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Telescopes have an exciting fascination for young children. With International Astronomy Day on May 5, many Centres will have telescope displays and demonstrations set up for the public to view the skies – and no doubt catch the imaginations of young and old alike!

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Stars and Schools: Ideas for Presenting Astronomy in a Grade School Classroom (Part I)

by David H. Levy
Jarnac Observatory, Tucson, Arizona
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Foreword

With a little thought, some knowledge, and a lot of enthusiasm, astronomy can be the most exciting and fascinating aspect of a school curriculum. For all the ingredients of challenge and excitement are contained, so to speak, in the stars: massive and beautiful instrumentation, tales of extraordinary labors by men and women who use telescopes, and the unfathomable dimensions in size and time of the universe.

But astronomy offers something even more important. For children, it is a participatory science. We don't need books to learn the stars, for they are right over our heads, every clear night, just waiting for a new pair of young eyes to enjoy them. The stars belong to children.

This article is designed to offer guidance to teachers who are planning an astronomy unit for their 2nd to 4th grade classes. It will suggest some specific experiments, but its main purpose is to offer an approach to the science of stars that will captivate the minds and the imaginations of young people. Astronomy is not something extra, or something to do after hours; it is an activity that can awaken young minds to other joys in learning.

Stars and Children

Everything in astronomy is big. The stars are of unimaginable size and distances between them are mind-boggling. This vastness of space makes astronomy especially appealing to young people, especially teenagers. But what about younger students, aged 7 to 12? Can they grasp enough astronomical concepts to make the time spent doing an astronomy unit worthwhile?

I had some doubts when I accepted a position as Nature and Science Director some years ago at a large day camp near Montreal. So did my employer. After all, biology (nature walks) is equivalent to camp science, while geography reigns in school, right?

After two weeks or so, attitudes at this large camp began to change. The camp director insisted that the astronomy programme be continued and expanded. Children were lining up for extra sessions of astronomy!

I had taught astronomy to 12– 15 year olds before. The concepts I had used seemed to work with these younger children, but now it was even more important to present the facts and theories as simply as possible. I carefully selected facts that would appeal to their imaginations and be understood.

Original Ideas

I was astonished at some of the theories children would put forth. In one session we talked about how meteors are formed. I asked the children if they had any ideas on the subject. One child certainly did, "they could have been made" she suggested, "by a larger rock blowing up and falling apart into many smaller rocks."

Another time we had an unusual discussion about life on other planets. After explaining that there may be anywhere between one and one hundred thousand planets in our galaxy capable of supporting life as we know it, I mentioned the "close encounter" during which two New Hampshire travellers, Barney and Betty Hill, claimed to have been kidnapped by extraterrestials. The children were reluctant to believe the whole story. Four believed that the couple had been examined by an alien spacecraft. Three others flatly rejected the idea. One eight-year-old abstained, saying that he was "75 percent against" believing it. "Had the sighting been confirmed by another witness?" he asked. "It had taken place on a fairly busy highway."

Though the programme varied from the first year to the second, there was considerable overlapping. Many children in the second year were new. But during discussions of the moons of Jupiter, one child remembered the discussion from the previous year, and objected to the statement that Jupiter has more than 12 moons. "I looked it up in the encyclopedia after last summer," he said. "Jupiter has only 12 moons." While it took some convincing that his source was out of date, I noted that he had been interested enough to check out something he had heard and that he had remembered both my comment and his investigation of it from a year earlier.

The caliber of questions that the children asked impressed me. They grasped that the moon, sun, planets and stars were of greatly varying distances from us. They proved their understanding when they began asking such questions as "How much more distant is the sun than the moon?"

The Concept of Vastness

The idea that young children will be turned on to something big is well known, but it has not been widely exploited in schools. In astronomy this is particularly evident. The children in my programmes wanted to learn about the stars, and their hunger for knowledge knew no bounds. Some of them couldn't believe that scientists had given a child-type name to our major theory of the creation of the universe, the Big Bang. A simple technique will convey an idea with more clarity than countless oral or written explanations ever could.

Use a deflated balloon you had earlier freckled with little dots while in the blown up state, then inflate the balloon, watch the universe expand. How many tiny universes exploded that night at the children's homes as they created their own universe to explore?

Dinosaurs and Stars

Although the nature programme was broad in scope, I could always count on students' attention when the discussion turned to bigness – either of dinosaurs or of the universe. On the subject of dinosaurs, many of the youngsters were already experts. They could teach me as much as I could teach them, even though few of them had studied dinosaurs at school. One of our most effective sessions was on the cause for their extinction. Students talked about some of the normal theories about food supply and temperature changes. Then they heard the supernova theory. I explained that nobody knows for sure, since no remnants of such a supernova have been found, but the primary and secondary effects from a nearby supernova could have caused, within five million years, all dinosaurs to die. We also discussed the possibility that an asteroid collision could have done the same thing. These ideas were presented not so much for their value as plausible hypotheses, but because they served as a tie between the two fields of

nature – stars and dinosaurs. From these two great interests, it was easy to generate another, the subject of evolution. The children were surprised to discover how relatively short a time humans have been on Earth. They were left with an idea of what we have done to the planet in the short time that we have been here. They also gained new respect for the colossal age of the Earth and the universe.

The birth and death of the sun also presented even the youngest child with food for thought – too much, for here is where their lack of understanding of huge numbers presented a problem. Even though we talked about the slowly and fatally expanding sun as happening only in the far, far distant future, some billions of years from now, some counselors later asked me to clarify to the children exactly what I meant. Some children were concerned about the sun dying during their lifetimes. Since concern in young children translates to fear, this problem had to be corrected. We discussed how safe and stable the sun is. Other stars which change in brightness were used as examples and we talked about what could cause the temperature of planets to change by degrees, one way and then the other, in a short time.

Story Hour

In a sense, all education is story-telling. Why not begin astronomy with a story? A story with humor, tragedy, one the children will remember, and one that will point their way toward an interest in the stars.

I think the story of Galileo, told with feeling, is ideal. And after years of sharing this tale with six, seven and eight year olds, I am still amazed at its value for capturing their minds.

Let's recreate the drama that is possible with a story such as that of Galileo as he discovered that we do not live in the centre of the universe. With a small telescope he found four moons that dared to defy the inquisition and revolve with stately pride around the giant planet Jupiter.

Galileo is sitting in his room, just waiting for the celebration to begin.

There was a knock on the door (three loud knocks) and four men in long (pause) black (pause) robes came in.

"Galileo, we understand that you are telling the children that there are four moons that do not revolve around the earth! (pause) EVERYTHING revolves around the earth! The MOON revolves around the earth (is that true?), the SUN revolves around the earth (what about that?) ALL the PLANETS and the STARS go around the earth too!"

(I then go through a similar episode with regards to the sunspots and once again there are the three loud knocks and the four men in the robes.("We teach our children that the sun is perfect! The sun doesn't have any spots, your telescope has spots!" Then they made Galileo stay in his house. They locked the door from the outside and they kept the key. Much later, they took him away to Rome, to a large hall. (pause) At one end of the hall, at a large ornate table, sat the men in the long black robes. At the other end, in a small wooden chair with one loose leg that dangled, and with a back that was straight and hard, sat Galileo. And in the middle of this great hall sat Galileo's little telescope. (The choice to recant or not to recant is then offered.) For a long time Galileo just sat there. He looked at the men in the robes. And again he looked at his telescope (I've told this story a hundred times and each time the children are at the edges of their chairs by this point.) Finally, Galileo stood up from his rickety chair. "Gentlemen in the long black robes (pause), my telescope (pause) is (pause) broken!" And with that he picked up his telescope and returned to his house where he would spend the remainder of his years. And as he entered his front door, he turned to his sister and said, "But there is nothing wrong with my telescope. And one day a group of children will look at these same sunspots through telescopes much better than this, and they will remember me." And now, girls and boys, let's go outside and see these sunspots of Galileo.

This is a story, not a record of historical fact. It is designed to transport children to a different time and especially to give them a sense of respect and reverence for telescopes.

We can follow this story with themes from at least two directions; first, we can talk about modern telescopes from the small refractors that are sold at camera and department stores to the giants of Kitt Peak National Observatory. All these scopes – even the small refractor would have stunned Galileo with the improvement in quality over his.

Or we can relate to social questions. Galileo suffered because of his beliefs – does that happen today? Where? Why? Have we matured in 400 years?

Whatever approach we take, this story is designed to excite. The stars are distant, but people who study them and suffer for them, and enjoy them, are people like us.

(To be continued)

Letters to the Editor

W. Jutting of Niagara Centre sent this letter regarding David Stokes' article "Some Reflections on the Personal Computer for the Amateur Astronomer" in the October 1983 *National Newsletter*, p. L74–L76. Mr. Stokes' comments follow this letter. – Ed.

David Stoke's article points to a shortcoming in the software available for home computers, undoubtedly caused by the lack of expressed demand for the "double precision" type of arithmetic that many astronomical calculations require.

One example is described in *BYTE*, p. 248, Oct. 1982. Radio Shack's Disk BASIC has double-precision floating-point arithmetic, but only single-precision for the transcendental functions – obviously useless for most astronomical calculations. On the other hand, TRS-80 Extended Color BASIC, using 40-bit floating-point arithmetic, gives 8- to 9-digit accuracy on the trigonometric functions. This isn't bad for the price, but it only accepts radians for input, so you have to write your own conversion routines.

As David pointed out, the errors are cumulative: after 20 consecutive calculations with 7-digit accuracy, there may only be 6-digit accuracy left. While addition and multiplication are straightforward operations in the binary arithmetic inside the computer, the transcendental functions are calculated by approximation through power series formulae. The constants used in these subroutines must have the required precision, of course, and since more terms are needed for high precision, the calculations run much slower.

We could use FORTRAN instead of BASIC and speed up run-time operations considerably. Unfortunately, too little information is available on FORTRAN versions for microcomputers to make any decisions. Only Microsoft FORTRAN (sold by Heath) has an advertised set of 32- and 64-bit floating-point routines and all features of ANSI 1966 FORTRAN except COMPLEX data type. That would include the transcendental functions, but you should check before spending money on it. It is not the current ANSI FORTRAN version, either.

I do not agree with other parts of David Stokes' "Reflections". I'll take them in the order in which they appear.

Trigonometric functions and Degrees vs. Radians. The FORTRAN versions I know have only *sin*, *cos* and *arctan* available, in radians only. Even then, *cos* is calculated as $-(sin\ (x-(\pi/2)))$: i.e. only one regular and one inverse function are really callable (after all, the programmer – you – has to earn his keep). Since I started astronomical calculations with seven-place log tables, and learned FORTRAN before pocket scientific calculators existed, I considered the additional features of the little things as a bonus, rather than seeing a problem now in FORTRAN. It all depends on your age, I suppose.

Warning: the proposed ANSI BASIC standard does *not* cover double-precision arithmetic, but *will* offer all normal and inverse trig. functions, in radians and degrees.

Accuracy. I quite agree with David on the lack of it; it is just unfortunate that he chose the Julian Day example. The full 7-digit day number is seldom required in calculations, only the differences. Even long-period variable stars seldom have periods over 1000 days, and then the timing is relatively inaccurate anyway, certainly not in minutes. (By the way, all division signs in the second paragraph on page L75 should be changed to multiplication signs; where that error crept in, I won't even guess.)

The IBM-PC can be outfitted with an optional INTEL 8087 Numeric Data Processing chip, which, with the appropriate software, will give double-precision arithmetic, including the transcendental functions. According to INTEL, the 8087 chip fully implements the IEEE floating-point standard. This may explain why the PC's regular BASIC software performs so poorly in this respect. A check with the nearest Computerland store revealed that the package (8087 + BASIC software) was available for about $1000. – (one quarter of which is for the chip). I would prefer to get the FORTRAN version at the same price, because it gives you an additional language for the money. I skimmed through the manual, and it seemed to do what I expected. Unfortunately the two IBM-PC's in the store did not have it installed and the FORTRAN package I saw (5 floppies and a fat manual) had been ordered for a customer and was not available for demonstration.

There are cheaper ways to do these calculations, however. The IBM-PC again is compared with the HP-75 in *BYTE* Dec. '83, p. 12. Even without the optional Math ROM this hand-held computer has

almost all the functions of the 8087 options for the IBM-PC, at a fraction of the price, admittedly, with a much smaller memory.

Sin (360′ × 10^n + 30). This seems to be the perfect test at first glance, but the result with the HP-67 shows that not all calculators work the same way. However, with a few extra instructions you can get the same result with the TI's and the HP-55. Just subtract the 360′ × 10^n and you are in business. But it would be nice if they all did it without extra programming.

Casio. Although I'm still planning to buy Jean Meeus' book *Astronomical Formulae for Calculators*, I do not have it yet and therefore do not know if he explains why the Casio can't handle this "angle". I only hope it is explained in the Casio's manual! (TI does.)

$2^3 = 7.9999999$. This problem is more insidious than it looks, because it seriously affects the results of decisions in programmed tests during calculations. The TI 58c/59 manual makes it quite clear when discussing "accuracy". Whenever I have run into trouble, it has always been my own fault, and I now make a habit of checking the 3 "guard" digits in critical calculations.

Last beef. Why does David use "Integer" instead of "Digit"?

I fully agree with the last two paragraphs. Considering the oblique way I happened to find the information on RS Disk BASIC (the article reviewed another programme and compared it, amongst others, to RS Disk BASIC) it is not surprising that information is hard to find. The only way to get decent software for astronomical calculations is to keep asking for it, and protesting loudly when a programme does not do what the advertising makes you believe it will do. Keep up the good work, David!

W. Jutting, Niagara Centre.

David Stokes replies:

I appreciate your transmission of Mr. W. Jutting's comments; it is rewarding to receive feed-back to one's meagre efforts.

At this point I would only add that astronomical computations are complex enough without the added burden caused by the ill-conceived architecture of most home-computer systems!

Since writing that note for *Regulus* I have gone on to calculate the essential elements of Longitude, Latitude, RA and Dec. and parallax and distance of the sun and moon, using the equations developed by Jean Meeus and published in *Astronomical Formulae for Calculators*. From there one can develop programmes to give rise time, transit and set times, as well as twilight, using the methods described in the *Explanatory Supplement to Astronomical Ephemeris*. This is an interesting and instructive exercise, especially for lunar motion, if one aims to equal the published, tabulated data within 10 seconds. Using Meeus's equations of the moon's motion, taking only fifty terms, compared to Brown's complete theory which takes account of several hundred terms, I find RA and Dec. at 0h UT to be within a few seconds of the data in the Astronomical Ephemeris. One quickly appreciates how rapidly the moon is moving and how swiftly that motion varies with time. I may write this up in a short paper for the Hamilton General Assembly.

I am currently using a Hewlett-Packard 86A with single disk-drive. The HP-Basic is most suited to scientific work and for astronomical computations in particular. However, the BASIC takes up 48K of ROM. Programmes for Solar and Lunar positions take almost 20K and require 15K and 24K respectively for storage on the disk. I have found the Lunar positions for 0h on each day of 1984 take 85 minutes computation and storage time. From there one can calculate moonrise and set times for one's own location, or any place on Earth for that matter.

One last plea. Don't buy software or "cookbook" methods for writing such programmes. One gains little and loses much insight into dynamic astronomy. Do it yourself and enjoy positional astronomy from the inside; it's very rewarding to the persistent.

David M. Stokes, Kingston Centre

The Star of Bethlehem: A Postscript

by Anthony A. Barrett
Vancouver Centre

In the December 1983 issue of the *National Newsletter* I provided some historical background to the question of the Star of Bethlehem, and concluded with the opinion that of all the natural phenomena associated with the event, a comet seems best to fit the evidence. In his comment the reviewer noted the problem that comets "were always thought to be omens of calamity or of natural disaster such as fire or flood – even as portents of death or war – never of a royal birth." We have in fact relatively few Classical descriptions of comets (see the R.A.S.C. *Journal* 72 (1978) 81ff.), but among the few that have survived not all portend calamitous events, and at least one does indeed portend a royal birth. Justinus, writing in the Third Century AD., but using sources that can be traced to the First Century B.C., says of Mithridates, the remarkable king in Asia Minor, who died in 64 B.C.: "Heavenly phenomena had also *predicted the greatness of this man*. For both *in the year in which he was born* and in the year in which he began to reign a comet shone through both periods for 70 days in such a way that the whole sky seemed to be ablaze (37.2.1)."

Department of Classics, University of British Columbia

1984 Summer Events

The Copernican Observatory and Planetarium of New Britain, Connecticut will host the Third Annual International Space Exploration Festival on May 3–6, 1984. There is an interesting programme of lectures, displays, demonstrations, planetarium shows, workshops, etc. Information is available from The Copernican Observatory and Planetarium, Central Connecticut State College, New Britain, CT 06050.

The Astronomical League's National Convention will be held August 1 to 4 at Carroll College, Waukesha, Wisconsin, near Milwaukee. Papers sessions, workshops and Astromart '84 (an equipment exhibition by manufacturers and retailers) are featured on the programme. For information write to the Milwaukee Astronomical Society, c/o Bill Konig, P.O. Box 275, Mequon, WI 53092.

The 1984 Summer Meeting of the Astronomical Society of the Pacific will be held at the University of California, Santa Cruz from July 7 to 12. Programme highlights include a tour of Lick Observatory, a session on the history of astronomy, and a symposium on stellar populations. For details write Santa Cruz Meeting, ASP., 1290 24th Ave., San Francisco, CA 94122.

The 1984 International Astronomy Youth Camp will be held at Obersteinbach, West Germany from August 1 to 21. The programme includes discussions and workshops on a variety of astronomical topics as well as cultural and athletic activities. Conducted in English, the programme is designed for students aged 16 to 22 years, and is limited to 50 participants. For information write Christoph Muenkel, Richard-Koehn-Str. 24, D-2080 Pinneberg, West Germany.

The North York Astronomical Association will hold its third annual observing convention/camping weekend, Starfest '84, at the River Place Campground near Mount Forest, Ontario. There will be observing sessions, slide presentations, a workshop on personal computers in astronomy, and a twilight talk. Information on the meeting is available from Starfest '84, c/o Andreas Gada, 701-145 St. George St., Toronto, Ontario M5R 2M1.

On September 10 to 12 the Astronomical Observatory of Trieste will host a meeting on "Cosmological Relevance of Active Galactic Nuclei: Observations and Theories." For details contact Fabio Mardirossian, Observatorio Astronomico di Trieste, Via G.B. Tiepolo n. 11, I-34131, Trieste, Italy.

Across the R.A.S.C.

by Peter Jedicke
Assistant Editor

It should come as no surprise that many amateur astronomers are also heavily involved in the computer field. In fact, the number of amateurs who use the popular Apple computer makes it worthwhile to consider exchanging thoughts and ideas and programmes prepared by Apple users. For example, some exchange has already taken place between members such as Don Jones of Castlegar, B.C., Steve Brent of St. Catharines, Ontario, Eric Clinton of London, Ontario, and Dick Karlson of Rochester, New York – all Apple owners. Now comes word that the Victoria Centre may acquire an Apple for their telescope. Other members who may be interested in participating in an Apple Astronomy users' group should write to *Across the R.A.S.C.* and watch future issues for more information.

KINGSTON: In the Kingston area, December's weather was mostly awful. But the night of the penumbral Lunar Eclipse, December 19–20, was clear and the seeing was quite good. For well over an hour, the darkening of the lunar disc was easily visible to the naked eye and its extent could be detected by binoculars, by 1h05 UT, a greyish band appeared in the Southern Hemisphere, reports Leo Enright, and, by mid-eclipse, at about 1h49, binoculars showed it clearly extending up to an area north of the equator in the region of Mare Tranquilitatis, though on the other side the darkening was not as pronounced as in the Oceanus Procellarum. The grey was still visible at about 2h20. This eclipse was unusually dark for a penumbral eclipse because the moon was very close to the earth's umbra.

KITCHENER: Rob Robotham, editor of the Kitchener Centre's newsletter, *Pulsar*, reports that, on the night of November 17, he witnessed a fireball while sitting indoors! In a classroom at Wilfrid Laurier University, while watching a film, he saw a blue-green streak of magnitude –5 or –6 moving slowly just west of Orion towards the horizon. Although Rob saw it only for one or two seconds the fireball did trace from the Hyades, and was quite likely a member of the Taurid shower, which often features slow fireballs.

EDMONTON: Across Canada, excitement continues to mount as the Edmonton Space Sciences Centre moves inexorably toward its opening. On December 31 came a bittersweet moment with the closing of the venerable Queen Elizabeth Planetarium, adjacent to the new Centre. Although occasional use will be made of the QEP for special night sky courses throughout 1984, no general admission public shows will be offered. Even the bookstore will be closed, although some sales will continue for a few months yet. In the meantime, equipment is arriving at the new Centre, and work on exhibits is progressing.

LONDON: The Hawaiian Islands, and especially the magnificent Canada-France-Hawaii Telescope atop Mauna Kea, were the focus of attention at the regular meeting of the London Centre on January 20 in Room M147 of the Medical Sciences Building at the University of Western Ontario. Mike Jewison, a graduate student in astronomy at UWO, gave a delightful travelogue based on his working visit to CFHT during the summer of 1983.

VICTORIA: On January 11, in Elliott Room 061 at the University of Victoria, Dr. Claudio Solazzo spoke to the Victoria Centre. On leave from the University of Catania Physical Observatory in Sicily, Dr. Solazzo spent a year at Newfoundland's Memorial University before moving to Victoria. His topic was "Cepheid Variables as a Means of Determining the Scale of the Univese."

HALIFAX: Centre member Patrick Kelly spoke on "Ancient American Astronomy" on January 20 at the Nova Scotia Museum in the lower theatre. He focussed on the astronomical history of the Plains Indians and the Maya. The Halifax Centre has many members outside the Halifax-Dartmouth area, including some 20 persons who make up the "Bridgewater satellite" and frequently hold their own meetings. The concept of centre "satellites" has been successful in other locales as well – many readers will be familiar with the activities of the Kingston Centre's "satellite" in Tucson, Arizona. Since the

formation of "satellites" is presently beyond the jurisdiction of local or national constitutions, they can be set up with considerable flexibility, little formality, and good fellowship. And, remember, any time one or more R.A.S.C. members get together for a little friendly astronomy, "Across the R.A.S.C." would like to hear about it!

NIAGARA FALLS: Dr. John Black of Brock University showed slides of his "African Safari" at the Niagara Falls Public Library on December 22 at the Niagara Centre meeting . Unfortunately, most of his trip was spent under cloudy skies, so he had few astronomical opportunities. Ron Gasbarini had better luck in Trinidad & Tobago, however, and he showed a few slides of constellations as seen from there.

TORONTO: The Centre's cable television programme *Astronomy Toronto* started its new season on March 1 with a discussion of the return of Halley's comet. Response to the May solar eclipse expedition to Virginia has been good and at time of writing at least one busload of members will be observing from the centre line. International Astronomy Day programmes have been organized for May 5 at Toronto City Hall and Harbourfront. Janet Mattei of the American Association of Variable Star Observers was a recent surprise guest speaker at a Centre meeting. Planning is well underway for a major Centre Awards Dinner at the Harbourcastle Hilton Hotel in November.

Please send Centre newsletters and late items describing the activities of R.A.S.C. Centres and members to Peter Jedicke, 810-1297 Huron Street, London, Ontario, Canada, N5Y 4L9. (Note the address change since last issue.) Centres should also delegate one member to call late items in during the last few days of the third month prior to an upcoming issue of the *National Newsletter*. The number to call is (519) 455-5907. (Note that change of telephone number since last issue, as well.) You may call late at night, when the rates go down.

Circumstances of the Solar Eclipse of May 30

by Gunther Moller
Alpine, Texas

The calculations required for the circumstances of an eclipse are an intricate business even in this day of the electronic calculator. However, an amateur who wishes merely to predict the aspects of the eclipse as seen from his backyard observatory can achieve this goal with fairly straightforward calculations, provided he is willing to sacrifice a little accuracy. We will use the solar eclipse of 1984 May 30 to illustrate this.

Outline of the Method

The aspect of an eclipse at a given time T is obtained by calculating the observed horizon co-ordinates of the moon and sun, the angular separation D of the centre of their discs, and the position angle P of the moon as defined in Figure 1–1. Simplification of the calculations is accomplished by ignoring certain complicating factors: the oblateness of the earth, and the observer's altitude above sea level. Further, the small region of the celestial sphere occupied by the moon and sun is treated as a plane surface.

First and last contacts of the eclipse occur when the angular separation D equals the sum of their semi-diameters S_m, and S_s. Maximum eclipse occurs when D is a minimum. The aspect of the eclipse at any other time can be predicted by calculating D and P at that time.

Circumstances of the eclipse of 30 May for various locations in North America were calculated. The aspects of the sun and moon at time of maximum eclipse are shown in Figure 1 and listed in Table 1. The position angle P is measured on the solar disc as indicated in Figure 1–1.

Example

We illustrate the method by computing the circumstances of the partial eclipse for Dallas, Texas. The geographic co-ordinates for Dallas are longitude 96.8° W., latitude 32.8° N. (taken from Funk and Wagnall's *Hammond World Atlas*). The eclipse is known to occur between 11^h and 18^h UT. We either

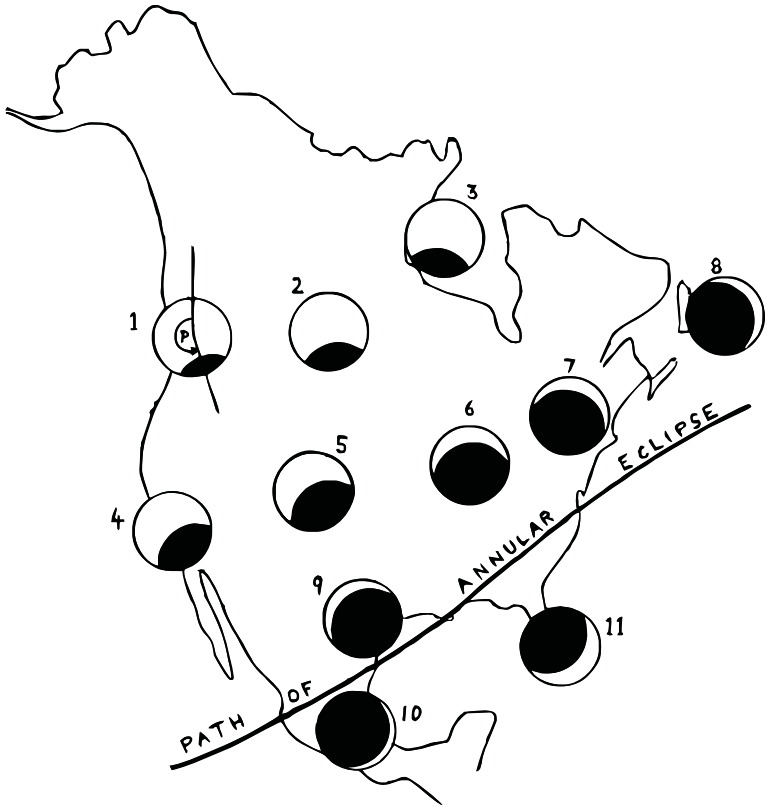

FIGURE 1

TABLE 1

No.	Place	Universal Time	Altitude of Sun	Azimuth of Sun	D	Position Angle
1.	Vancouver	16:07	35°	97°	25′.4	201°
2.	Saskatoon	16:24	47°	119°	21′.3	192°
3.	λ90°W, ϕ60°N	16:51	50°	156°	21′.2	172°
4.	Los Angeles	15:42	35°	85°	16′.3	217°
5.	Denver	16:04	49°	103°	13′.8	207°
6.	Chicago	16:31	64°	135°	8′.0	188°
7.	Montreal	16:59	66°	184°	6′.3	156°
8.	St. John's	17:36	54°	236°	5′.3	127°
9.	San Antonio	15:52	53°	93°	4′.3	222°
10.	Mexico City	15:33	48°	78°	2′.4	59°
11.	Miami	16:18	76°	102°	7.9	44°

compute, or find in *The Nautical Almanac*, the Greenwich hour angle (GHA) and declination (Dec.) of the moon and sun at these times:

UT	GHA M	Dec M	GHA S	Dec S
11h	348.7233°	+21.3300°	345.6250°	+21.8333°
18h	90.0150°	+22.2850°	90.6133°	+21.8750°

From these quantities the hourly motions (HM) of the moon and sun in GHA and Dec are derived:

Moon:	HM in GHA 14.47024°	HM in Dec 0.13643°
Sun:	HM in GHA 14.99833°	HM in Dec 0.00595°

Suppose we want to calculate the phase of the eclipse at it T^h UT. The GHAs at it are:

$$\text{GHA } M = (\text{T} - 11)\ 14.47024 + 348.7233$$
$$\text{GHA } S = (\text{T} - 11)\ 14.99833 + 345.6250$$

To convert to local hour angle (LHA) we use:

$$\text{LHA} = \text{GHA} - \text{longitude}.$$

The declinations at T^h are:

$$\text{Dec } M = (\text{T} - 11)\ 0.13643 + 21.3300$$
$$\text{Dec } S = (\text{T} - 11)\ 0.00595 + 21.8333$$

Using the values of LHA, Dec, and the latitude ϕ of Dallas, we solve the astronomical spherical triangle for the altitude and azimuth values of the moon and sun at Dallas. The altitude a is given by:

$$\sin a = \sin \text{Dec} \sin \phi + \cos \text{Dec} \cos \phi \cos LHA$$

and the azimuth A by:

$$\cos \text{A} = \frac{\sin \text{Dec} - \sin a \sin \phi}{\cos a \cos \phi}$$

The solution for the moon yields altitude a_m and azimuth A_m. We must correct a_m for lunar parallax to obtain the observed altitude a_{mo}, $= a_m - H \cos a_m$, where $H = 0.9483°$ is the horizontal parallax of the moon. For the sun we obtain a_s and A_s, and we ignore the very small parallax of the sun. We need not correct the altitudes for atmospheric refraction because its effects on the sun and moon are equal.

As the two bodies are very near each other on the celestial sphere, we can treat their neighbourhood as a plane surface in computing D and P. We find the quantities $\Delta a = a_{mo} - a_s$ and $\Delta A = (\text{A}_m - \text{A}_s) \cos a_{mo}$, and then the angular separation $\text{D} = \sqrt{(\Delta a)^2 + (\Delta \text{A})^2}$. Next, we determine the position angle P of the moon. P is related to

$$\arctan \left| \frac{\Delta a}{\Delta \text{A}} \right| .$$

Care must be taken to place P in the proper quadrant. For instance, if both Δa and ΔA are negative (the moon lower than and to the left of the sun), then

$$P = 90° + \arctan \left| \frac{\Delta a}{\Delta \text{A}} \right| .$$

The entire procedure can be programmed so that the only input needed is the desired time T^h UT. It is then easy to search for the times of first and last contact (times T when $D = \text{S}_m + \text{S}_s = 31.3'$) and for time of maximum eclipse (the time T when D is at a minimum). The predic-

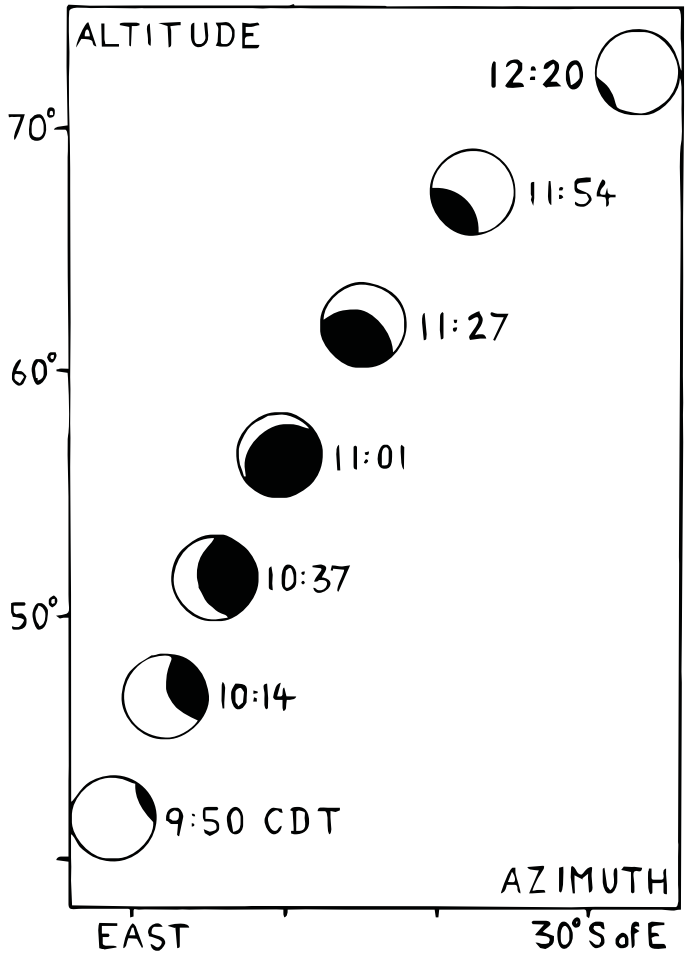

FIGURE 2

tions given here were calculated with a TRS-80 Pocket Computer. The results for Dallas are:

First contact 14:43 UT
Maximum eclipse 16:01 UT
Last contact 17 28 UT.

A sequence of phases of the eclipse in the skies over the Dallas area is shown in Figure 2.

The method has been thoroughly tested. For example, Greenville, South Carolina will have an annular eclipse at 16:29 UT, when the true D is zero. The method correctly predicts this time as the instant of maximum phase, although the prediction is slightly off annularity because of an error in D of 0°00′28″. The predictions of times of first and last contacts have also been tested. For example, according to the eclipse map from the U.S. Naval Observatory, at longitude 110°W., latitude 52.25°N. the eclipse begins about 15:30 UT. My search procedure predicts first contact at 15:31 UT.

La mémoire de Rolland Noël de Tilly

de Lucien Coallier

Le 18 mai 1983 R. N. de Tilly décédait à l'hôpital Rosemont à Montréal. Il était d'une personnalité qui a fortement marqué le monde des amateurs d'astronomes. Pendant nombreuses années, il a agit comme secrétaire presque perpétuel. Il se plaisait à le dire, avec un beau sourire entendu. De ce poste, il en a aidé des jeunes à persévérer afin de faire leur marque. Combien de fois il l'a fait aux dépends même de ses proches. Il aimait surtout les jeunes. Pendant de nombreuses années il a écrit une chronique dans le bulletin des Jeunes Naturalistes sous le nom de "l'Ami des Etoiles". Sur le train du Pacifique Canadien, de Montréal à Québec, il en a donné des leçons d'astronomie à des députés et autres personnes. Au secretariat, il a agit comme rédacteur en chef du bulletin du Centre Français de la S.R.A.C., plus tard celui de la Société d'Astronomie de Montréal. Malgré ses nombreuses obligations comme chef de famille, de secrétaire, il a trouvé le temps de donner de très nombreuses causeries et conférences. Il a été honoré a plusieurs reprises: la plaque Georgette Lemoyne, l'Etoile d'Argent de la S.A.M. pour l'ensemble de son oeuvre, la Médaille du Mérite de la Société Royale d'Astronomie du Canada. Rolland a aussi gravé son nom en lettres d'or sur le temple de la Science qu'il a si bien servi. Il est maintenant aux côtés de Monseigneur Choquette et de son grand ami J. Edgar Guimont. Sa mémoire survivra longtemps et servira de modèle à tous, jeunes et moins jeunes. Vive Rolland Noël de Tilly!

Note de l'editeur: M. de Tilly était également une personnalité bien connu et respectée au sein de la S.R.A.C., pour avoir assister souvent a l'Assemblée Générale annuelle de même que comme représentant national du C.F.S.R.A.C. sur le conseil national.

In Memoriam: A.G. Kindy

A.G. Kindy, President of the Niagara Centre, passed away on 24 January 1984 after a brief illness. He joined the Royal Astronomical Society of Canada in 1961, and was an active member of the Niagara Centre and frequent contributor to its newsletter, *Niagara Whirlpool*. At the time of his death he was also involved with plans for the 1984 General Assembly which is being organized by the Hamilton and Niagara Centres. He had been awarded the Society's Membership Certificate in 1980. We extend our condolences to Mr. Kindy's family, and to the Niagara Centre on the loss of this dedicated member of our Society.

Report of the January National Council Meeting

by Leo Enright
National Recorder

The National Council of the R.A.S.C. met on Saturday, January 28, 1984 in the library of the Society's National Headquarters in Toronto. Mr. Franklin Loehde, the National President, chaired the meeting, and ten centres of the Society were represented.

The agenda included reports from officers and several standing committees, as well as a number of significant decisions and announcements. Mr. Loedhe reported that the legal firm which had been consulted concerning the Society's establishment of an endowment fund, as recommended at the last meeting of Council, saw no problem in the institution of such a fund, and the measures suggested for its establishment seemed to be satisfactory. As a result, Council passed a motion to set up the endowment fund, amalgamating the Society's special funds (except the Ruth J. Northcott Memorial Fund which is under a separate trusteeship). The Treasurer, Mrs. Fidler, reported that Mr. Altman, who has served as Auditor for the Society for many years, had indicated that his schedule would not allow him to complete an audit of the Society's finances before 1 March 1984 as required, and as a result Council instructed the Finance Committee to appoint an auditor, subject to ratification by the membership at the 1984 Annual Meeting.

Mr. Broughton, as Chairman of the Property Committee, reported on attempts under way to have the Society exempt from property taxes on that part of the building used for office space, because of its

status as a registered public scientific institution. It appeared that the matter would be settled in favour of the Society. Mr. Broughton announced his intention to resign from the Committee after serving for 7 years, the last four as Chairman. The Society is indebted to him for an enormous amount of work done over these years.

Dr. Halliday reported that the Awards Committee had received six nominations for the Service Award: Leslie Powis and James Winger of Hamilton Centre, Cyril Hallam and Henry Lee of Windsor Centre, Hugh MacLean of Niagara Centre, and Peter Jedicke of London Centre. All were approved by Council. Six nominations for Honorary Membership were received by the Nominating Committee, and a decision will be announced at the General Assembly in Hamilton. A slate of officers for election in 1984 was presented, as well as an additional nomination. Information and ballots will be mailed to members.

As Astronomy Day Co-ordinator, Mr. Enright reported that very extensive planning had been done in the U.S. and Britain, which is preparing for Astronomy Week. He looked forward to 5 May when several centres will combine innovation activities with the "tried and true" projects of mall displays and public star nights. An information package with ideas and suggestions was approved by Council, and will be sent to all centres. The 1985 Astronomy Day has been set for April 27. Dr. Halliday hoped that Halley's Comet Bulletin #2 would be ready for use on this year's Astronomy Day.

Dr. John Percy noted the approaching fiftieth anniversary of the David Dunlap Observatory in 1985. On behalf of the Department of Astronomy, University of Toronto, he extended an invitation to members of the Society to mark the occasion by attending a special symposium on variable stars which is tentatively scheduled for July 12 to 14, 1985.

Mrs. Fassel reported on behalf of the Hamilton and Niagara Centres on preparations for the 1984 General Assembly. Air Canada has recognized the General Assembly as an eligible convention, and will apply a 20% discount to air fares to Hamilton. Travellers should book their arrangements with Air Canada's Convention Central by telephoning (800)361–7585.

Council was happy to receive a report from Mr. Harlan Creighton that he has arranged with CPR the permanent loan of a valuable railway station clock which will serve as a reminder of Mr. Malcolm Thomson, Past President of the R.A.S.C., who was associated with the Dominion Observatory's time service. The clock will be presented to the Society at the General Assembly.

In all, a great deal of business was conducted at the second meeting of the National Council to be held at our new headquarters. Further details may be found in the minutes of the meeting which have been sent to Centre Presidents and National Council representatives. Financial statements from the Treasurer and reports from the Editing Committee and Editor of the *Observer's Handbook* are attached as appendices to the minutes.

Ex Libris

Philip Mozel
National Librarian

The door closing behind me locks out the last rattle of traffic in the street as my private journey begins. A quick survey of the room I have entered reveals shelves lined with magazines: astronomy magazines. The latest information concerning other worlds and our place in the universe fills these pages which wait only for a reader. These temptations are restricted, however. My objective lies elsewhere.

Descending the stairs I am surrounded by volume upon volume of works concerning themselves with all aspects of the heavens. Sightseeing through the printed spines, I spot my quarry and pull it from the shelf. An ancient tome, it has travelled through the years to be in my time. Turning back the cover, reflections of a great astronomer from long past are laid bare upon the yellowing pages. Entering his mind, I see what he saw and consider what he thought. Communication necessarily flows in only one direction but questions still formulate themselves. What a thrill it would be to quiz the originator of these words!

The darkening day ends all musing soon enough and the volume is returned to its place. The stairs are climbed and the door opened once more as sounds of the modern world confirm my return to the present.

The R.A.S.C. National Library, 136 Dupont St., Toronto, Ont. M5R 1V2. It's waiting for *you*.

Société Royale d'Astronomie du Canada
Assemblée Générale 1984
29 juin–2 juillet

Pour marquer le 75^{e} anniversaire du centre de Hamilton, l'Assemblée Générale sera caractérisée par deux grands banquets, une soirée chaque jour et des excursions en quantité. Et avec tout ceci les exposés, la réunion annuelle et l'occasion de renouer d'anciens liens d'amitié. Une visite au Jardin botannique royal fera partie des excursions de même qu'une visite à un château local et des excursions dans les environs du port. De plus, un jour entier sera consacré aux Chutes du Niagara, où nous pourrons admirer la tour Skylon, le téléphérique espagnol, les tunnels panoramiques etc., le tout couronné par un banquet. L'emploi du temps est agréable, aussi n'hésitez pas à venir.

Les membres sont invités à participer aux exposés. Des exposés d'une durée de 10 minutes sur tout aspect de l'astronomie seraient bienvenus. Les extraits de ces exposés doivent être envoyés avant le 15 avril à la S.R.A.C., au Président des exposés, C.P. 1223, Waterdown (Ontario) L0R 2H0.

D'autre part, nous vous demandons d'écrire à l'adresse ci-dessus pour obtenir des imprimés pour participer au concours d'expositions. Seules les expositions dûment inscrites pourront faire partie du concours de prix. Les inscriptions devront parvenir chez le juge en chef au plus tard le vendredi 29 juin 1984 à 22h. À noter que chaque exposition ne peut entrer que dans une seule classe (c.-à-d individuelle, groupe, centre) et dans une seule catégorie (c-à-d. solaire, lunaire, étoile variable, etc.) et ne peut être combinée à une autre exposition, avec celle d'un centre par exemple. Les règlements de l'exposition sont énoncés ailleurs dans la présente publication.

Afin de faciliter l'organisation de ces diverses activités et l'hébergement des participants, nous vous prions de remplir le formulaire ci-dessous et de nous le renvoyer d'ici le 15 avril. L'envoi d'une enveloppe pré-affranchie à votre adresse nous permettra de vous renvoyer une formule d'inscription plus détaillée. Nous prévoyons que le prix par personne, en occupation double, sera moms de 250,00 $ et comprendra l'hébergement, les repas, les deux banquets, les excursions et les frais de transport s'y rapportant, y compris ceux de l'excursion aux Chutes du Niagara.

Vous êtes priés de faire parvenir les renseignements ci-dessous (le 15 avril) au Secrétariat d'Accueil, soit: General Assembly 1984, P.O. Box 1223, Waterdown, Ontario, L0R 2H0

J'assisterai _____
J'assisterai peut-être _____ Nombre de personnes _____

Je demande au Comité d'Accueil de s'occuper de mon hébergement

Type de logement souhaite:

Résidence universitaire _____ motel _____

Je m'occuperai moi-même de mon logement _____

Indiquer vos dates probables d'arrivée et de départ: juin 27, 28, 29, 30, juillet 1, 2, 3, 4

Nom _____

Adresse _____

_____

Centre local ou club _____

Royal Astronomical Society of Canada
1984 General Assembly
June 29–July 2

As a special feature of the 75th Anniversary of the Hamilton Centre, the General Assembly will have two major banquets, a party every night and excursions galore. All this and the Papers Sessions, annual meeting and the opportunity to renew old friendships. The excursions will include the Royal Botanical Gardens, a local Castle and trips around the Harbour. Further a complete day will be spent in Niagara Falls, where we will enjoy seeing the Skylon Tower, Spanish Aerial Car, Scenic Tunnels etc., along with one of the Banquets. This will be a fun filled time, so do come.

Members are invited to participate in the Paper Sessions. Papers of ten minutes duration on any aspect of astronomy are welcome. Abstracts must be sent before April 15, to R.A.S.C. – Papers Chairman, P.O. Box 1223, Waterdown, Ontario, L0R 2H0.

Further we would ask you to write to the above address to obtain application forms for the Display Competition. Only Pre-Registered Displays will be allowed to compete for prizes. These must be in to the Chief Judge by 10pm, Friday June 29, 1984. Further it should be noted that each display can only be entered in one Class (ie. – Individual, Group, Centre) and Category, (ie. solar, lunar, variable star, etc.) and cannot be mixed-in with another display such as a centre display. The display rules are listed elsewhere in the February issue.

To assist in planning for the various events and accommodations, please fill out the form below and return by April 15. By enclosing a stamped self-addressed envelope, we will then forward a more detailed registration form. It is currently projected that the cost for a single person based on double occupancy will be less than $250.00 and that includes all accommodations, meals, 2 banquets, trips and their attended transportation charges including those to Niagara Falls. Air Canada has been designated as our official convention carrier and will apply a 20% discount on all fares. Additional information will be in the information package.

Would you please send the following information before April 15, to: General Assembly 1984, P.O. Box 1223, Waterdown, Ontario, L0R 2H0

I plan to attend _____ Number in party _____
I may attend _____

I wish the Organizing Committee to make arrangements for me.

Accommodation desired: on campus _____ motel _____

I will make my own arrangements _____

Circle expected dates of arrival and departure: June 27, 28, 29, 30, July 1, 2, 3, 4

Name _____

Address _____

_____

Centre or affiliation _____