STARS

WITH

OBSERVING VARIABLE STARS

--WITH BINOCULARS

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A Centennial Observatory Publication

Public Price 50¢

Price to RASC Members 35¢

Introduction

This booklet is not intended to be a technical treatise on variable stars. Nor is it for the serious amateur astronomer whose instruments and capabilities carry him far beyond what is to follow. Rather, I intend this to be read and used by the beginner, equipped only with his eyes and a pair of binoculars.

The information contained herein has been gathered from many sources, including my own experience. I do not pretend, however, to be an expert on variable star observing. I write this only as a guide to those who follow, so that they may avoid some of the pitfalls involved in variable star observing. Hopefully, this booklet will enable the beginner to make a start, make a few observations, and progress into more serious work.

My own equipment, aside from the telescopes housed in the observatory, consists of a pair of 7x50 binoculars, which I use to observe many of the stars mentioned herein. The only other equipment needed is a wrist watch, a flashlight, a comfortable lawn chair, some warm clothing, a pencil, this booklet, and the desire to learn and see something different!

I wish the reader good fortune and clear skies for his debut in the field of variable star observing with binoculars.

K. E. Chilton

Chapter 1

Why Observe Variable Stars?

Have you ever stood in the quiet solitude by a northern lake on a moonless summer night while an orchestra of crickets played their favourite symphony and myriads of stars reflected off the calm water ? Have you ever lain on your back, gazing up at the seemingly countless points of light and wondered if shepherds, long ago, had done the same ? If you watch those stars for hours and hours, you may never see a change, and if you watch them for years and years, you may be almost certain that the stars looked the same to those ancient shepherds as they do to you now. But you will be wrong!

The stars do change! Now, it is true that the average star looks almost exactly the same as it did 100 or even 1,000 years ago. In the span of a lifetime most stars appear to remain constant in brightness and fixed in position in relation to the other stars. There are, however, certain stars which change in brightness quite a bit. These are called "variable stars".

Why should one observe variable stars? In actuality, there are as many reasons as there are observers. However, some of the more general reasons can be stated here.

First of all, it is fun! It is a bit like a detective mystery. The observer has to be able to identify one single star out of all those thousands, track him down and describe him. At times, this can be a bit frustrating, as the culprit gets clean away. But then there are those times of success, when the investigation leads you to the suspect and he is positively identified.

Secondly, it can be exciting! There are certain types of stars which suddenly flare up intensely in brightness and others which fade rapidly. They are quite irregular and one never knows quite what to expect. Then again, you can imagine the excitement felt by the student astronomer at the David Dunlap Observatory in Toronto who discovered that a variable star had stopped varying!

Variable star observations, when carefully and correctly made, can be of use to professional astronomers. There are many thousands of variable stars, and not so many professional astronomers. Of those, only a small proportion are working on variables. Thus, they depend on amateur astronomers for observations. This isddone through the major variable star organizations about which more will be said later.

It might be well to state here, some of the uses to which variable star observations have been put. Stars give us huge chemical laboratories where we can study elements under conditions not found elsewhere. Normal stars, however, are pretty well constant while variables give examples of how the elements react when the conditions vary.

In the past, variable star observations have given us a yard-stick against which we could measure the scale of the universe. Certain types of variables are interesting in that they have a connection between the length of the cycle of their variation and their true brightness. Since the apparent brightness of a star depends on two factors, namely true brightness and distance, it is obvious that when the true brightness is known, the distance can be computed. This connection between the cycle and the true brightness is called the "Period-Luminosity Law".

Since variable star observing can be fun, exciting, and useful, it is the ideal field into which the beginning amateur astronomer can step, knowing that he is going to have an interesting and rewarding pasttime.

Chapter 2:

What Can You Observe ?

At this time, it might be well to consider what we are observing when we turn our binoculars on a variable star. Basically, there are two types of variable stars.

The first variety are called pulsating variables. Although the mechanism by which they pulsate need not be explained in this booklet, it should suffice to say that the physical size of such a star grows and then shrinks. As it does so, it gets brighter and then fainter. The length of time from faint to bright and then back to faint is called the "period". Certain variables have periods longer than one year, while others are quite short, being only 2 or 3 hours long. Some are extremely regular and predictable while others are quite wild and unpredictable.

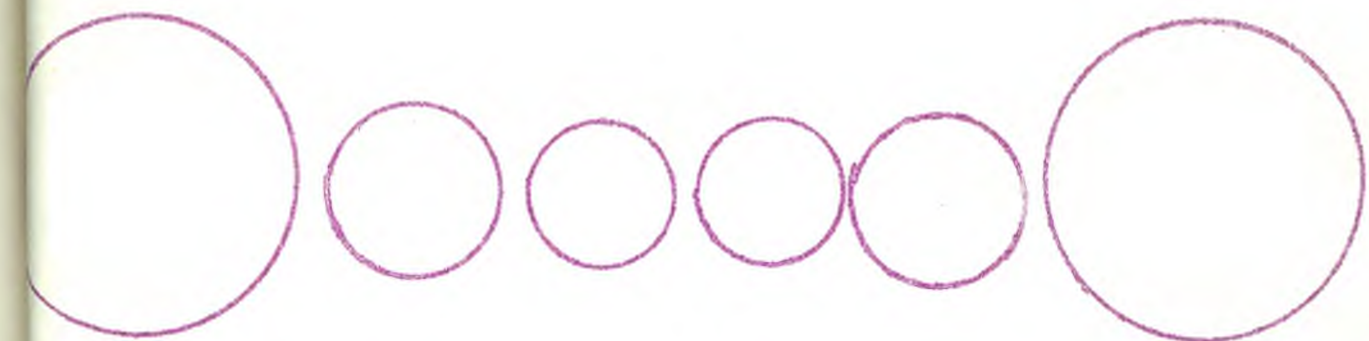


Fig. 1

The second basic type of variable star is the "eclipsing binary". It is a fact that the majority of stars are double stars. These are called binaries, and the two stars orbit around each other. In some cases, the orbit is oriented so that one star passes right in front of the other as seen from the earth. This causes an eclipse. The light from one star is cut off by the physical body of the other, causing the pair to appear as one star only. If the case happens that the stars are so close to each other, and so far away from the earth that they cannot be distinguished, then the apparent effect is that we have a variable star.

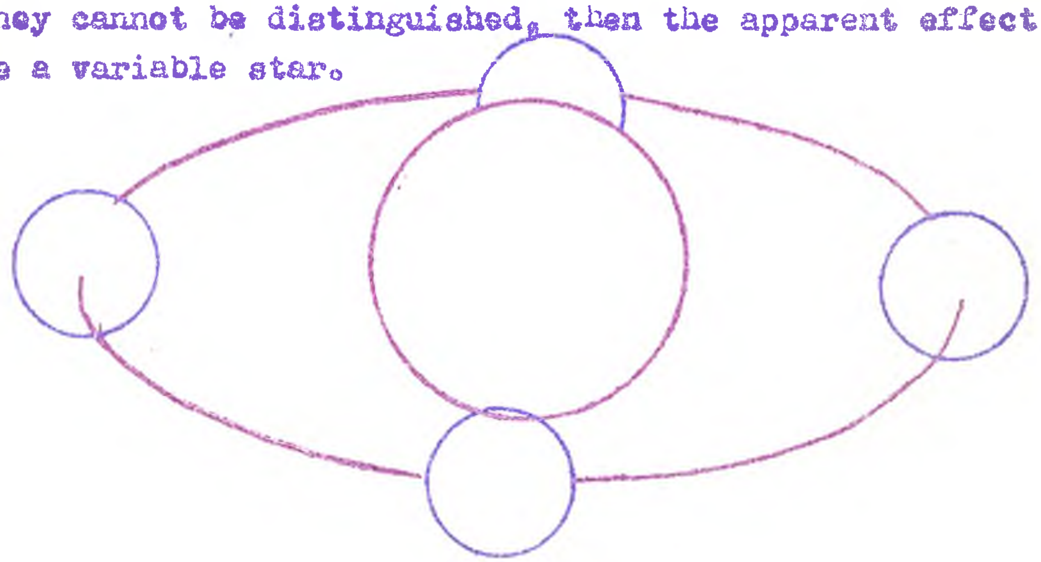


Fig. 2

Both types of variables have sub-varieties such as RR Lyrae, Cepheids, RU Cam and UV Ceti stars. The individual characteristics of each type need not be explored here. However, the reader should know that these sub-types are classified according to the length and rapidity of the variation, and usually are named after the first of its variety to be discovered. If the reader wishes to know more about these sub-varieties, it is suggested that he procure a copy of "Variable Stars" by J.S.Glasby.

It is interesting to discover the pattern used in naming variable stars. The first one recognized in a constellation is given the letter R. So we have R Orionis, R Scuti and R Leonis, for example. The next to be discovered is S and the next, T etc. as far as Z. After that, we use double letters RR, RS, RT etc. to RZ and then SS, ST, SU etc. down to SZ. This series continues until ZZ is reached. Then comes AA, AB, AC etc.. It may happen that a constellation has a great many variables and there aren't enough letters to go around. This difficulty is met by naming the next variable after QZ with a number-V335, V336, etc..(QZ is the 334th possible combination using the letter system.)

Variable stars are also known by a serial number or "designation" which is based on its position in the sky. The first 4 digits in the designation indicate the star's Right Ascension (equivalent to celestial longitude.) The last two give the star's Declination (equivalent to celestial latitude.) If the star is south of the Celestial Equator the designation is underlined.

A few examples might be well in order. In the constellation of Ursa Major there is a variable, Z Ursae Majoris. Its designation is 115158, which means that its Right Ascension is 11 hours 51 minutes and its Declination is +58°.

The designation of R Scuti is 184205. Therefore its Right Ascension is 18 hours 42 minutes and its Declination is -05°.

(If the reader is not certain as to the meaning and use of Right Ascension and Declination, he should consult a basic astronomy text.)

Quite often the name of the variable may be abbreviated. There is quite a system to this, too. The letter of the variable is given, followed by the first 3 letters of the constellation. So we have R Orionis shortened to R Ori and S Andromedae becomes S And. Certain constellations have identical sets of letters (Sagittae and Sagittarius for instance) so that some other letters have to be employed. Therefore R Scuti is R Sct and R Sculptoris is R Scl.

Chapter 3

How To Observe:

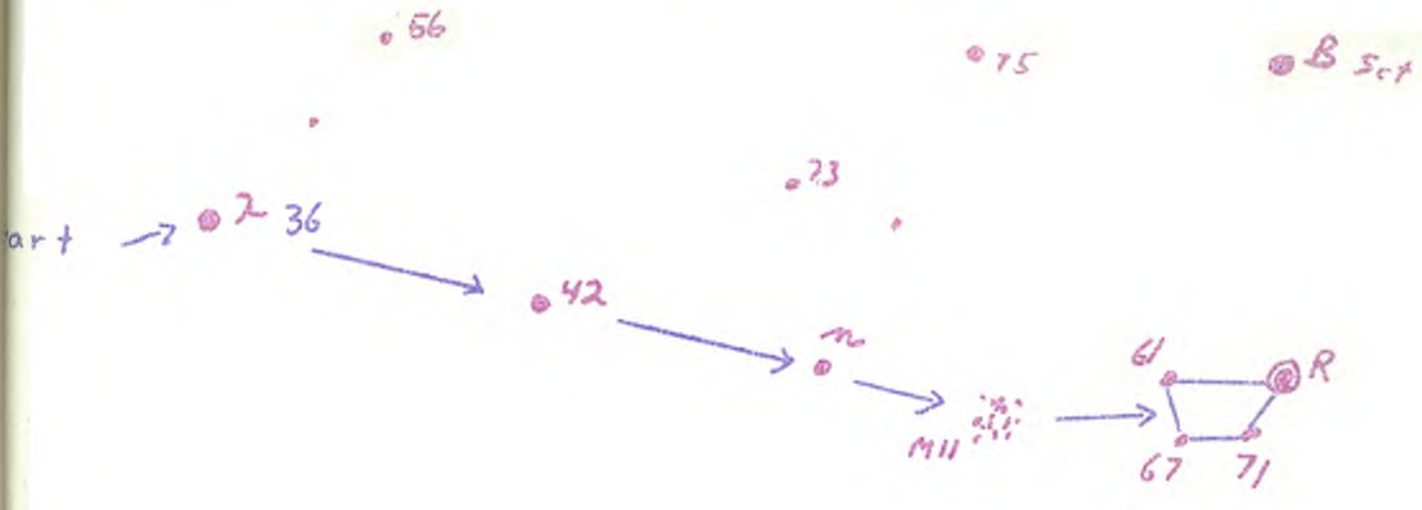
Observation of variable stars is really divided into two tasks, finding the star, and estimating its magnitude, or brightness. The magnitude of a star is a number which indicates how bright it is. The system was started long ago, probably in ancient Chaldea or Arabia. The stars visible to the unaided eye comprise the first 5 magnitudes, the brightest being 1st magnitude, the next brightest being 2nd magnitude, and so on until the faintest visible are 5th magnitude. However, the binocular or telescope user can see many more stars than are visible to the unaided eye. So the magnitude system has been extended through 6th magnitude down to about the 20th magnitude, which is about as faint as can be seen in the very largest telescopes. The limiting magnitude of 7x50 binoculars is 11th.

This system is not accurate enough for variable star observations and each magnitude is divided into tenths. A star can be listed, for instance, as having a magnitude of 7.5, which means that it is half-way between 7th and 8th magnitude.

What the observer must remember is that the fainter the star, the higher the magnitude number.

As stated before, the two activities involved in variable star work are finding the star and estimating its magnitude. Sometimes, finding the star can be quite a job. The easiest way of finding a star is to use a star map, several of which appear in the back of this book. The system I use is to find the brightest star on the map and then work my way to the variable using the other stars as sign-posts.

Quite often,you can use little patterns of stars in the form of triangles, squares, etc. to help you find the star you want.



Look at the map for R Scuti, which is Fig.3 above. The stars marked 36,42, and 50 are naked eye stars in the tail of Aquila, the Eagle. I spot these with my eye, turn the binoculars upon them,swing slowly to the right until I spot the cluster M11,and then the little box containing R Sct in the top right corner.

After you have found the variable,then it is a reasonably simple matter to estimate its magnitude.The idea is to compare it with the other stars on the map.Their magnitudes are given right on the chart. Referring to fig.3, the star marked 36 has a magnitude of 3.6, since the decimal points are omitted on the charts to avoid confusion with the stars. Therefore 42 becomes 4.2 and 50 becomes 5.0 etc...

The actual estimation is made in a simple manner.There are two methods,both quite easy. Suppose that you had found R Scuti and noticed that it was brighter than 71 but fainter than 67. Then the magnitude would be either 70,69 or68. The observer would have to try and judge whether it was more similar in brightness to 71 or 67.With a bit of experience, it becomes quite easy to judge.

The other methods works well when the comparison stars' magnitudes are not too similar to that of the variable. Suppose you variable was situated in a star field where the only two comparison stars are marked 69 and 88. The way to estimate is to fix in your mind a scale of 10 between the two stars.Then you have to estimate the position of the variable on this scale. Suppose that you imagine the variable to be 4 tenths of the way from 69 to 88 in brightness. There is a difference of 19 between the comparison stars so that .4x19= 7.6. So, add the 7.6 to 69 and you get 76.6, or rounding off 77. So the brightness of the variable is 7.7. When doing this, it is advisable to do it twice, once from the brighter comparison star and once from the fainter.

(For each variable that I suggest as suitable for the beginner, I have included star maps in the back of this book.)

If you are observing variable stars scientifically, then you will want to keep accurate records. A sample page of a variable star record is given. I have found this quite satisfactory as it provides a continuous record of the variations in brightness.

The only point which might need explaining with regard to the observational record is the term "Julian Day". The Julian Day is a system of dating, accurately counting the days since January 1, 4713 B.C.. January 1, 1970 was Julian Day 2,440,588.The day begins at noon at Greenwich, England and is usually measured in tenths of a day. The most difficult part is remembering that the day starts at Noon and not at Midnight. To help out here, I have prepared a table which converts Eastern Standard Time to decimals of a Julian Day.

5:48 PM — 8:12 = .5
8:12 — 10:37 = .6
10:37 — 1:00 AM = .7
1:00 — 3:25 = .8
3:25 — 5:48 = .9

You may wonder how often the stars should be observed. There is no hard and fast rule, but I follow the following principle, that the shorter the period, the more often the star should be observed. Irregular variables are observed every night, while stars with periods less than 30 days are observed weekly. I observe stars with periods of 30 to 80 days every two weeks and stars from 80 to 160 days once a month. Others are done monthly.

hapter 4

hat Happens to Your Observations ?

The use to which you put your observations depends upon the purpose for which you are observing. However, if we may assume that you, like most, will be observing for scientific purposes, then a great deal happens to your observations.

You may wish to transfer them to graph paper. In this way you can follow exactly what is happening to the stars over a period of time.

There are several organizations which collect observations of variables. The most well known of these is the American Association of Variable Star Observers. For many years, its director has been Mrs.Margaret Mayall. The AAVSO publishes articles about variables, sells charts to observers, holds twice-yearly conventions and coordinates observations. The reader can write to the AAVSO at 187 Concord Ave., Cambridge,Mass.,USA 02138.

The Variable Star Section of the British Astronomical Association works in a similar fashion. The address is: Mr.J.S.Glasby,7 Kilwinning, Stevenston,Ayrshire,Scotland.

The International Union of Amateur Astronomers has a variable star commission, which coordinates observations on a world wide scale. While the AAVSO and the BAA already do this to some extent, there are certain gaps. The IUAA fills these, and provides a chance for variable star observers the world over to exchange, thus bringing about close cooperation between nations. Those interested should write to: M.Leon Menager, 98A rue de la Hulpe,Rosieres-St.Andre,Belgium.

Each of these organizations will make your observations available to those who need them.

Conclusion:

Whether you observe for science, or for pleasure, you will find the study of variable stars worthwhile. The author hopes that this booklet will have helped.

Sample Page of Observational Record

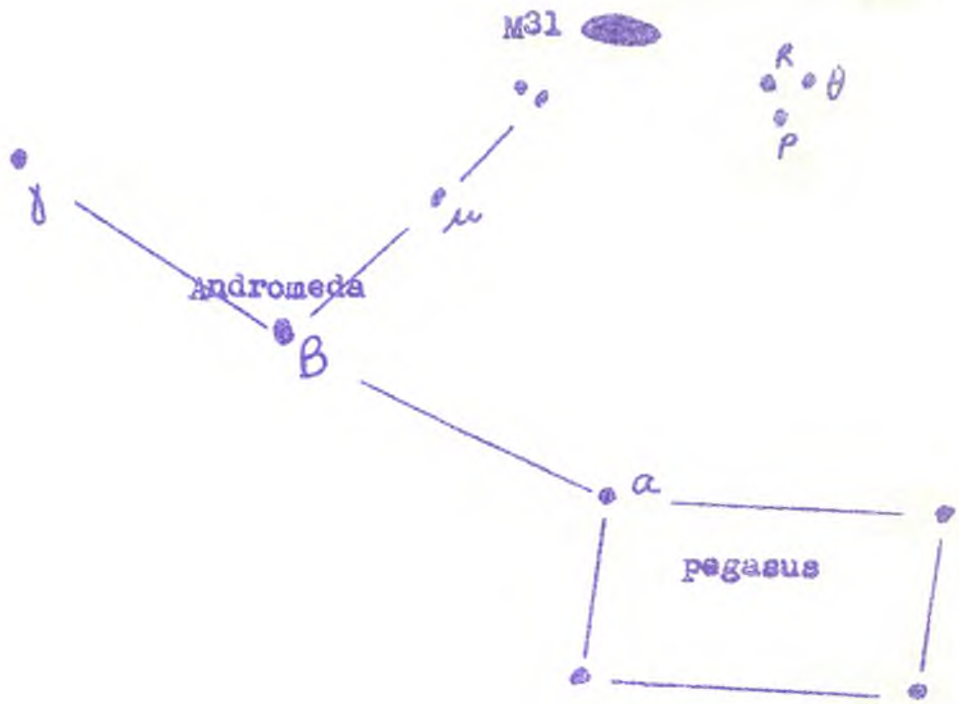
Variable: Z Ursae Majoris
Designation: 115158

ate	Julian Day	Time	Comparison Stars	Magnitude	Remarks
an.3	2440590.8	1:15	7.6 7.2	7.4	
an.7	595.8	1:09	7.6 7.2	7.5	
eb.10	627.8	1:27	7.6 8.1	8.0	
eb.15	632.7	11:38	8.1 9.0	8.5	

001838 R Andromedae

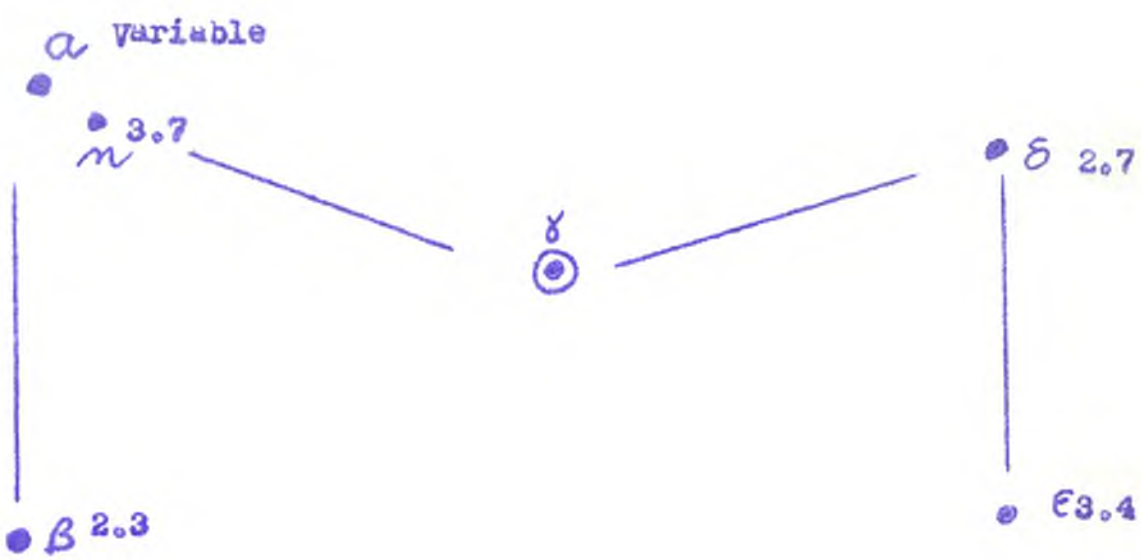
6.9-13.3
period 409 days

Naked eye chart



005360 γ Cassiopeiae

1.7-3.4
period irregular

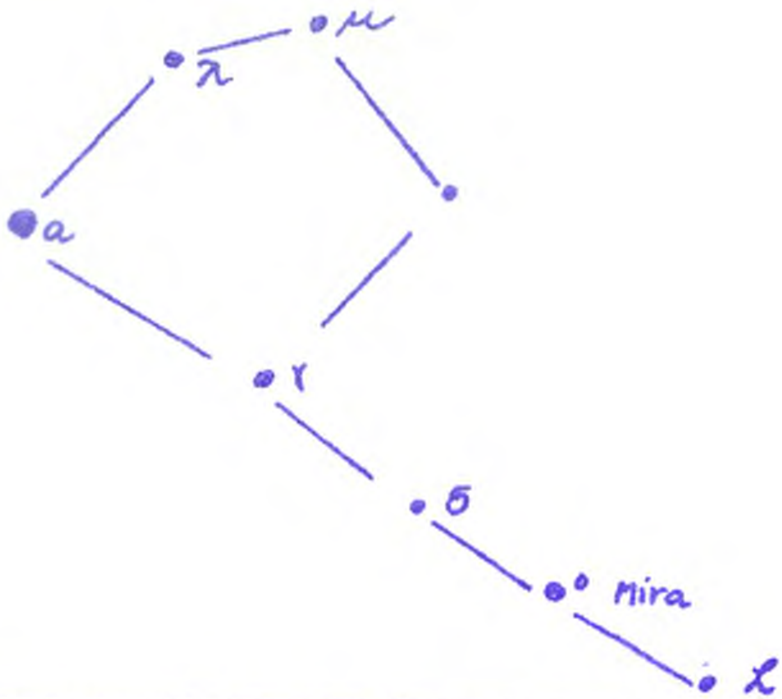


This should be a good one for naked eye viewing since the comparison stars will be out of the binocular field.

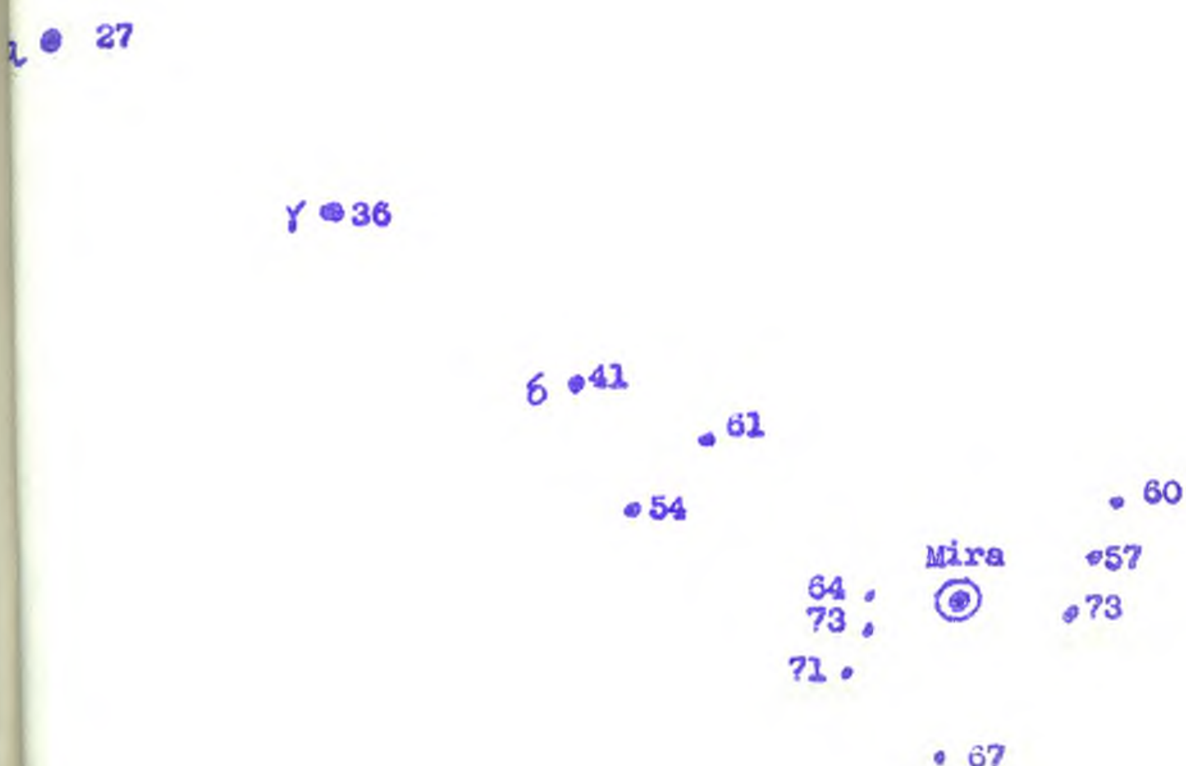
021403 o Ceti (Mira)

3.4 - 9.2
Period 332 days

Naked eye chart



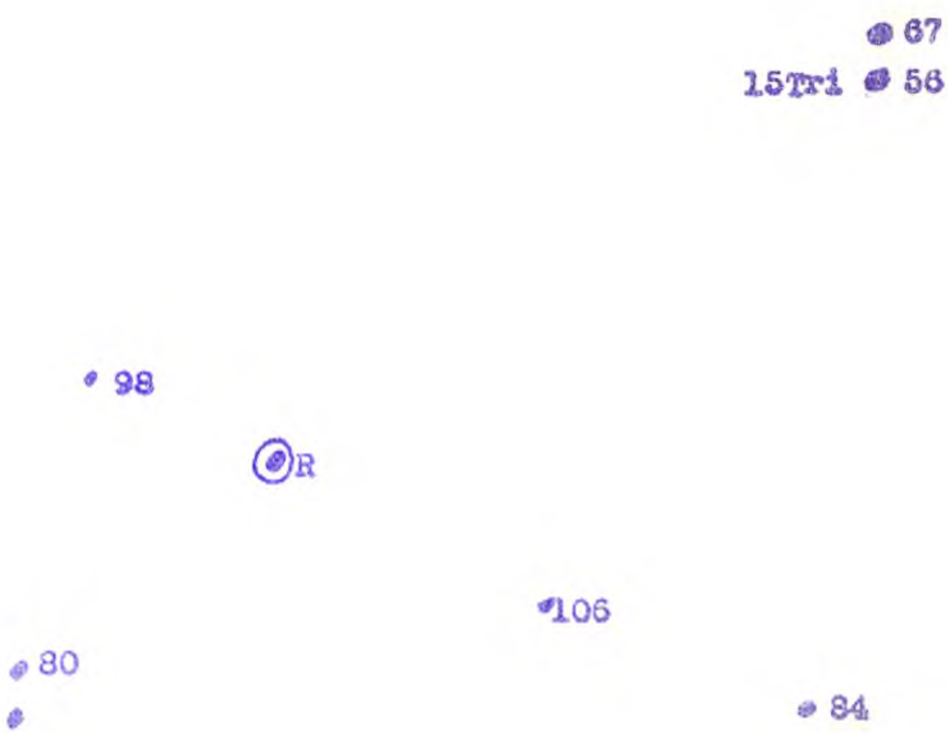
Binocular Chart



023133 R Trianguli

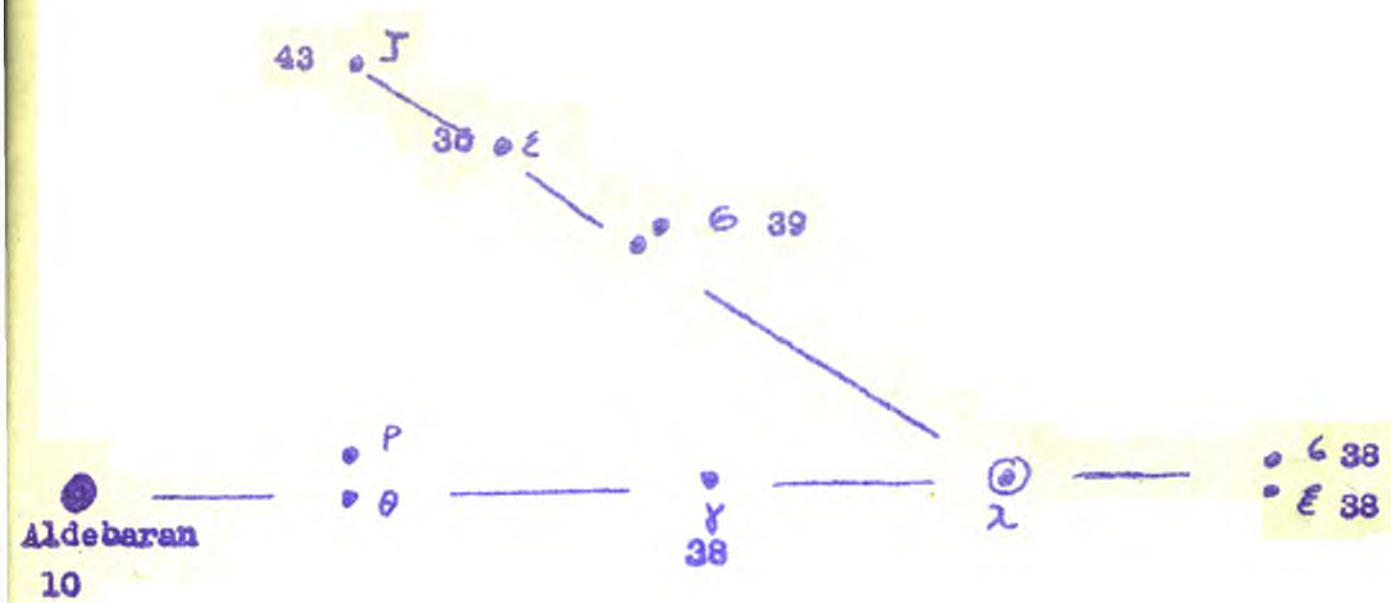
6.0 - 11.5
Period 266 days

Naked eye chart



035512 λ Tauri

Eclipsing
3.5 - 4.0

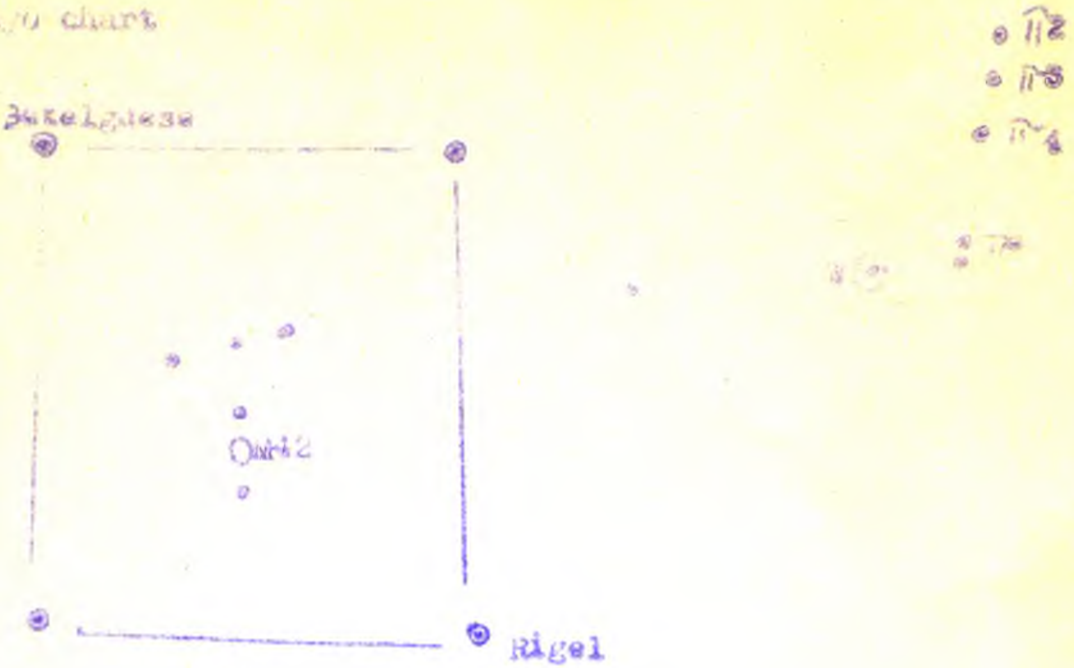


This eclipsing binary may be best observed with the naked eye since the comparison stars are beyond the field of the binoculars. Predictions for the time oft the eclipses are available from the Observers Handbook of the Royal Astronomical Society of Canada.

05[illegible] W Orionis

8.9–?.7
Period 200 days

Naked e/o chart

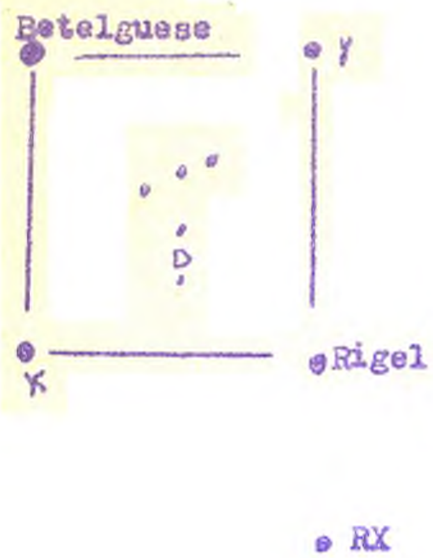


Binocular Chart

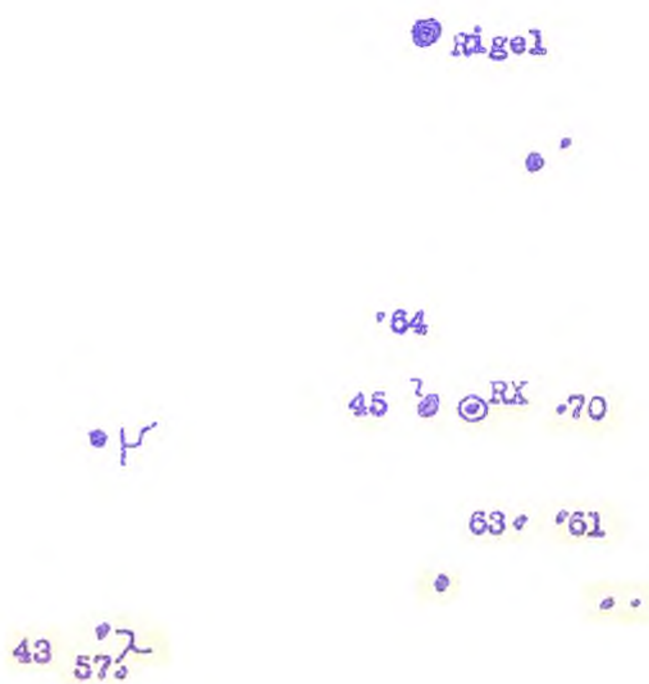
050611 RX Leporis

5.9 - 7.0
Period irregular

Naked eye chart



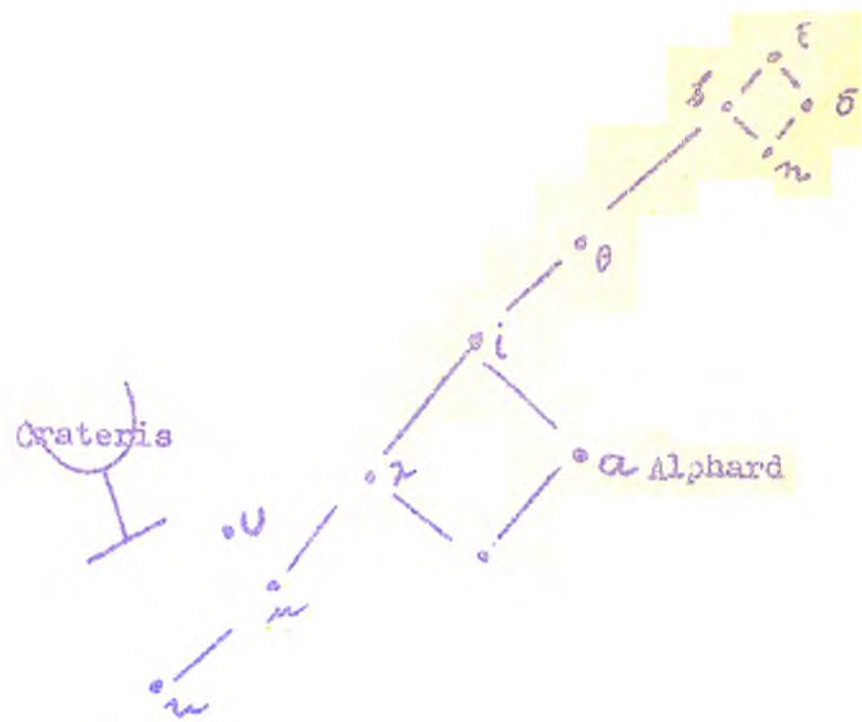
Binocular chart



103212 U Hydrae

4.8 – 5.8
Period Irregular

Naked eye chart

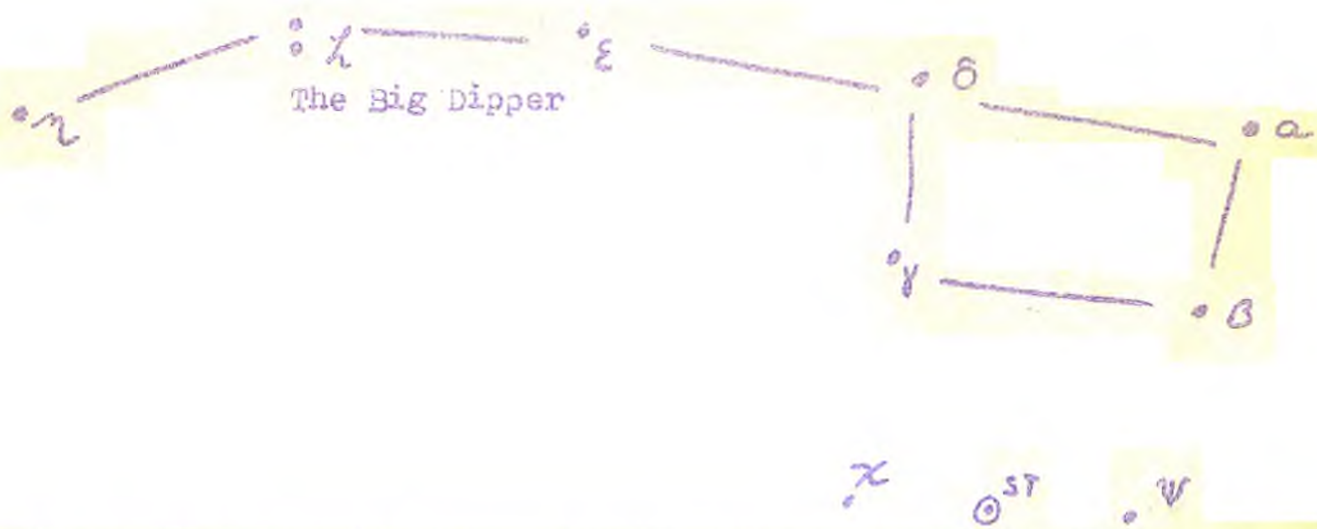


Binocular chart

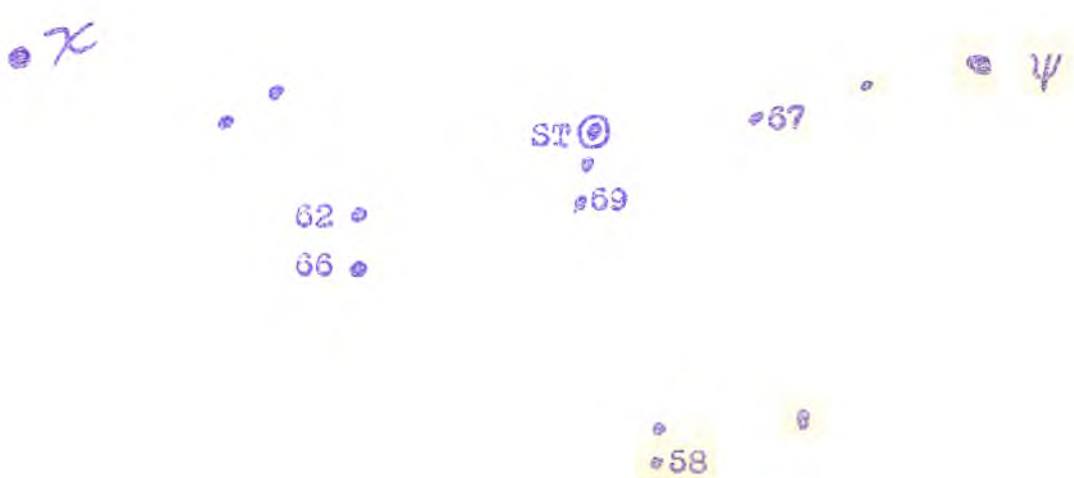
112245 ST Ursae Majoris

6.4 - 7.5
Period 81 days

Naked eye chart



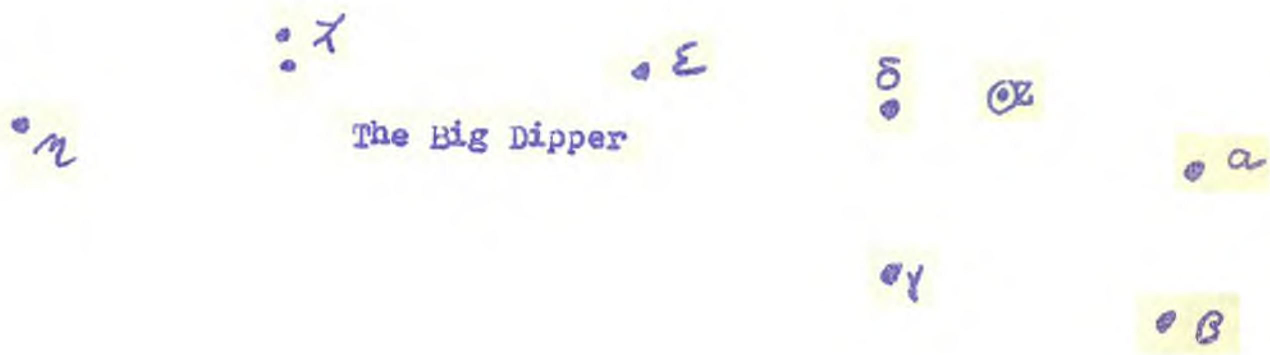
Binocular Chart



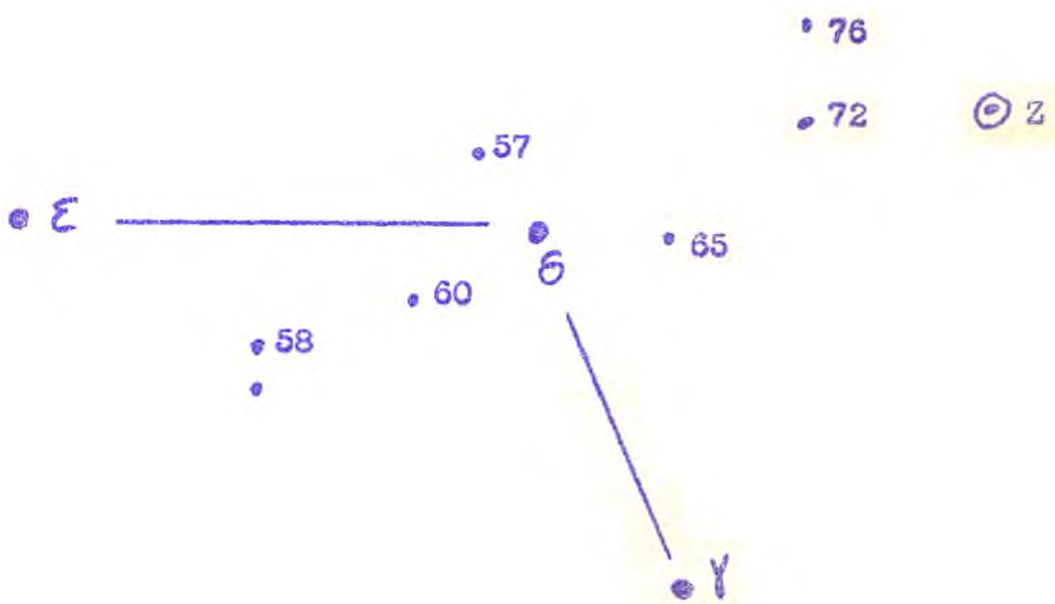
115158 Z Ursae Majoris

6.5 - 8.3
Period 198 days

Naked eye chart



Binocular chart



184205 R Scuti

5.0 - 8.4
Period Irregular

Naked eye chart

Binocular chart

184205 R Scuti

5.0 - 8.4
Period Irregular

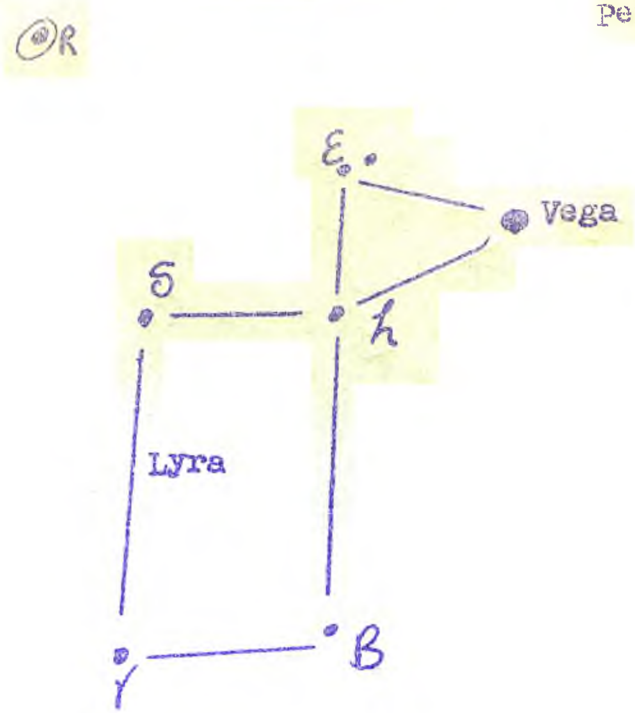
Naked eye chart

Binocular chart

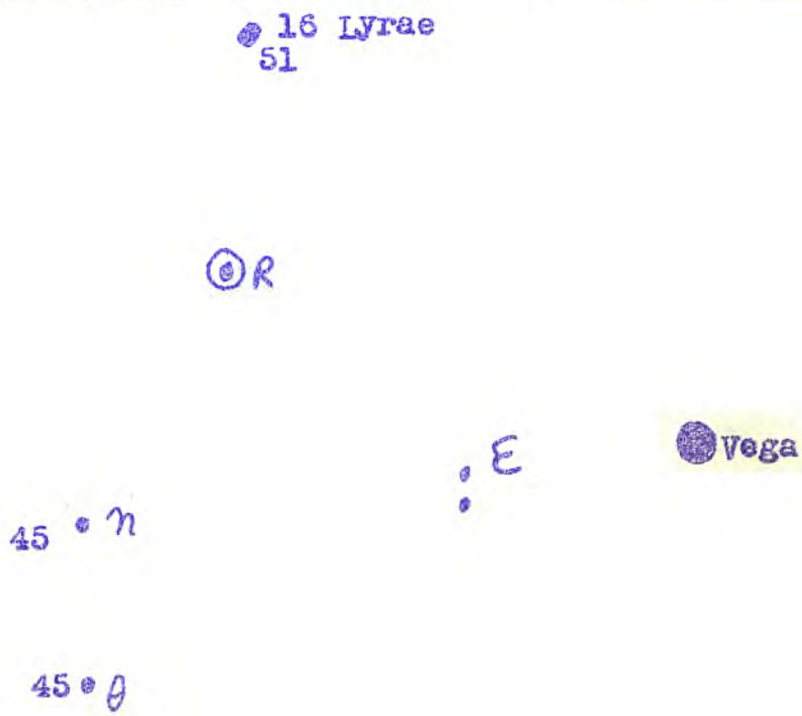
185243 R Lyrae

Semi regular
Period 46 d.

Naked eye chart



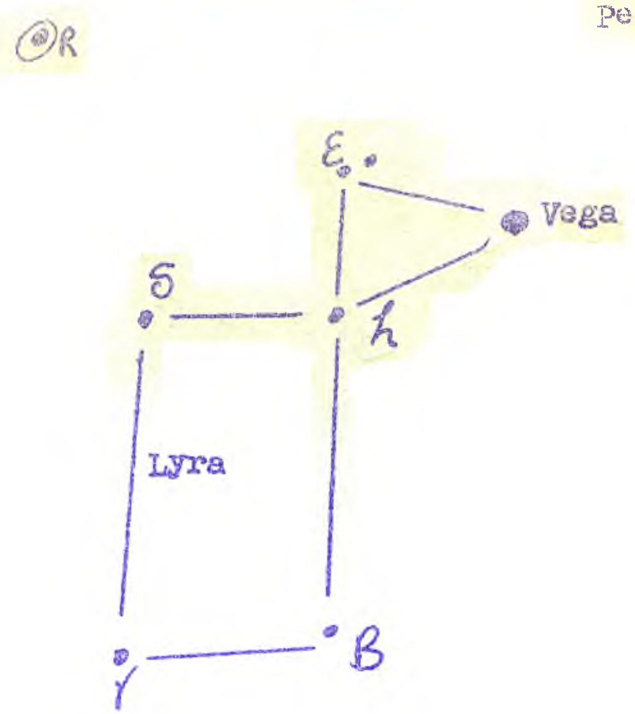
Binocular chart



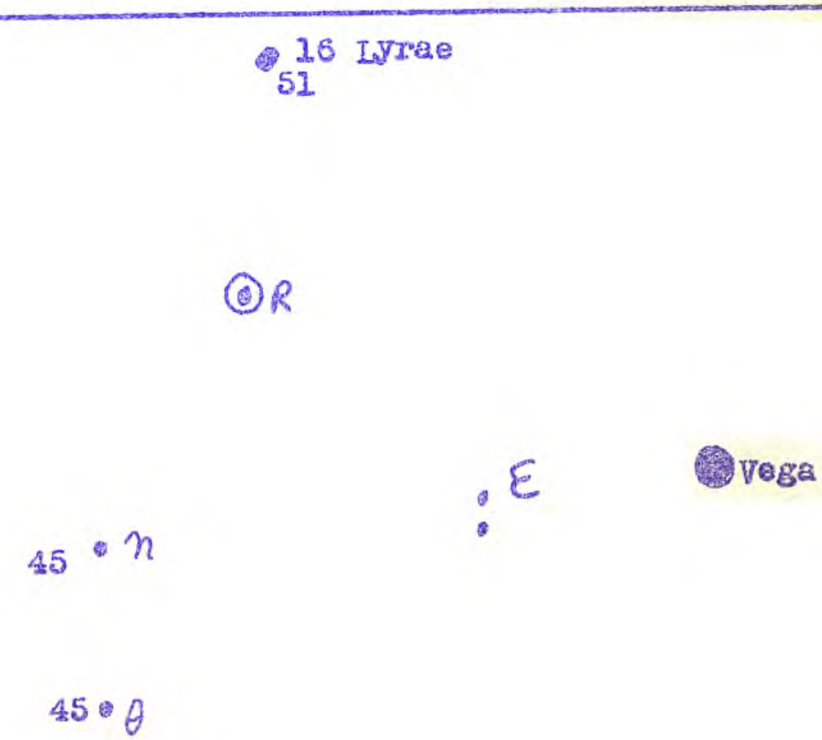
185243 R Lyrae

Semi regular
Period 46 d.

Naked eye chart

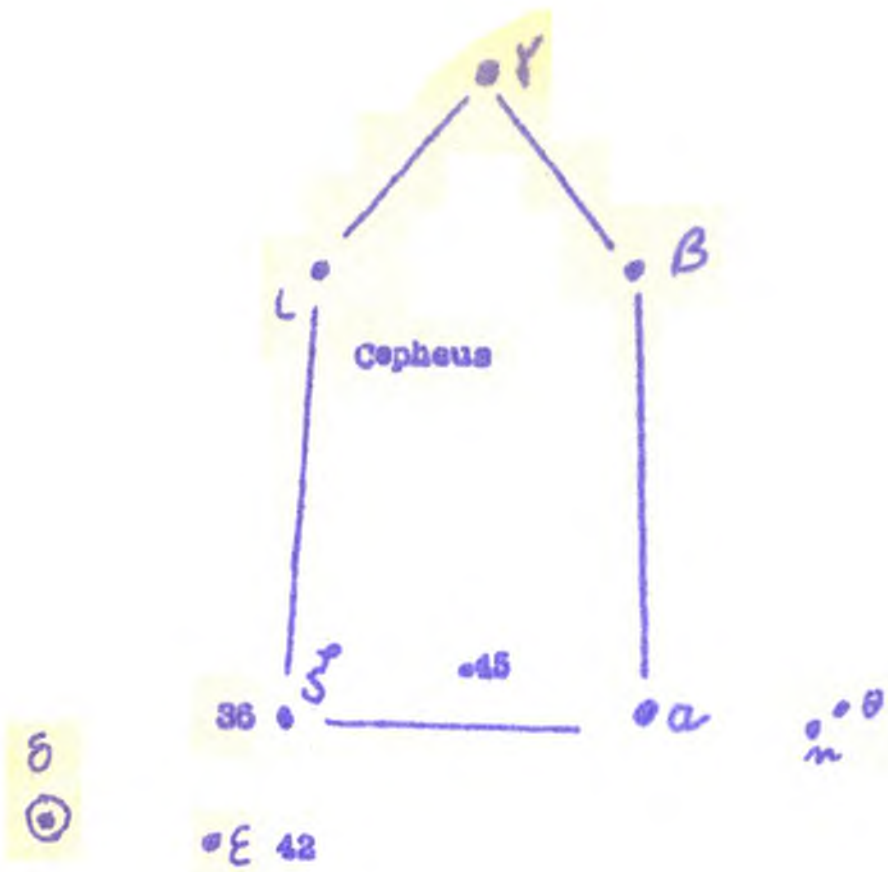


Binocular chart



222557 δ Cephei

4.1 - 5.2
period 5.3 days



Chilton, K. E.

Observing Variable Stars--
with Binoculars

DATE DUE	ISSUED TO
1/4/71	Ra Kelnis Greenhurst
16/7/71	Walter Sh... NF
27/8/71	Paul Petterson
Apr 11/72	J McLeimie
July 18/72	Peter Kirk 23 Oxford Cres Amherst View Ont
15/3/73	H Koller 833 Grace St Newmarket.
1/3/74	Mrs. E. Beveridge Porcupine Plain Sask
16/4/75	Barry Matthews Ottawa
10/11/75	Dennis Durst Port Elgin NOH 2C0
15/5/76	Peter Kirk, 618 Pinewood St OSHAWA, Ont L1G 2S4