Leuschner set Whipple and Ernest Bower, another graduate student, to work calculating an orbit for the new world based on a few precise observations of its position. "We eventually computed several orbits," says Whipple, "and some of the elements were not far from the final values; not bad for a six-week arc!"

After receiving his doctorate from Berkeley, Whipple arrived in 1931 at Harvard College Observatory in Cambridge, Massachusetts, then under the direction of Harlow Shapley. Whipple's interests included galaxies, but Shapley, who wanted that aspect of the universe for himself, subtly refused. "He specifically didn't want me working on galaxies," Whipple grimly remembers of that early crisis.

Whipple took charge of Harvard's observing program, which included systematically inspecting some 70,000 8-by-10-inch sky-survey photographic plates with a hand magnifier. During roughly 1,200 hours of scanning he discovered six comets, including 36P/Whipple, the 36th known periodic comet. By the end of the 1930s Whipple was well ensconced in his domain of the solar system.

Dirty Snowballs

In the 1940s many astronomers believed that comets were not discrete bodies but were "gravel banks" flying through interplanetary space. In March 1950 the *Astrophysical Journal* published Whipple's seminal paper entitled "A Comet Model. I. The Acceleration of Comet Encke." His meteor-stream studies showed that Comet Encke had made at least 1,000 revolutions around the Sun. "No gravel bank could have lasted intact that long!" he says. Whipple proposed in his landmark paper that comets instead have large, solid nuclei that consist of conglomerates of ices, such as water, ammonia, methane, carbon dioxide, or carbon monoxide, mixed with meteoritic particles. This theory, now popularly known as the "dirty snowball" model, could account for peculiarities in the observed orbital motions of comets. It had long been known that some comets, such as Encke, persist in returning about an hour earlier than the Newtonian theory of gravitation would predict, while others, such as Halley, arrive a few days later than expected.

According to Whipple's model, as an

icy comet nucleus approaches perihelion, its closest distance to the Sun, solar radiation heats up the nucleus's frozen gases, forming the comet's head, or coma, and, in some cases, a beautiful sweeping tail. "The vaporizing ice leaves the comet at relatively high speed, producing a reactionary force," says Whipple. "This results in a slight change in the comet's orbital motion."

In 1965 he hired British astronomer Brian Marsden, who later became the director of the International Astronomical Union's Central Bureau for Astronomical Telegrams. "I hired Brian because he didn't believe my comet theory," Whipple explains. "I hired him because I knew he would confirm it, which he did."

Well, almost: Marsden at first didn't believe that Whipple had convincingly demonstrated that the motions of comets were altered by nongravitational forces, such as the erupting gases in the nucleus proposed by Whipple's model. "But by means of careful orbital calculations," Marsden wrote, "I convinced myself and others that most comets are indeed affected by nongravitational forces."

Nearly four decades after Whipple's paper was published, his model was dramatically confirmed when the European Space Agency's Giotto spacecraft passed within 370 miles (596 kilometers) of Comet Halley's nucleus in March 1986. Giotto sent back beautiful images of the comet's dark, potato-shaped nucleus the size of Manhattan and affirmed Whipple's reputation as "Dr. Comet."

Marsden did win another aspect of his debate with Whipple, who had predicted that comets like Encke were losing so much nucleus material that they would disappear by the end of the 20th century. "Comet Encke is still with us," Marsden adds, "and while some short-period comets have fizzled out, the number is very much smaller than Fred had suggested."

In 1986 the Giotto spacecraft sent back beautiful images of Comet Halley's nucleus that affirmed Whipple's reputation as "Dr. Comet."

This disagreement led to a highly fruitful professional collaboration and friendship between the two comet scientists. "I'm very happy with Brian's work," says Whipple.

The Energizer Bunny Scientist

Whipple's list of accomplishments seems to go on like floats in a parade. During World War II he coinvented a way to produce aluminum-foil chaff that, when dispersed from a B-17 or B-24 bomber, produced echoes that confused German radar. In 1946 he designed a "meteor bumper," a thin protective shield attached to a spacecraft to absorb the impact of meteoroids (traveling at many miles per second) by breaking up the particles into harmless clouds of debris. Such "Whipple Shields" have been installed on the Stardust spacecraft, which is on its way to an encounter with Comet Wild 2 in 2004.

In addition to his studies of meteor orbits and the Earth's upper atmosphere, in 1959 he proposed and helped organize Project Moonwatch, an international network of amateur observers that tracked Earth-orbiting artificial satellites from the late '50s to mid-'70s, which helped improve geodetic accuracy (*S&T:* December 1996, page 100).

In 1955 Whipple became director of the Smithsonian Astrophysical Observatory, a post he held until his retirement in 1973. He was instrumental in merging the SAO and Harvard College Observatory into the Harvard-Smithsonian Center for Astrophysics and moving its headquarters from Washington, D.C., to Cambridge, Massachusetts. In recognition of his contributions, the Smithsonian Institution's observatory on Mount Hopkins, Arizona, was renamed the Fred Lawrence Whipple Observatory in 1982. Its facilities include the former Multiple Mirror Telescope (now replaced with a single 6.5-meter mirror) and a 10-meter optical gamma-ray reflector.

Whipple also wrote or cowrote several popular-level books on the solar system and space travel, including *Earth, Moon, and Planets* (1941), *Across the Space Frontier* (1952), *Conquest of the Moon* (1953), and *The Mystery of Comets* (1985).

In 1999 the 92-year-old Whipple joined the science team for NASA's Comet Nucleus Tour (CONTOUR) mission, set to explore comets Encke, Schwassmann-Wachmann 3, and D'Arrest between 2003 and 2008 (see the mission's Web site at www.contour2002.org).

Until a few years ago, Whipple rode the three miles from his home to his Harvard office on a bicycle. Three times a week he still shows up at his office, where he follows the latest developments in cometary science. In particular, he is amazed at the sheer number of Sungrazing comets that have been discovered by the Solar and Heliospheric Observatory (SOHO) spacecraft. When Whipple started on his long career, discoveries of Sungrazers were rare events, but in just the last few years SOHO has raised the total exponentially. "More than 300 so far!" he exults. "It's incredible that so many cometary pieces can be around."

As we celebrate Whipple's 95th orbit around the Sun, we can say the same thing about his rich and varied career.

DAVID LEVY *has discovered or codiscovered 21 "dirty snowballs" so far, 8 of them with his backyard telescope. His radio talk show on the Web,* Let's Talk Stars, *is at www.letstalkstars.com.*

HALLEY MULTICOLOUR CAMERA TEAM

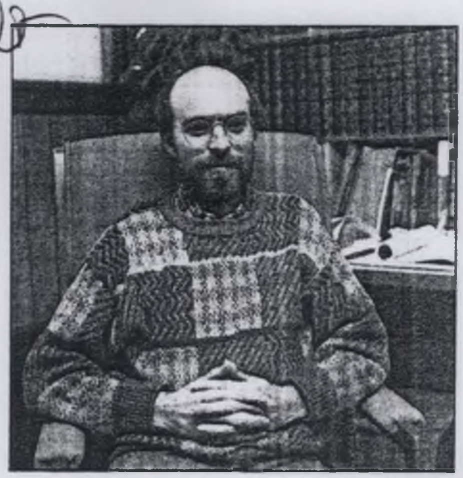
In 1950 Whipple proposed that the nucleus of a comet consists of a "dirty snowball" of frozen gases mixed with meteoritic dust. As the comet approaches the Sun, the gases vaporize rapidly, producing jets on the nucleus's surface. Such jets could then affect the comet's orbital motion, either by accelerating or decelerating it. This model was confirmed 36 years later when the European Space Agency's Giotto spacecraft passed through Halley's Comet and took this composite of Halley's 10-by-5-mile (16-by 8-kilometer) nucleus. Giotto captured bright jets spewing material toward the Sun at left.

StarTrails

"IF I had to pick an observer and say either he or she is the most useful one in the world," says Brian Marsden, director of the International Astronomical Union's (IAU) Central Bureau for Astronomical Telegrams, "I should pick Rob McNaught."

A staff member at the Anglo-Australian Observatory at Siding Spring, Australia, McNaught is indeed worth his weight in stardust. As of November, 1991, he had discovered 6 comets, 27 supernovae, and 17 interesting asteroids — a total that seems to rise almost daily. His name appears on more IAU *Circulars* than anyone else except the editors.

But his own discoveries are not what make McNaught really special. It's his enthusiasm in confirming everyone else's — a time-consuming task that involves stopping whatever he's doing to photograph a star field and then scan it. If the suspect is there he carefully measures its position and reports the data to Marsden. He will search old photographic plates to determine, say, the precursor stars of newly found novae or to find prediscovery images of comets. He'll also make photometric measurements, "all very reliably and at breakneck speed," adds Marsden. "He is truly a remarkable, most energetic



Modest and reserved, Robert McNaught is a one-man observing mill in Australia, cranking out dozens of discoveries of comets, asteroids, and variable stars. McNaught is shown here during a visit to *Sky & Telescope* in 1990. Photograph by Dennis di Cicco.

observer who knows how to go about his work in an efficient and timely manner."

McNaught is an invaluable problem solver. Last March, for instance, a 5th-magnitude nova was discovered in Hercules. The telegram bureau buzzed with newly arrived positions, but they all differed so much that Marsden couldn't possibly publish them. It was McNaught

who sent in not only an ac
but also the result of an ins
plates, all within a few hour

He also saved the day f
Shoemaker-Levy comets.
1991, on the day before ful
lyn Shoemaker found a
comet on films taken a we
longer on the mountain,
how to confirm it. McNaug
rescue, taking advantage of
utes of dark sky between
dawn to confirm it with
Uppsala Schmidt telescope.

Born in Ayr, Scotland, M
became interested in astro
seven, when he traded his p
attendance at Sunday schoo
student's award: an excitin
with sketches of astronaut
Mars. He claims it was
coveted that steered him skyw

But, like many of us, M
tered the field through the s
university years were spent
chology, specifically how br
create original thoughts and
he graduated with honors
what did he do with his ps
gree? He got an observer's po
graphing artificial satellites,
the University of Aston, in
England! There he learned

ure the positions of satellites on photographic plates. His measurements were so accurate that they showed changes in satellite velocity, due to "wrinkles" in the Earth's shape and atmospheric drag.

McNaught joined the staff of the Anglo-Australian Observatory in 1984. With two large Schmidt cameras and a host of larger telescopes, this beautiful observatory site provided an ideal locale for an observer of McNaught's caliber. But an extraordinary phase in his life would soon begin with an amateur program he worked on in his spare time. For 18 months McNaught used a Canon T-70 camera and 24- and 85-mm lenses to take a nightly portrait of the Milky Way and its neighboring galaxies, the Large and Small Magellanic Clouds. His 60 exposures yielded three galactic novae, a fourth in the Small Magellanic Cloud, and more than 20 other new variable stars.

One day in February, 1987, McNaught awoke after a night of observing and prepared his films for scanning. But suddenly he changed his mind and decided to spend the rest of the day reading. "I made a specific mental choice not to search that day," he recalls. That night the telephone rang. At the other end of the line someone was reporting a brilliant supernova in the Large Magellanic Cloud. McNaught stepped outside and saw the 4th-magnitude interloper with his unaided eye. To his chagrin, the supernova was indeed recorded on his unexamined films.

Although he missed that discovery, McNaught's estimates of the supernova's incredible brightness changes appeared almost every day on the IAU *Circulars*. Unperturbed at not finding the supernova, McNaught continued his program. Several months later he noticed something that looked like a ghost image in a photograph he had taken a week earlier. But there was no star to cause such a reflection. McNaught had discovered his first comet, which within a few months would become a binocular object.

In May, 1990, McNaught joined Duncan Steel in a program for searching every plate taken with the 48-inch U. K. Schmidt telescope for unidentified objects. In recent months McNaught has found two extraordinary objects. The first is 1991 DA, an asteroid that thinks it's a comet — every 41 years it travels around an orbit inclined 61° to the ecliptic. However, observations made with even large telescopes have failed to detect any coma. The second find is indeed a comet. But this distant visitor, known as Comet McNaught-Russell, won't get closer than seven times the distance between Earth and the Sun.

Despite increasing attention to his work, McNaught remains modest and reserved — a personality that camouflages the single-minded dedication that, over many years, brought him to his current success. He rarely rests. If the sky has been cloudy and there are no new films, he goes back to examine older data. During one of these spells he noted a single image of an asteroid on films from 1984. At the Minor Planet Center, Gareth Williams was able to link this image with one in 1985 and another in 1991, and finally announce the recovery of 878 Mildred, an asteroid that had been lost for more than half a century.

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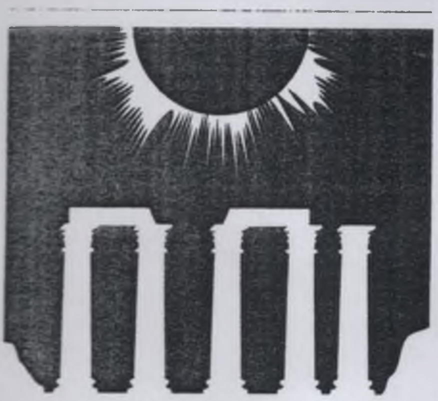


star trails | *By David H. Levy*

Edward Sczcepanski

People of the Texas Star Party

THERE IS SOMETHING SPECIAL ABOUT dusk at the Texas Star Party. For many of the hundreds of people who attend this event, it is a time they've been eagerly anticipating for months. The TSP is an amateur gathering unlike any other. Walking along the telescope field in the growing darkness is like experiencing a scene straight from *Close Encounters of the Third Kind*.

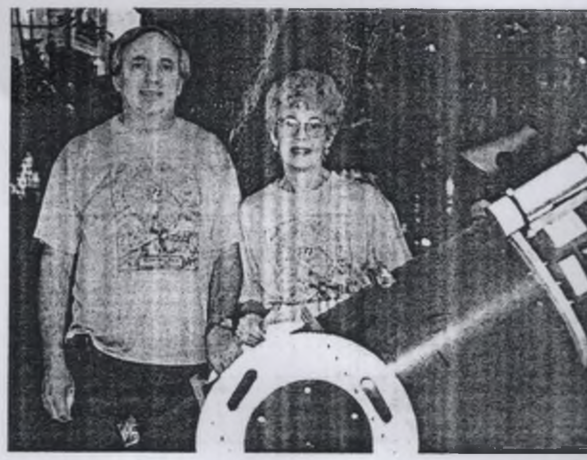
Last year's TSP, held May 4–11 at the Alto Frio Baptist Encampment near Leakey in central Texas, was hampered by cloudy skies. However, this failed to dampen the spirit of the nearly 700 deep-sky enthusiasts assembled there. The final night did offer several hours of pristine, pitch-black skies, with stars as faint as 7th magnitude being visible without optical aid to some eagle-eyed observers. But time during overcast sessions was far from wasted. It was a chance to get acquainted with some remarkable people. This month let's meet three of them: a lawyer, a computer-systems director, and an executive secretary.

Edward W. Szczepanski is the lawyer. Specializing in maritime law, Szczepanski (pronounced shu-pan-ski) is also an accomplished astrophotographer and telescope maker. One day in January 1996 he was perusing old astronomy magazines during his lunch break when an article I wrote on comet hunting caught his attention. As he read he wondered what it would be like to discover a comet. That evening Szczepanski drove out to the Houston Astronomical Society's observatory site near Columbus for a solitary astrophotography session. He set up his 4-inch Takahashi refractor and, with Kodak Technical Pan 2415 film, began imaging deep-sky objects.

M101, the huge spiral galaxy north of the Big Dipper's handle, was the last one on his list. When he developed his film the following day, he was surprised to see the trailed image of a 10th-magnitude fuzzy object ½° south of M101. He immediately reported it to the IAU's Central Bureau for Astronomical Telegrams. On January 28th IAU *Circular* 6296 announced to the world the discovery of Comet Szczepanski, C/1996 B1. Although overshadowed by Comet Hyakutake, C/1996 B2, Szczepanski's first comet find produced a decent showing as it cruised the northern sky in early spring (*S&T*: May 1996, page 99).

Above: **A long-time Houston, Texas, amateur, Edward Szczepanski stands by the 4-inch Takahashi refractor (white tube) he used to discover his first comet in January 1996.**

Two of the moving forces behind the annual Texas Star Party, Steve and Amelia Goldberg pose with their 13-inch Dobsonian at their home in suburban Houston.



Amelia and Steve Goldberg met through the Houston Astronomical Society in 1981. When Steve, then the club's president, asked for Astronomy Day volunteers, Amelia was among the first in line. Married three years later, the couple spent their honeymoon at — of all places — the Astronomical League convention in Milwaukee, Wisconsin. A computer-systems director for Stewart Title Company, Steve is mainly interested in educating the public about astronomy; he also engages occasionally in astrophotography. The Goldbergs enjoy helping novices find their way around the skies at star parties.

Amelia, an executive secretary for an oil and gas company, is the observer of the two. Her first look through a department-store telescope was at Saturn. "Those magnificent rings," Amelia says, "just burned in my mind! I'll never forget them." She has been attending Texas Star Parties regularly since 1983. Just recently she completed observations of all the objects in the Astronomical League's Herschel 400, which lists the best targets from William Herschel's deep-sky catalogs.

A private, soft-spoken person, Amelia is nevertheless as devoted to getting new observers going as she is passionate in adding more faint objects to her list. For the past two years she has been working on an observing program for beginners called Universe Sampler. Designed to familiarize them with all aspects of the night sky, the program is based on a few basic concepts and sample targets spread around the year. The project opens with the fundamentals of sky movement, how objects are found in the sky using celestial coordinates, and the technique of star-hopping. Unlike stargazing primers written by people who have never really looked at the sky, the Universe Sampler has a whole chapter on the art of seeing.

"You have to train yourself to observe the sky," Amelia insists, "or you won't see anything." Amelia should know — she lives for those precious dark nights of the Texas Star Party, when she and her trusty 13-inch Dobsonian peer deep into space. She observes with quiet intensity, carefully logging each observation, each target much dimmer than the last. Through her experienced eye and under a clear, coal-black sky, the universe is more exciting than we can ever imagine.

Last year's Texas Star Party was author DAVID LEVY's *tenth.*

A Starlight Night

A STARRY NIGHT. IF YOU'RE AN AVID stargazer, as I am, then nothing gets your juices flowing more than the sight of the Sun setting in the west with the promise of a dark, crystal-clear night. And that's precisely how *Starlight Nights: The Adventures of a Star-Gazer* — Leslie C. Peltier's magnum opus — begins. I love the opening lines of the book, and each year, when I lecture to a group of children attending an astronomy camp at the 61-inch Kuiper telescope near Tucson, I begin with those words:

> There is a chill in the autumn air as I walk down the path that leads along the brow of the hill, past the garden and the big lilac, to the clearing just beyond. Already, in the gathering dusk, a few of the stars are turning on their lights. Vega, the brightest one, now is dropping toward the west. Can it be that half a year has gone since I watched her April rising in the east?

The quiet strength of Peltier's words fills the telescope's cavernous dome as I throw a switch and the huge shutters begin to slide apart, revealing a darkening sky. I continue:

> Low down in the southwest Antares blinks a red-eyed sad farewell to fall while just above the horizon in the far northeast Capella sends flickering beacon flashes through the low bank of smoke and haze that hangs above the town. Instinctively I turn and look back toward the southeast for Capella's co-riser. Yes, there it is, Fomalhaut, the Autumn Star, aloof from all the others, in a sky made darker by the rising purple shadow of the earth.

"The world's greatest nonprofessional astronomer" is how Harvard astronomer Harlow Shapley described Leslie C. Peltier (1900–1980). A prolific observer, Peltier discovered 12 comets and two novae, and made more than 132,000 variable-star observations. His autobiography, *Starlight Nights,* celebrates the virtues of being an amateur stargazer.

Leslie Copus Peltier, who was bo
January 2, 1900, and died May 10, 19
in Delphos, Ohio, was already a fam
stargazer decades before *Starlight Nig*
first appeared in late 1965. Peltier sav
$18 to buy his first telescope — a 2-in
brass refractor — by picking 900 qua
of strawberries on his family farm at
cents per quart. In 1918 he joined
American Association of Variable S
Observers, then a fledgling organizatio
On November 13, 1925, he discover
the first of his dozen comets, and
years later, when his brightest one glid
gracefully across the sky, he was argual
the most famous amateur astronomer
the Western Hemisphere. By the tim
began looking skyward in 1960, Pelt
had become more involved with mo
toring his beloved variable stars.

I first came across his name whe

COURTESY THE PELTIER FAMILY

about his codiscovery of a nova in Hercules. A few weeks after the appearance of Ikeya-Seki, the Great Comet of 1965, *Starlight Nights* was published by Sky Publishing. I began reading it one evening and couldn't put it down. It was absolutely mesmerizing, this autobiography of a man whose lifelong passion was the night sky, its variable stars, and wandering comets. In public lectures I give these days, rarely does an event go by without my quoting something from this book. As we commemorate the centennial anniversary of Peltier's birth, Sky Publishing has reissued *Starlight Nights.* When the company's publications manager, Sally MacGillivray, asked me to write the introduction for the new edition, it took me only a tenth of a second or so to say yes.

For the first time, the new edition will have an index. While preparing it I had the most fun with the topics listed under "I" called "Insights." The book offers Peltier's wisdom on so many aspects of life that have little to do with astronomy and everything to do with living life to its fullest and appreciating the wonders of the environment around us. One such insight is about light pollution. When he noticed one night how all the fields around where he grew up were lit by bright lights, he wrote:

> The moon and the stars no longer come to the farm. The farmer has exchanged his birthright in them for the wattage of his all-night sun. His children will never know the blessed dark of night.

Starlight Nights is a book for every reader of this magazine, especially its young, city-bound budding stargazers who have never seen a farmer's field, a dark sky away from city lights, or the gibbous Moon rising over a distant mountaintop. There are so many titles out there that tell us *how* we should watch the sky and *what* we should do to get the most out of our telescope. *Starlight Nights* tells us *why.* This book won't teach you how to set up and initialize your computerized "Go To" telescope or process a CCD image, but it will make you stop and appreciate the beauty of what your telescope shows you. This book is about astronomy's big picture and it reminds us why we chose to become skywatchers in the first place.

David H. Levy *has quoted from* Starlight Nights *more than 600 times in his public presentations since 1982. The book is available from Sky Publishing for $19.95.*

Comet Ikeya-Zhang reached perihelion, the point in its orbit closest to the Sun, on March 18th, at a distance of 76 million kilometers (47 million miles). Japanese astrophotographer Shigemi Numazawa obtained this tricolor view of the comet 2° from M31, the Andromeda Galaxy, on April 6th, using a Bitran BT-214E CCD camera and a 200-millimeter f/1.8 lens.

star trails | *By David H. Levy*

The Comet Master

On the evening of February 1st, just four days after full Moon, 58-year-old Japanese comet hunter Kaoru Ikeya brought out his homemade 10-inch (25-centimeter) Newtonian telescope. Just as he has always done on clear nights, Ikeya set the scope on its alt-azimuth mount in his front yard in Mori, Shizuoka Prefecture, about 195 kilometers (120 miles) southwest of Tokyo. Inserting a 40-millimeter Pentax eyepiece into the focuser, which gave him a 1.6°-wide field at 39×, he began to search for comets by systematically sweeping the sky toward the southwest. "The evening twilight was not completely over yet," he recalls.

Some 30 minutes later, at 6:48 p.m., Ikeya came upon a faint smudge of light in Cetus about 2 arcminutes across with a weak central condensation. "I estimated its brightness to be about 9th magnitude," he says. "The object was very difficult to see visually because of the significant light pollution from the city of Hamamatsu. I carefully identified the object's position and marked it directly on the *Uranometria 2000.0* star atlas." Suspecting it to be a comet, he observed the object over the next half hour. After confirming that it was indeed moving slowly northeastward, he then checked to see if there were any known comets near its location. There were none. Ikeya excitedly notified comet expert Syuichi Nakano, who in turn relayed the news to the International Astronomical Union's Central Bureau for Astronomical Telegrams (CBAT) in Cambridge, Massachusetts.

Meanwhile, 2,200 km to the west near the city of Kaifeng in China's central Henan Province, amateur astronomer Daqing Zhang was also scanning the skies with an 8-inch reflector around the same time as Ikeya. He too spotted the new visitor and promptly reported his find.

Within hours CBAT was announcing the discovery to the rest of the world. Comet Ikeya-Zhang, also designated C/2002 C1, soon delighted skygazers worldwide, attaining naked-eye prominence by late February and sporting a slender tail up to 6° long (see the June issue, pages 108 and 124). The finest comet to grace the northern skies since Hale-Bopp in the spring of 1997, C/2002 C1 reached a peak brightness of magnitude 3 in late March. Orbital calculations showed that the object is likely the return of a comet last seen in 1661.

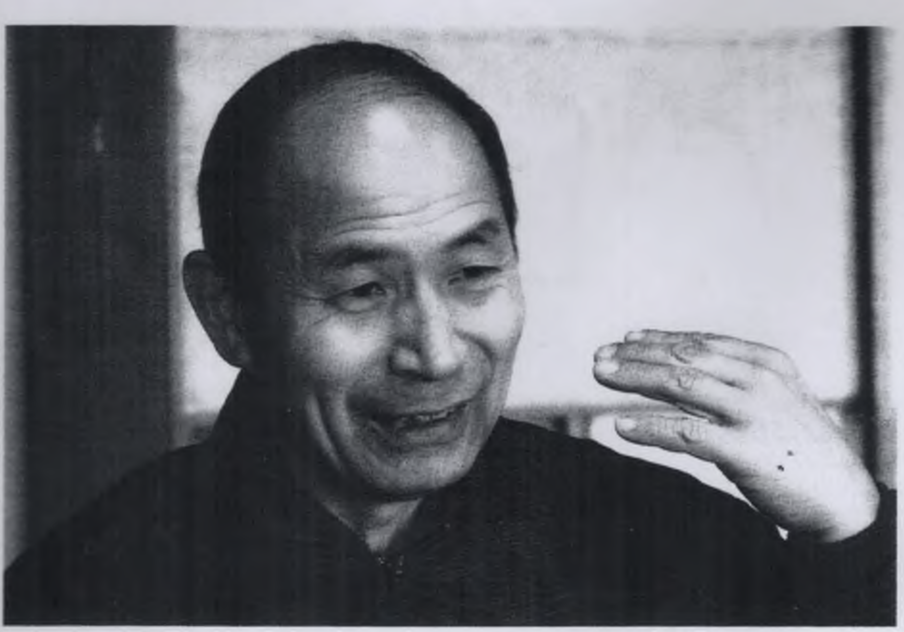
This was Ikeya's first comet find in 34 years. Who is this man whose name ranks as one of the most recognized in the annals of comet hunting?

Humble Beginnings

When Ikeya discovered his first comet on January 2, 1963, at age 19, with a homemade 8-inch reflector, his modest, self-effacing story captured the hearts of many amateur astronomers. By the time a second Comet Ikeya made its way around the Sun, the name, if not the person, was already well known to avid skywatchers. But it was his third find, the great Sungrazing comet Ikeya-Seki of 1965, that made the young Japanese amateur's name a household word. Articles in the press around the world praised his tenacity and perseverance, and told glowing stories of how an

AKIRA OTAWARA, TENMON GUIDO

Japanese comet hunter Kaoru Ikeya with the homebuilt 10-inch (25-centimeter) f/6.2 Newtonian reflector he used to find Comet Ikeya-Zhang, C/2002 C1. Ikeya also discovered or codiscovered five other comets, including the great Sungrazer Ikeya-Seki in 1965, as well as two supernovae. In 1990 the International Astronomical Union honored him by naming asteroid 1987 EC as 4037 Ikeya.



KATSUMI KASAHARA, AP/WIDE WORLD PHOTOS

A modest man with modest means, Ikeya does not have a permanent observatory at his home in central Japan or own computer-controlled telescopes. He grinds and polishes his own mirrors. "I don't have a lot of money to put into my equipment," he says. "But it does the job."

why he chose to pursue the sport of comet hunting. I remember being particularly moved by one story published in a major magazine that told how Ikeya's father had failed in his family business, and that his son had chosen to "take the failed family name and scrawl it across the sky."

Touching as this story was, it isn't true. Born in Nagoya City, Aichi Prefecture, in 1943, Ikeya moved with his family to Bentenjima, near Lake Hamanakako in Shizuoka Prefecture, and attended elementary and middle schools in Maisaka. Here he developed an interest in astronomy at age 13. "My father did own a small business, which failed when I was 15," Ikeya explains. But contrary to press reports, "he did not go to the bar frequently in order to forget his business failure. My family was rather ordinary and our family name was not associated with any special family. There was no family name to be redeemed before and after my father's business failed, so I never decided to try to redeem it by discovering a comet. I've never thought of or said in any similar quote that I wanted to take my family name and scrawl it across the sky."

So why did Ikeya pursue comet hunting? His true story is even more moving than the published fable because it focuses not on his personal ambition but on his reaction to the majesty of the night sky itself. "I love to observe not only the Moon and planets at high magnifications but also star clusters and galaxies at low powers with my homemade telescope," he says. "This is the reason why I started comet hunting. I thought that I could contribute a little bit to astronomy if I found a comet." In 1962 he began his search.

In those days, the sky above Ikeya's observing site near Lake Hamanakako was clear and relatively free from light pollution. "I'm shy and not good at being in public and socializing," he admits. "I seldom go out." The peace and serenity of a dark, star-filled night are ideal companions for a somewhat reserved person, but the predawn hours of September 18, 1965, changed all that. Sweeping through Hydra with a 6-inch scope, he picked up an 8th-magnitude tailless glow west of Alpha Hydrae. Fifteen minutes later Tsutomu Seki, searching independently from Kochi, 400 km away, also spotted the same object.

Some 10 days later and a half world away, Brian G. Marsden was beginning his first day on the job at CBAT. His initial task: to refine the orbital computations for the new comet — Ikeya-Seki, C/1965 S1. With just three weeks left till perihelion, the comet's closest approach to the Sun, on October 1st Marsden joined a press conference to announce the coming of the brightest and best-placed Sungrazing comet since 1882.

The Great Daylight Comet

"I remember it was one to two weeks after discovery that I knew how close Comet Ikeya-Seki would approach to the Sun," Ikeya recalls. "There was speculation that the comet would evaporate and disappear during closest approach."

As Ikeya-Seki neared the Sun, observers could catch a glimpse of it just by covering the Sun with their hands. They estimated the comet's brightness to be magnitude −10 or −11 (about as bright as a gibbous Moon). On October 21st Ikeya-Seki passed a mere 450,000 km above the Sun's photosphere. In Japan, where the comet reached perihelion around local noon, astronomers at Mount Norikura solar observatory saw the comet's nucleus split into three.

"After perihelion I knew that Ikeya-Seki had survived the Sun's heat when I saw the comet's tail on the other side of the Sun in late October," says Ikeya. As the comet began to fade, its tail became its most spectacular feature, with estimates of its length as great as 60°.

I'll never forget my first view of Ikeya-Seki as its majestic tail rose over the St. Lawrence River near Montreal. Trying to avoid the poor eastern horizon fr[...] home, I rode my bicycle uphill fo[...] than a kilometer in the predaw[...] until I reached the summit of a [...] hill. The comet pierced the sky th[...] the bright lights of downtown Mo[...] its tail shining upward like a searc[...] beam. It was an indescribable thrill[...]

More Discoveries

Not resting on his laurels, Ikeya con[...] his comet search. In 1966 he shared [...] with American astronomer Edgar Eve[...] and in the closing days of 1967 he an[...] codiscovered their second comet. [...] was Ikeya's last find for the next 34 [...]

"I've been continuously searchin[...] new comets since 1967," he w[...] "Sometimes I slowed down the se[...] but I've never stopped my comet hu[...] completely." By the 1980s his sky wa[...] coming light polluted and less favo[...] for comet searches, especially nea[...] horizon. Since it was still relatively [...] close to the zenith, he concentrate[...] search to that area. As part of his o[...] ing project, he carefully checks the s[...] ture of each galaxy he encounters d[...] his regular sweeps. In this serendip[...]

NOAO / AURA / NSF

One of the most brilliant comets in history, in 1965 Ikeya-Seki was visible to the naked eye even in broad daylight. Roger Lynds recorded this scene at dawn from Kitt Peak, Arizona, on October 29th, eight days after perihelion.

way, in December 1984, using a 10-inch reflector, he discovered his first supernova, SN 1984R, in NGC 3675; four years later he found his second, SN 1988A, this time in M58.

The 10-inch telescope is just one of many; over the years Ikeya has indulged in his passion of grinding and polishing mirrors, an activity he has been engaged in since he was 15. For the past two decades he has been fabricating mirrors for his business in a workshop adjacent to his home, where he lives with his wife.

"I will continue to observe and hunt for comets the same way I've been doing in the past — at my own relaxed pace," he says. It's a philosophy that follows the advice given him by the late Minoru Honda more than 40 years ago. Honda, who discovered 12 comets and 12 novae during his lifetime, was responding to Ikeya's letter, written before the latter's first comet find: "If you desperately want to find a new comet, please stop your search because you may never be able to find a new comet. However, if you are content to search the sky without ever experiencing a new comet discovery, please keep searching, because someday you may be able to find a new one."

DAVID LEVY *wishes to thank Shigemi Numazawa for facilitating his contact with Kaoru Ikeya, and Shigeru Hayashi, who translated Levy's interview with Ikeya.*

Tsutomu Seki and the Great Comet of 1965

ON THE NIGHT of November 4, 1965, I set my alarm clock in the hope of getting a predawn view of the newly discovered comet, Ikeya-Seki (C/1965 S1). Clouds had spoiled several of my attempts earlier that week, but this time the morning sky cleared up and my friends, the Jorgensen family, and I finally got a good look at Ikeya-Seki.

The year 2005 marks the 40th anniversary of a great sungrazing comet.

Halfway around the world, 35-year-old Japanese comet hunter Tsutomu Seki was just viewing a picture of the comet he had taken from his discovery site. For many comet lovers, the visitor that Seki helped discover would go down as one of history's greatest comets. For me that morning, it was the first one I'd ever seen, and it was pure magic — not only because of the way its long, majestic tail soared high into the dawn sky, but also because it was first spotted by two amateur skywatchers whose dedication and perseverance helped inspire me to begin my own comet search.

A Daytime Comet

The discovery of Comet Ikeya-Seki on September 18, 1965, was truly fortunate since the day before, a very strong typhoon had passed through Kochi, where Seki and his wife, Okiko, live. "I was half asleep, hearing the sound of roaring winds," Seki recalls of that fateful night. "I didn't know how much time had passed, but then I heard Okiko whispering in my ear, 'Honey, the sky's clear now.' I sprang out of bed and looked out the upstairs window to the north. I saw an awesome starry sky in the wake of the typhoon."

Using his homemade 9-centimeter ($3^1/_2$-inch) refractor with 19× magnification and a $3^1/_2$°-wide field, Seki quickly began to scan the eastern sky systematically from an observing deck he'd built atop his home. Sweeping through Hydra, he spotted an 8th-magnitude tailless glow west of Alpha Hydrae at around 4:15 that morning. Fifteen minutes earlier, 21-year-old fellow comet hunter Kaoru Ikeya (*S&T:* July 2002, page 70), searching independently from Bentenjima, 400 kilometers away, also spotted the same object. Reports of their findings quickly reached the International Astronomical Union's Central Bureau for Astronomical Telegrams (CBAT) in Cambridge, Massachusetts, the world's clearing-house for astronomical discoveries.

Brian G. Marsden, then with the Smithsonian Astrophysical Observatory, calculated an orbit for the new object and announced at a press conference that Ikeya-Seki was a Kreutz sungrazing comet and could become visible in the daytime (*S&T:* August 2005, page 32). "One week after the discovery," remembers Seki, " I read an article in the local *Kochi Shinbun* newspaper headlined 'Comet Ikeya-Seki, the greatest comet of this century?' I couldn't figure out what it was all about. It was very difficult to imagine that this faint comet would become a great comet."

A great comet indeed — as Ikeya-Seki neared the Sun, observers could catch a glimpse of it by blocking the Sun with their hands. At perihelion on October 21st, it passed so close to the Sun that there was doubt the comet would survive.

"Okiko and I saw the golden-colored comet shining in a very bright twilight a few minutes before sunrise," says Seki. "It looked as if the comet was trying desperately to escape the intense heat of the Sun. Okiko and I hugged each other and shouted 'Banzai!' Long live our comet!"

A Symbol of Friendship

Born November 3, 1930, in Kamimachi, Kochi City, Tsutomu Seki has had a lifelong interest in music, particularly classical guitar. When renowned guitarist Andrés Segovia visited Japan in 1969, Seki attended one of his recitals and was inspired by his music to master the instrument. Seki has taught classical guitar since then and still offers lessons three times a week.

In 1948 legendary Japanese amateur astronomer Minoru Honda codiscovered the faint periodic comet, Honda-Mrkos-Pajdusakova. Seki was fascinated by Honda's discovery and began to study astronomy on his own. The idea that

Japanese comet hunter Tsutomu Seki with the $3^1/_2$-inch refractor he used to discover three of his six comets: Seki, C/1961 T1; Seki-Lines, C/1962 C1; and Ikeya-Seki, C/1965 S1 (pictured at left). In addition to comets, he found 222 asteroids photographically at Geisei Observatory in Kochi.

"a comet bearing [his] name mi
the universe" intrigued him, an
advice of Honda himself, the fo
year Seki ground a 4-inch mirro
first telescope.

"On August 8, 1950, I started
search using this telescope," say
"There were many Perseid mete
night and I searched the easter
dawn to my heart's content." Th
night was a harbinger of quiet,
nights to come; all six of his co
found from his rooftop site. Bu
Seki could claim a comet of his
had to endure 11 years of searc
years of patiently learning the s
years spent wondering if the ne
would yield a new comet.

At last, on October 10, 1961, S
covered an 8th-magnitude objec
dawn sky using the 3½-inch ref
wasn't sure if it was a new come
my bike to a telegraph office tw
ters away. I was so excited I cou
of anything else while pushing t
Mr. Honda verified my discover
lowing day. A telegram was sent
hagen [where CBAT was then lo
Comet Seki was announced."

On February 4, 1962, Seki dis
another comet that rapidly reac
eye brightness. Comet Seki-Line
covered by Richard and Helen L
Phoenix, Arizona, attained magn
in early April. This was followed
other visual finds, including a se
Comet Ikeya-Seki at the end of 19
the presence of the young comet
Mr. Ikeya," Seki recalls. Only 15 n
separated Ikeya's sighting from th
back in 1965; this time the differe
only five minutes. "I believe I wa
continue comet hunting because
competitors like Mr. Ikeya," he ad
still has a 4-inch mirror that Ikeya
for him "as a symbol of our frienc

Although it has been a long wh
Seki's last discovery, he still searc
comets. He maintains a Web site
.comet-web.net/~tsutomu-seki) a
ducts astrometric observations of
and asteroids with Geisei Observa
24-inch telescope.

"I live for astronomy," says Seki
as I can hope to find new objects,
keep observing for the rest of my

DAVID LEVY *wishes to thank Eiji Kat*
troducing him to Tsutomu Seki and fo
in translating the interview.

Terry Lovejoy

Tales of Two Comets

If you think the age of amateur comet discoveries is over, think again.

WHEN I REFLECT BACK on it, my first impression of Australian Terry Lovejoy was that of an amateur who would ultimately succeed in discovering comets. He had a great sense of humor and a passion for astronomy. It was 1988, and Lovejoy was visiting the United States when he stopped by my small home and observatory. In a wan attempt to imitate the great 19th-century observer Edward Emerson Barnard, Lovejoy jokingly signed my observing log with something like "Good to meet you; come and visit me in Tennessee sometime. — Ed." Behind the fun, however, I could sense that Lovejoy had a deep commitment to observing.

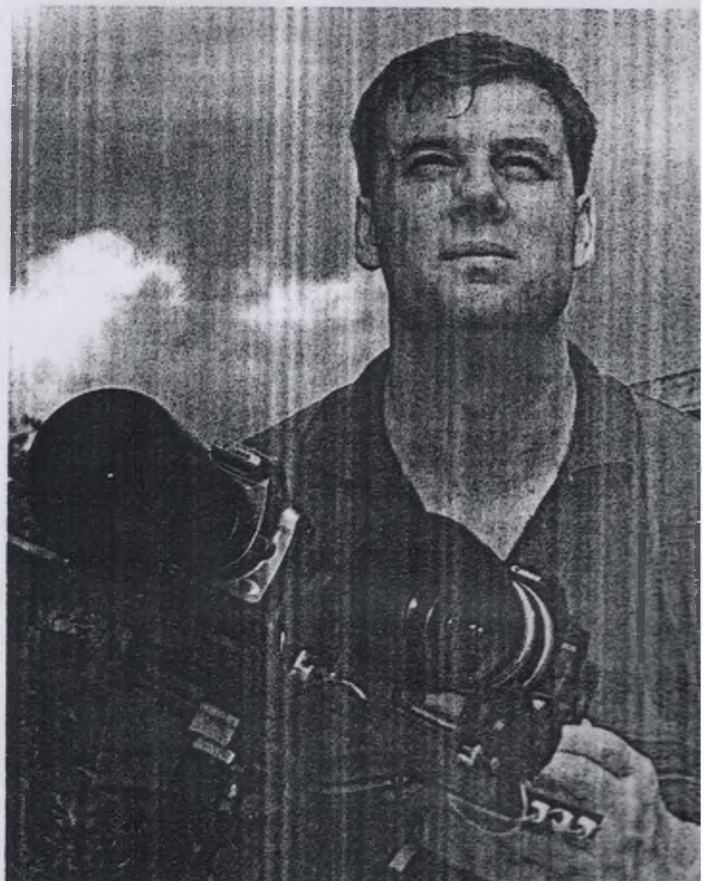
Born November 20, 1966, in Orange, New South Wales, about 70 miles (110 km) northwest of Sydney, Lovejoy completed his "Seniors" at MacGregor High School in Brisbane. A year after his US visit, he earned a degree in mechanical engineering at Queensland University. "I never really enjoyed being a mechanical engineer," he says, and a decade later he embarked on a new career in information technology.

Lovejoy's interest in astronomy started at a young age. "My father had a 60-mm Unitron refractor, which he used to show us the planets, double stars, and the like," he recalls. "I first started identifying stars and constellations with the help of a planisphere in July 1977 at the age of 10." That same year he got his first telescope, "a cheap 60-mm refractor." But in 1978, as a present for his 12th birthday, he received an 8-inch Newtonian reflector. "The improvement in image quality put my interest into hyperspeed."

That interest continued, eventually focusing on the search for comets. Now, it's one thing for a longtime comet hunter to *continue* a search program in an era when professional sky patrols make virtually all routine comet discoveries. It's quite another for an amateur to *begin* a search program under these circumstances. But that's what Lovejoy did.

"I had done some casual comet searching in the late 1980s," he says, "but nothing serious." In 2002 he made some test exposures with a CCD can that had too small a field for an efficient sky patrol. Bu then came the age of digital SLR cameras.

Lovejoy began experimenting with a Canon 300D equipped with a 100-mm f/2.8 lens. Convinced this system would work for comet discovery, he began a se ous search on May 16, 2004. With the addition of anot Canon DSLR — a 250D with a 70-to-200-mm f/2.8 zoo lens — Lovejoy was covering a respectable amount of t southern sky in his hunt.



Terry Lovejoy found two comets in two months earlier this year, proving that amateur astronomers can still make discoveries in an age of compre hensive professional sky surveys.

Lovejoy's search method melds tra-
onal techniques with today's digital
ınology. "It basically involves making
sets of exposures of a star field sepa-
:d by about 20 minutes," he explains.
hen stack the images of each set and
nk' the resulting pair on a computer
een. As the alternating images flash on
screen, moving objects appear to bob
kward and forward."
On the morning of the Ides of March
year, Lovejoy made his first comet dis-
ery, C/2007 E2. "After having scanned
ne 1,400 fields, it was a real shock to see
obvious comet at the top of one of my
ıges," he recalls. "The comet, at mag-
ıde 9.5, was bright enough to be clearly
ble in my individual, unprocessed
ıges. It was a further shock to realize
ody else had found it!"

o in Two Months

t about the time the excitement sur-
nding Lovejoy's first discovery was
ing, the comet became visible to those
ıs in the Northern Hemisphere. I saw
an oval, mostly featureless patch,
despite the lack of a visible tail, the
net's elongated coma shone brightly
inst a field of Milky Way stars.
Meanwhile Lovejoy had resumed his
rch. On the evening of May 26th, he
tured a diminutive bluish green haze
his photos. "I downloaded the images
n my 300D," Lovejoy explains, "and
them through the usual automated
cessing steps. On examining the first
ıge I almost immediately noticed a
ll hazy object with the distinctive
e-green color typical of many comets."
The comet was confirmed two nights
r when Lovejoy and New Zealander
n Drummond each snapped follow-
photos. Found after only 20 hours of
rching, Lovejoy's second comet, C/2007
shows that the age of amateur comet
overies is far from over. ✦

uly the Smithsonian Astrophysical ervatory announced that David Levy, y Lovejoy, and Australian John Brough- will share the 2007 Edgar Wilson Award he amateur discovery of comets.

star trails | by david h. levy

Bill Bradfield.

Harvester of Comets

An indefatigable Australian comet hunter bags his 18th find.

IT WAS SHORTLY after sunset on March 23, 2004. Following his routine, then-76-year-old William A. Bradfield drove the six kilometers from his home in Yankalilla, South Australia, to his observing site near a tourist lookout overlooking the town. When he got there, Bradfield found the sky to be very clear, right down to the horizon. He quickly set up his homemade 250-millimeter (10-inch) f/5.6 Newtonian reflector and began his comet search, systematically scanning the twilight sky for any telltale sign of an interloper.

After two or three minutes, Bradfield swept up an 8th-magnitude blob of light in the constellation Cetus, the Whale, very close to the horizon. "I was dumbstruck because I couldn't remember seeing anything in that general area," he recalls. "Suddenly, I was in a panic! If I didn't get an idea of the comet's position I could lose it." He made a quick rough sketch of the suspect's location relative to the background stars before the field disappeared into the horizon.

The next night — the sky was, thankfully, still clear — Bradfield was out at the site again. "There was the comet. It had moved!" he says. Unfortunately, he was still having trouble matching his sketch with his star charts. Without the comet's exact position, he couldn't report his discovery to the International Astronomical Union's Central Bureau for Astronomical Telegrams in Cambridge, Massachusetts. (CBAT is the world's official clearing-house for astronomical discoveries.) On his third attempt, the following night, a strong wind was blowing southward from the city of Adelaide. The air pollution it carried rendered the comet invisible. On succeeding evenings clouds and bright moonlight had moved in — time and the comet were marching on.

There was nothing Bradfield could do but wait. On the evening of April 8th — three days after full Moon — there was a half-hour window of dark sky. Estimating the comet's motion based on his two earlier observations, he tried to find it again. "There it was," he exclaims. "I had it!" With this new sighting, he contacted Robert H. McNaught at Australia's Siding Spring Observatory, who quickly confirmed the discovery using 20 × 120 binoculars. Comet Bradfield, C/2004 F4, was soon announced by CBAT to the rest of the world.

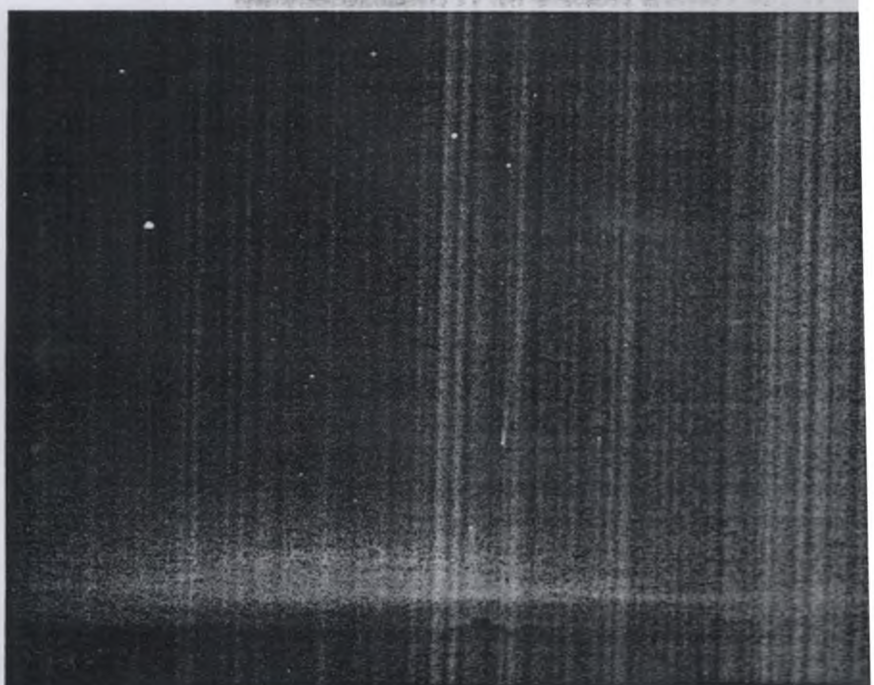
This was Bradfield's 18th visual comet discovery — ni years since his last one, C/1995 Q1. All those comets be his name alone, which means he spotted and reported them well ahead of any other observer (*S&T:* April 199 page 86). Comet C/2004 F4 delighted skywatchers at mi northern latitudes last April and May, reaching 4th mag tude in brightness and sporting a tail about 5° long.

"To discover 18 comets visually is an extraordinary accomplishment in any era," declares CBAT director eme tus Brian G. Marsden, "but to do so now is truly remarkable, and I think we can be pretty sure nobody will be al to do it again. And it's all the more astounding that in no case did he have to share a discovery with some other in pendent discoverer. More than any other recipient, Bill Bradfield outstandingly deserves the Edgar Wilson Awar (For more information about the award, see page 114.)

A Rocket Scientist

Born on June 20, 1927, in Levin, on New Zealand's North Island, Bradfield spent his early life on his father's 160-ac farm. His childhood fascination ranged from rocketry to astronomy. "The first optical device I ever used was a pair opera glasses, with a magnification of two," he explains. "I was tickled pink when my uncle lent me a brass ship's tele

Japanese astrophotographer Sho Endo captured this view of Comet Bradfield, C/2004 F4, just before sunrise last April 24th. He used a Canon EOS D60 digital SLR camera with a 50-millimeter f/2 lens for this 27-second guided exposure at ISO 400.



scope with a magnification of seven!"

Bradfield went on to obtain his bachelor's degree in mechanical engineering at the University of New Zealand, which has since been broken up into several individual institutions. He worked as a research scientist on rocket-propulsion systems for an Australian government laboratory near Adelaide until his retirement in 1986. There he met a fellow employee, Eileen, whom he married in 1957. They have three daughters: Katherine, Caroline, and Jennifer.

The launch of Sputnik in 1957 turned Bradfield's interest toward Project Moonwatch, a program in which amateur astronomers worldwide used small, wide-field telescopes to note the local passages of early artificial satellites. That project gave him a lot of observing experience. Then, in March 1970, Comet Bennett graced the predawn eastern sky. This event inspired Bradfield to take up comet hunting.

In 1970 Bradfield joined the Astronomical Society of South Australia (*S&T*: June 2002, page 70). From one of its club members he bought a rich-field telescope fashioned from an antique 6-inch f/5.5 portrait lens (*S&T*: April 1977, page 306). Armed with this telescope, he officially began his visual search for comets on January 1, 1971. In March the following year, after he had searched 260 hours, the first Comet Bradfield, C/1972 E1, was announced by CBAT. By the early 1980s, with 11 comets under his belt, he decided to build the 10-inch reflector with optics bought from Coulter Optical in California. So far, he has found three comets with this scope: P/1984 A1, P/1989 A3, and the latest one, C/2004 F4.

The success of ongoing professional near-Earth-object search programs, such as LINEAR and NEAT, means that amateurs' chances of finding comets visually with backyard telescopes are now severe limited, especially from the Northern Hemisphere. "However, until a similar system is based in the Southern Hemisphere," notes Bradfield, "there will continue to be opportunities for the visual discovery of new comets that come from the south."

He adds, "I must admit I was a little disturbed when these automated professional search programs started, but one adapts. I've spent a lot of time comet hunting. To stop now would be impossible. Short of going blind, I can't stop what I do." ✱

DAVID LEVY *and his wife, Wendee, interviewed William Bradfield by phone last May in their show* Let's Talk Stars. *You can listen to this interview at www.letstalkstars.com.*

CHARLES HARVEY

William A. Bradfield, the most prolific amateur visual comet discoverer of the 21st century, with the home-built, altazimuth-mounted 10-inch f/5.6 Newtonian reflector that he used to discover C/2004 F4. He spotted the comet near his home in Yankalilla, South Australia, about 65 kilometers (40 miles) south-southwest of Adelaide.

ROYAL ASTRONOMICAL SOCIETY OF CANADA MONTREAL CENTRE

Isabel K. Williamson (center) was one of the most active members of the Royal Astronomical Society of Canada's Montreal Centre. For three decades, she helped organize the RASC's observing programs, teaching newcomers how to view the Moon, meteors, auroras, and deep-sky objects. Here she conducts her Lunar Training Program, circa 1960.

star trails | *By David H. Levy*

Skyward Bound

When an astronomy club goes through a period of intense activity, the credit often goes to just one or two "live wires" whose enthusiasm and organizational talent tend to jump-start the entire group. That's how it was at the Montreal Centre of the Royal Astronomical Society of Canada (RASC) for a period of 30 years beginning in 1940. The person behind this extraordinary era was Isabel K. Williamson, who passed away on June 2nd at 92. During those years Williamson was a mentor to countless new observers, including me.

I first became acquainted with Williamson way back on October 8, 1960. It was a Saturday, and for many amateur astronomers living in Montreal that meant a trip to the local observatory, where the RASC was holding its weekly meeting and observing session. It was springtime in astronomy for me — I had just started to use my first telescope, and on this magic night my brother, Richard, and I were about to share my new hobby with real astronomers. Isabel Williamson was the first person we met after walking into the observatory. Greeting me with a bright smile, she asked me a few questions and then made a specific suggestion: I should buy *Sky & Telescope*'s Lunar Map, which was available for 25 cents at the time. She said I should try to observe and identify all 326 lunar features plotted on it and then draw them on a fresh map.

That evening helped define the course of my career. It was a call to action. Here I was, at age 12, being asked to do a scientific experiment that was way beyond what I was used to at school. This Lunar Training Program was one of Williamson's ideas to turn armchair astronomers into active observers. Another was the Messier Club. Today, the Astronomical League is but one of several organizations that offer certificates to people who successfully hunt down all 110 deep-sky objects listed in Charles Messier's famous catalog, but the club Williamson started in the early 1940s was the first in North America.

"Its main purpose," she wrote, "was to stimulate members into becoming active observers instead of being content to look through the telescope at objects that others had located." To receive credit, the observer would have to use his or her own telescope and manually sight each target through the main scope or finder by star-hopping. In earlier years, the use of setting circles was prohibited, but that rule was relaxed later on. (I wonder, though, if Williamson would have allowed the use of computerized Go To telescopes.)

Although she didn't graduate from college, Williamson was an avid reader and learner throughout her life. At 16 she gave up a scholarship to McGill University in order to help her family through difficult financial times. Bitten by the astronomy bug, she joined the Montreal Centre in 1942 and quickly mastered the skills necessary for a visual observer. What interested her most, however, were programs that required organizing and training groups, such as meteor observing. She formed teams to monitor summer's major showers, such as the Delta Aquarids and Perseids. They followed the method endorsed by meteor astronomer Peter Millman, wherein the sky was divided into eight sections, each section watched by an observer. During the all-night vigil observers would take turns observing for an hour and then have a half-hour break to avoid fatigue. A central recorder kept a tally of the meteors seen by everyone.

On the evening of October 9, 1946, events conspired to propel a storm of meteoroids toward Earth and Williamson's name into the annals of Canadian astronomy. She had put together a team of 25 observers to keep an eye on the Giacobinid shower, also known as the Draconids, which was expected to be strong that year in the wake of the passage of the stream's parent comet, 21P/Giacobini-Zinner. The team began observing at 9 p.m., and by midnight it had logged nearly 3,000 meteors (*S&T:* October 1998, page 102).

Partly as a result of that effort, the RASC presented her with its Chant Medal in January 1949. Williamson had since written for and been written about in *Sky & Telescope* (March 1989 issue, page 319).

In 1948 Williamson put her writing skills to good use by launching *Skyward*, the Montreal Centre's newsletter. I've seen many astronomy club newsletters, some humorous, many filled with technical articles, but *Skyward* was devoted to crediting members who had added another Messier object to their list, separated a difficult double star, or even shoveled snow off the observatory's walkway. Williamson felt that acknowledging the observers' work would motivate them to stay in the hobby. The newsletter's slogan, "You saw it first in *Skyward*," was actually a powerful message to its readers. The publication would con-in no reprints of articles easily found in her magazines or newspapers (or on the ternet, if she were still at it today). It did fer original articles of interest to mem- rs, as well as reports of the Centre's ac- ities.

From 1956 through 1958 many nations ined the effort to study Earth during the ternational Geophysical Year (IGY). ost of us remember it as the time when story's first artificial moons were sent oft to study Earth's ionosphere and mag- tic field. For American amateurs the Y was marked by Moonwatch, a world- de network of visual observers orga- zed by the Smithsonian Astrophysical bservatory to track these new satellites.

Montreal, being a bit too far north of e paths of most satellites, seemed left t. The Canadian amateur effort went in- ad to a detailed study of the aurora bo- alis, in which Williamson excelled. Ob- rving forms were handed out to all ASC members, and we were encouraged check the sky several times each night r any signs of auroral displays. Until the ening of July 8, 1966, I had patiently ecked off the little "no aurora in sky" x at the bottom of the form exactly 801 nes over a two-year period. My patience s finally rewarded, for that night a spec- cular display began with shimmering een and red rays. This was followed by ved arcs and flames that covered most of e sky and lasted all night. The fact that illiamson had spurred me to report all ose previous negative observations made y first aurora even grander.

Around 1970 Williamson decided to rtail her activities at the Montreal Cen- e. After that she devoted her energy to r church projects and other work. Al- ough she did make an occasional ap- arance at the observatory that now ars her name, I thought that perhaps e had lost interest in the night sky after those productive years. A few months o, I called her with the news that the ok she had introduced me to decades rlier, Leslie Peltier's *Starlight Nights*, was print once again. Although she barely d the strength to lift the phone's receiver, e did want a copy. What she didn't tell e, however, was that she had recently esented an hour-long talk to her friends the special joy of being an amateur as- onomer. Williamson's love of the sky, it emed, never left her after all.

vid Levy is always on the lookout for what's w on the amateur-astronomy scene.

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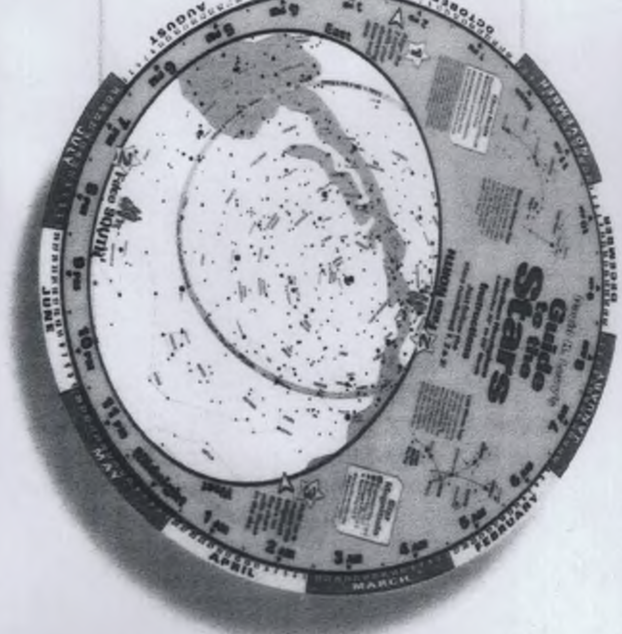

Discovery of Pluto just one tiny debt astronomy owes to Tombaugh

CN3z

Sky Watch

By Don Sheron

The passing of astronomer Clyde Tombaugh on Friday closes a remarkable chapter in the history of astronomy.

Tombaugh, 90, was best-known for discovering the planet Pluto, but his contributions to astronomy span to more than just that distant planet.

Actually, his contributions can be remembered by anyone who met him. He was a friendly, down-to-earth person who enjoyed sharing the wonders of the cosmos.

Several of us from San Antonio have had opportunities during the past few years to meet Tombaugh, whether at the Texas Star Party or one of the annual meetings of the Association of Lunar and Planetary Observers.

Although I was just one of the thousands of faces and handshakes during Tombaugh's public appearances, each one of us who had met him was impressed with his friendly approach and enthusiasm.

He was not the type of person to put on airs. He was the type of man who would walk up to you and ask how things were going, what you thought about observing Pluto, and what people could look forward to in the years ahead.

One of Tombaugh's favorite things to do during a public speech was to present a slide show, including what he called the latest NASA photo taken of Pluto.

Once he saw everyone leaning forward to get a better look at the upcoming slide, Tombaugh clicked on the slide projector to show not the planet, but the Disney canine of the same name.

Tombaugh's humor and down-to-earth approach was part of his upbringing as a Kansas farm boy.

During those days of the 1920s, Tombaugh was like most people.

He didn't have money to buy a telescope as most people do today, so he built his own instrument from farm machinery. He often showed pride in his telescope, explaining where the drive shaft came from or where a hunk of metal once was used on the farm.

When he left the farm at age 22, he embarked on a career in astronomy that two years later brought him worldwide attention with the discovery of Pluto in 1930.

Tombaugh outlined his career in a biography, "Out of the Darkness: The Planet Pluto." The book is out of print, but I was lucky to find a paperback version in a used bookstore several years ago. When Tombaugh was a guest speaker at the Texas Star Party in 1987, I took the book and got his autograph on a 1928 picture of him with his homemade telescope.

A more recent book, "Clyde Tombaugh, Discoverer of Planet Pluto," by David Levy, (1991, The University of Arizona Press) also examines Tombaugh's career.

Although Tombaugh had been in ill health for years, several of us drove by his house in Las Cruces, N.M., to visit him about four years ago, when we were there for a meeting of the Association of Lunar and Planetary Observers. Tombaugh wasn't home at the time, but to the side of his house we saw his homemade telescope sitting under large shade trees. The telescope didn't look like much, but it showed that Tombaugh wasn't the type to be taken in by the fancy doodads of today's amateur telescopes.

Tombaugh was fond of telling an anecdote about that telescope. For years, the Smithsonian Institution had requested that Tombaugh donate it, but Tombaugh kept saying that he was still using it.

Whether that telescope now goes to the Smithsonian or not, Tombaugh's contributions to astronomy and his friendliness with people will be remembered.

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Grab the binoculars and watch the moon pass close by the bright star Aldebaran on Saturday night.

The moon will pass within one-half degree of the bright star from about midnight through 2 a.m. Sunday.

Aldebaran marks one of the eyes of the constellation Taurus, the bull.

If you were along the U.S.-Canadian border, you would see the edge of the moon cover up the star.

To reach Don Sheron, send e-mail to dsheron@express-news.net or call 250-3243.

Sincerely
Clyde W. Tombaugh

CN3h

December 17, 2001

~~January 19, 2006~~.

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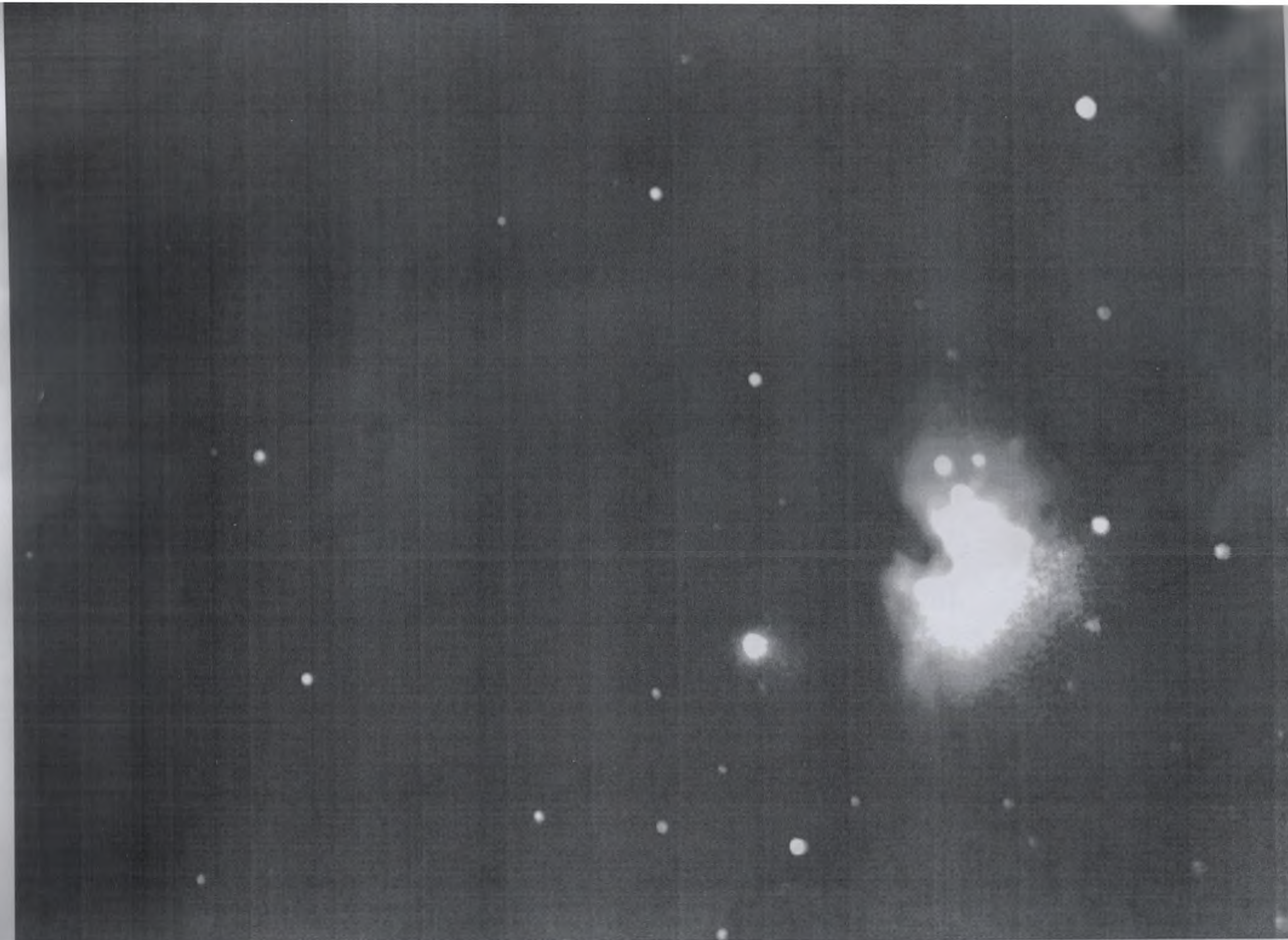

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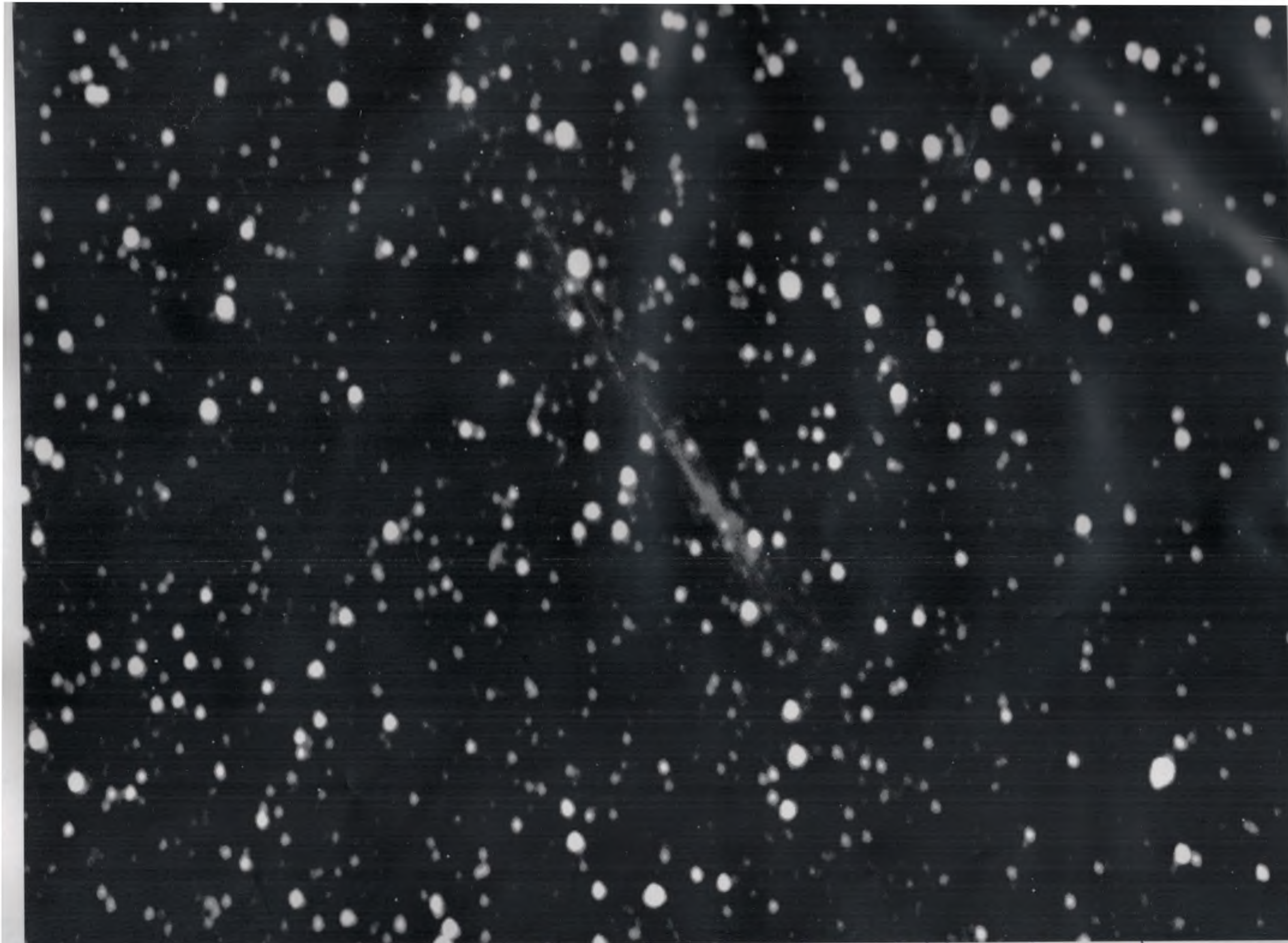

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