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AMERICAN ASSOCIATION OF VARIABLE STAR OBSERVERS

ABSTRACTS

OF

PAPERS

PRESENTED AT LIMA MEETING

1 JUNE 1968

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PAGE

187 Concord Avenue, Cambridge, Massachusetts 02138

AAVSO ABSTRACTS
Edited by R. Newton Mayall

The 57th Spring meeting of the AAVSO was held in Lima, Ohio at the kind invitation of the Lima Astronomical Society, on 30 May - 2 June 1968. This was one of our largest meetings. Over a hundred of us gathered to celebrate Leslie C. Peltier's 50 years of monthly reports -- 600 continuous reports to the AAVSO. Surely, this makes Leslie the dean of all observers.

Members began to gather on Thursday 30 May. That evening about 22 of us visited the home of Carolyn and Don Hurless to spend the evening with Leslie. The evening was climaxed by a composition written by Don Hurless, which he played with Carolyn.

Observing was not too comfortable, for Ohio had been inundated with rain for several days. The fields, farms, and the Hurless' backyard were flooded. However some donned rubber boots and went out to observe anyway.

On Friday 31 May, those who have been making charts held a meeting to settle some questions of format and delineation. Brady's scale of images was adopted. The business meeting was held in the afternoon. In the evening, Leslie Peltier talked to us about the early days of the AAVSO, the types of observations, the members he knew, and about his own work which has culminated in the gift of a 12-inch Clark refractor complete with building, which formerly belonged to Miami University in Oxford, Ohio.

At the last minute he received a letter from a former member Howard O. Eaton, Recording Secretary during the early 1920's. This he read to us. Following his talk, we drove to Delphos, Ohio, to Leslie's home. After looking over his famous "beehive" observatory, from which he made so many observations, discovered many comets and novae, we had a chance to look through his 12-inch, after which we went to his lovely home and partook of coffee, cake, and just plain talk, into the wee hours.

Saturday 1 June was given over to papers, with a break for lunch at the Schoonover Observatory. Over a hundred attended the banquet. Leslie Peltier was presented with a scroll from the AAVSO; and a painting by William Close of Decatur, Georgia which was commissioned by the Astronomical League and presented by Russell Maag. This was followed by a talk by Tommy Cragg, after which we all sang a song to Leslie with the words by Carolyn Hurless to the tune Anniversary Waltz. A humorous sketch based on a Gilbert & Sullivan operetta was given by Charles Good and Frank DeKinder.

Sunday was a beautiful sunny day to depart.

We were happy to see so many faces from the Midwest. Others came from Florida, California, Georgia, Massachusetts, Connecticut, Minnesota and Missouri. But the honors for the longest distance go to the Bridgens--they came from Victoria, B. C.; and the Craggs and Claude Carpenter from Los Angeles.

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PRELIMINARY RESULTS FOR MWF 361, by Leif J. Robinson

During the past year I have examined 33 variables in the southwest quadrant of MWF 361. The entire field covers roughly 120 square degrees, principally in Ophiuchus but also in Scorpius and Serpens. Each star was observed on about 200 Harvard plates, 45 minute exposures with the 10-inch Metcalf camera at Boyden, South Africa.

The pioneer investigation of MWF 361 was by Mrs. Emily Hughes-Boyce at Harvard, who discovered the bulk of the 150-odd known or suspected variables. Recently, T. D. Kinman, C. A. Wirtanen, and K. A. Janes added 35 more likely variables in the center of the field from plates taken with the 20-inch astrograph at Lick Observatory.

The aims of my program are:

1. To give elements and classifications for all stars or to improve existing data.
2. To provide finder charts, sequences, and light curves.
3. To check the computer-derived elements by Kinman and his colleagues to determine if their program is sufficiently comprehensive. This is practical since they used only 34 plates for most stars.
4. To provide detailed O-C diagrams for RR Lyrae stars.

Among the six stars mutually studied by Kinman and his associates as well as myself, periods could not be found for two. The computer-derived period for their Variable No. 7 was found to be definitely wrong, leading to a light curve that resembled an RR Lyrae star of type "c". Actually, the star is a W Ursae Majoris eclipsing binary.

A close examination of the Lick observations revealed a possible cause of the mistake. Basically, a computer searches for a period by trying different values, selecting the one that gives a light curve

surface of the eye.

In general, if we wish to find the illumination at a point, or more correctly, the luminous flux received by an object, we have to find the flux density and integrate over the area. Hence the limit depends on the area of the objective, which, for a circular aperture is πr^2, for the radius is directly involved.

This is the rationale behind the inclusion of the aperture in the formula.

Now, in this survey, I would like to investigate some of the factors which will affect the limit of our telescopes. The factors I chose were aperture, magnification, star field, and local conditions. In addition to this, I have requested the age of the observer, since the physiological conditions are important in the detection of faint objects. All of the material obtained will be plotted and the results will be used to see if a formula can be derived empirically.

It would be appreciated if fields would be used which are near the zenith, where the absorption due to the atmosphere is at a minimum, and that the eye be dark adapted for at least twenty minutes since the eye must adapt itself to a new field level. (The data required is given below. ED)

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LIMITING MAGNITUDE SURVEY

Name ____________________

Address ____________________

Age ____________________

Star Field used ....

Aperture ....

Focal Length ....

F.L. (eyepiece) ....

Magnification ....

Faintest Star seen ....

Local conditions (use "good" or excellent conditions for survey.) ....

Length of times eyes dark adapted before making observation. ....

Comments:

Send your report to: Roger S. Kolman, 1245 N. Kostner Avenue, Chicago, Illinois 60651.

NEW OBSERVATIONS OF SW CYGNI, by Lawrence Hazel

Last year I was fortunate in selecting to observe the Algol type binary SW Cygni, which has a period of about 4.6 days. Its primary eclipse is of 12 hours duration with a two hour period of totality at minimum. The magnitude range of this eclipse is from 9.3 to 11.8. Since this eclipse is of fairly long duration, an observing period of not less than six hours was found to be needed.

I had calculated times of minima from outdated 1909 elements given in the 1958 Moscow General Catalog of Variable Stars, but it was soon apparent that eclipses were occurring nearly seven hours after predicted times. With this information and more recent elements from Rocznik International Supplement provided by Marvin Baldwin, I determined new predicted times of future eclipses and set out to observe them. In all, I obtained useful data on three eclipses last year:

I. With respect to 1958 GCVS elements.

JD 2418440.693 + 4^d.5728386 E

Hel. JD	O-C	E	n
2439640.667	+0^d.294	+4636	22
39704.708	+0 .315	+4650	26
39759.602	+0 .335	+4662	17

065107	BG Mon	d,e	W	1,2	F
065510	BI Mon	e	W	1,2	F
070619	SY CMa	d	S	1	S
072820b	Z Pup	e	HCO,W	1,2	F
072820a	X Pup	e	HCO,W	1,2	F
073400	GK Mon	d,e	W	1,2	F
073914	BE Gem	b,e	S	1,2	S,F
075320	BP Gem	e	W	1,2	F
081710	GG Hya	d	W	1,2	F
083013	UY Cnc	d	W	1,2	F
085202	WW Hya	d	W	1,2	F
085300	TU Hya	b,e	W	1,2	C,F
085518	SY Cnc	d,e	C	1,2	C,F
091104	UZ Hya	b,d	S	1,2	S,F
093320	ST Hya	d	S	1,2	F
101806	X Sex	d	S	1	F
105802	SX Leo	b,d	S	1,2	S,F
111000	TT Leo	d	S	1,2	F
115903	TZ Vir	d	S	1,2	F
122917	U Crv	d	S	1,2	F
123517	V Crv	d	S	1,2	F
130105	YY Vir	cd	S	1	F
134000	WZ Vir	cd	S	1,2	F
135304	SY Vir	d	W	1,2	F
142204	AE Vir	d	W	1,2	F
152703	WW Ser	d	W	1,2	F
155420	AH Ser	d	W	1,2	F
155502	BC Ser	d	W	1,2	F
160710	DN Her	d	W	1,2	F
162623	DO Her	d	W	1,2	F
165007	V970 Oph	d	W	1,2	F
165504	V855 Oph	d	W	1,2	F
171904	V759 Oph	b,d,e	W	1,2	L,F
175423	FU Her	d	W	1,2	F
181512	V450 Oph	d,e	W	1,2	F
182604	TY Oph	d	S	1,2	F
182916	DS Her	d,e	W	1,2	F
185316	EU Aql	b,e	W	1,2	L,F
190017	V338 Aql	d,e	W	1,2	F
192201	TU Aql	d	HCO	1,2	F
193312b	LS Aql	d	W	1,2	F
193312c	V343 Aql	d	W	1,2	F
195818	TX Sge	b,d,e	W	1,2	L,F
200209	HI Aql	b,e	W	1,2	L,F
200706	TV Aql	d	HCO	1,2	F
201209	RU Del	d,e	W	1,2	F
201207	QZ Aql	d	W	1,2	F
202512	RX Del	b,d,e	W	1,2	L,F
202509	RY Del	b,d,e	W	1,2	L,F
202611	RZ Del	b,e	W	1,2	L,F
203513	SS Del	b,d,e	W	1,2	L,F
204104	BR Del	d,e	W	1,2	F
210408	Z Equ	d	W	1,2	F
214306	EV Peg	d	W	1	F
215247a	LX Cyg	e	HCO(?),S	1,2	F
215247b	LY Cyg	e	HCO(?),S	1,2	F
215445	MP Cyg	e	HCO(?),S	1	F
215545	MS Cyg	e	HCO(?),S	1	F
215813	DG Peg	d	W	1	F
223809	CSV5598 Peg	d	W	1,2	F
233109	FF Peg	d	W	1,2	F
234315	DL Peg	d	W	1,2	F

* W = J.L. Woods, 12" refl.
S = Scovil (Stamford Obs'y)
HCO = Harvard Obs'y

** C = Cragg
F = Ford
L = Lucas
O = Olivier, sketch only
S = Scovil

TABLE II.

REVISIONS AND/OR EXPANSIONS OF EXISTING CHARTS:--
STANDARD PENCIL-TRACED COMPLETIONS AS OF MAY 1, 1968

Design.	Name	New Chart Types	Original Chart Source *	Notes re New Chart(s)
010621	X Psc	e	d;C	Field stars added.
020356	UV Per	f	e;A	Expansion.
041813	AH Eri	d,e	d;C	Expansion.
042625	UZ Tau	f	e;Li	Expansion. First plot from photo.
050130	RW Aur	d,e	d;Li	Expansion. Field stars added.
052036	W Aur	f	e;A	Expansion.
052034	S Aur	e	d;A	Expansion.
053920	Y Tau	c	H	Revised sequence.
055716	RR Ori	d	H,A	Revised sequence, from Olivier.
060443	RR Aur	d	c;A	Expansion, revised disc scale.
060547	SS Aur	e	d;A	Expansion, revised disc scale.
061115	CZ Ori	e	d;A	Expansion, revised disc scale.
061317	UY CMa	bc,d	d;Z	Re-plot from new photos (Scovil).
061417	UZ CMa	bc,d	d;Z	ditto.
071026	WZ Gem	d	d;A	Revised disc scale.
072404	RX Mon	d	c;C	Expansion. Field stars added.
072811	T CMi	e	d;A	Expansion.
072820b	Z Pup	e	d;A	Expansion, sequence revision from Olivier.
073234	ST Gem	e	d;A	Expansion, revision of disc scale.
080428	YZ Cnc	d+	D	Sequence revision, field stars added.
081935	X Lyn	d	c;A	Expansion, disc scale revision.
082953	SW UMa	e	d;A	Expansion, disc scale revision.
085518	SY Cnc	d,e	d;A	Expansion, disc scale + sequence revision.
092421	TU Leo	d	d;C	New Photo (Scovil), field stars added.

093720	RS Leo	d	c;A	Disc scale revision.
114003	TW Vir	d	d;A	Re-plot, field stars added.
122402	3C-273 Vir	b,d	b;C	Re-plot, expansion.
164025	AH Her	e	d;C	Expansion, field stars added.
181031	TV Her	e	d;A	Expansion.
181141	V533 Her (N1963)	d	p;A	Expansion, addition of ltrd comp. stars.
183138	LL Lyr	d,e	d;C,Li	Expansion, addition of faint comp. stars.
184137	AY Lyr	e	d;A	ditto.
184826	CY Lyr	e	d;C	ditto.
185032	RX Lyr	f	e;A	Expansion.
194326	Nv Vul 68	a,b	p;A + b;C,H	Expansion, addition of fainter comp. stars.
195109	UU Aql	e	d;A	Revision, expansion.
195553	V476 Cyg	f	e;A	Expansion.
203718	Nv Del 67	b	p;A + b;A	Expansion, additional field stars.
204846	RZ Cyg	e	d;A	ditto.
213742	Q Cyg	b,f	b;A + f;CB	Re-plot, to standard chart form.
222924	SS Peg	d	c;C	Expansion, field stars added.
235053	RR Cas	e	d;A	Expansion.

* C = Cragg (Mt. Wilson) chart
A = AAVSO blueprint
Li = Lick Obs'y photo
H = Hagen chart

* Z = RASNZ chart
D = Darsenius chart
CB = Earl of Crawford chart
p = provisional

TABLE III.

NEW PENCIL-TRACED CHARTS WITHOUT SEQUENCES, FROM MT. WILSON PLATES:-- COMPLETIONS AS OF MAY 1, 1968.

Design.	Name	New Chart Types	Period	Notes
005427	W Psc	d	189	Plate damaged.
011638	TX And	d	233	
011724	TZ Psc	d	?	
012031	TY Psc	d,e	(UG)	Partial sequence OK.
012746	SX And	d	335	ditto.
224517	SX Peg	d,e	307	
235255	WY Cas	e	477	

PHOTOGRAPHY FOR CHART MAKING, by Charles E. Scovil

With construction of a camera to go with the Stamford Observatory 22" Maksutov Telescope, requests for programs were made. Clinton Ford suggested trying to rephotograph the field of UZ - UY Canis Majoris, an old AAVSO chart which was impossible to use because of lack of background stars.

Several photos were taken, and comparisons made with the original chart, and with provisional charts by Mr. Ford. There was no correlation whatever. A separate camera of 24" focal length was constructed for a wide angle view. Enlargements from its plates provided the key to the Ford charts. There was an error in scale when comparing with the photos taken with the 22".

This pointed out the need to construct a prime focus camera mechanism for the 22", which was done. This gives a relatively wide field of 3.5 degrees by 5 degrees, sufficient to cover a B chart. On a 5" x 7" plate, the plate scale is such that enlargements may be made up to an E chart scale.

Successful photos of the UZ - UY CMa field with the new camera setup prompted Mr. Ford to propose photographing fields covered by data from the Charles Olivier work. This was undertaken with the results mentioned by Mr. Ford in his paper.

John Bortle requested photos of Comet Ikeya-Seki 1967n. These were supplied, and Mr. Bortle has discovered from them that the comet has developed two tails, as well as determining precise positions for the comet.

With the advent of the comet discovered in Andromeda by three Japanese astronomers a program to photograph it was undertaken. A new wide angle camera using an f4.5 lens of 13".5 focal length was constructed to try to get better general coverage. This proved to be just barely sufficient to get photos which can be enlarged to a B chart scale, but shows that anyone with a camera of about 12" focal length or more can do useful work in this field. A focal length of 24" to 48" would give quite sufficient plate scale for B charts, and the longer focal lengths would permit enlargement to D scale.

PROGRAM FOR OBSERVING RR LYRAE TYPE VARIABLES, by Marvin E. Baldwin

As far as I know visual work as a source of information for RR Lyrae type stars has been almost totally neglected in this country. Although the visual magnitude range of these stars is small (almost always less than two magnitudes and often less than one magnitude) an analysis of a portion of some 12,000 observations by Robert Monske and myself forcefully illustrates the value of such observations.

It has already been determined from the limited work accomplished that visual work can be used to determine the following:

(1) To establish O-C values to a degree of accuracy comparable to that which can be established for eclipsing variables. Simple visual observations, made in quantity by a number of observers, could serve to establish a year to year record of the stability of the period for many stars. If the data are reduced and published promptly professional astronomers would have early warning of any major changes of period.

(2) To determine for each star the degree of deviation the individual light curve of each maximum may make from the normal light curve. Data on hand show clearly that most RR stars probably have some deviations from the normal light curve and that in some cases the deviations are extreme. Prime examples of this are VX Hya which sometimes fails to have a maximum and SZ Hya which never has a real maximum which resembles that indicated by the normal light curve. The normal light curve, which is usually the only one available to astronomers falsifies the record and misleads everyone as to the star's activity. Visual observations made at short intervals fully illustrate why.

(3) To establish a permanent record of the activities of a large number of the brighter RR stars.

With these things in mind I propose that the AAVSO should establish at the earliest practicable date a program to seriously observe the RR Lyrae type stars with the prime objective being to make more information about the behavior of the stars available with the hope that we may eventually contribute to a better understanding of the nature of their pulsating mechanisms.

If the AAVSO sees fit to establish an RR Lyrae type variable observing program the chairman for such a program should be responsible for co-ordinating activities to meet the following program requirements:

(1) Charts: There are now 34 charts available for some of the brighter and more interesting RR stars. However, almost all of these have been drawn via direct observation at the eyepiece and the charts therefore contain the expected number of position or distortion errors. These charts lack standardization of scale from one chart to another. Recommend standardization by obtaining photographs of the field of each RR star Each photograph should be of sufficient quality and of known scale to allow accurate measurement of star positions. All charts will require visual confirmation with special care to establish proper relative star disks sizes due to differences in visual and photographic representation of brightnesses.

(2) Sequences: The sequences for the comparison stars on all charts now available have been determined visually at the eyepiece. With some exceptions these sequences have proven to be fairly good for visual observing purposes. However, good photometric sequences in the visual range are definitely to be preferred. Recommend that an effort be made to obtain reliable photometric sequences for all program RR stars.

(3) Predictions. Prediction of maxima for RR stars is not a strict requirement for a successful observing program. However, current status of the overall analysis of the reduction of observational data indicates that a concentration of observations starting at a point slightly before the beginning of the rise to maximum and terminating an hour or two after maximum is highly desirable for defining the mean light curve and for establishing deviations from the mean curve. Recommend that the computerized prediction service now in effect be retained with distribution to observers as necessary.

(4) Observing: Obtaining accurate observations of RR stars is an arduous task and must be approached with the understanding that it will not be easy. The brightness ranges of many RR stars are small and therefore very unforgiving of small observational errors. Due to the nature of the light curve an individual observation of an RR star is seldom of any value. The observer should always plan to run a series of observations during the course of an evening -- the longer the better. Useful observations may be made at intervals varying from one hour to less than five minutes, in rare cases, depending upon the light curve characteristics of the star observed. The observations that an individual obtains will become considerably more valuable when he or she obtains some 200 to 300 or more observations on the star because this will allow the establishment of a mean light curve against which each night's observations may be compared. In this case lone observations should be retained because they may yield valuable information when compared to the mean light curve. It is too early to tell exactly what long-range observing program by the individual observer would be most effective, but for most RR stars an observing

program which obtained from 200 to 300 observations for each of three consecutive years followed indefinitely by observations of three maxima each year should serve to define the star's activity very well. Recommend that each would-be observer be thoroughly briefed on the magnitude of the task that he may be undertaking and further recommend that no great reliance be placed on an individual's observations until he has become well seasoned in the observation of RR stars and established a broad observational base sufficient to demonstrate that his observations are reasonably free of erratic influences.

(5) Analysis: Reduction of data can be done by hand, but proves to be extremely laborious when large numbers of observations are involved. Recommend that a computer program be developed which can establish a mean light curve for each observer's observations on any one star. O-C values for each maximum can be established by comparing individual nights' observations against the mean curve. Deviations from the mean curve (Blashko Effects) will be of particular interest and may be sufficient reason to alter observing goals.

(6) Publication: Publication of findings remains largely an open question. I have been advised that probably the best place to publish this information would be in the Russian publication Variable Stars. The Information Bulletins on Variable Stars might also be considered as a means of publishing some of our findings. I would expect to remain in contact with those astronomers at the Astronomical Observatory of the Jagellonian University in Cracow who publish the Rocznik Yearbook with ephemerides for eclipsing variables and RR type variables. This would enable them to use our most recent data to keep their ephemerides up to date.

The individual who coordinates the activities of the RR program should understand that at best, a period of two or three years will be required for the program to evolve from the early stages of the development of charts and establishment of procedures to a period of high production.

In some respects the establishment of an RR program is a step into the unknown. I have outlined what I consider to be the basic requirements of an RR observing program, but my experience level is limited and our findings may sometimes cause confusion relative to the necessity for making alterations in the program. For this reason I feel that a technical advisor with a good understanding of the problems involved and with well established contacts with other professional astronomers versed in the subject is necessary to assure that we obtain the greatest amount of results for our efforts.

PHOTOGRAPHY OF LONG PERIOD ECLIPSING BINARIES, by Carl A. Anderson

My experience has shown that it is much more difficult for me to obtain sharply defined, low scatter, curves of minima for those eclipsing variable stars whose curves offer the following problem conditions:

1. High apparent brightness, requiring the selection of comparison stars somewhat distant from the variable and requiring low power wide field instruments, or naked eye estimates.

2. Longer than average period, resulting in slowly changing apparent magnitude. This is further complicated if most of an entire night must be used to obtain a good minimum, since in New Hampshire there are relatively few nights available to an amateur which will be clear for a sufficient length of time. The result frequently is a waste of four hours or more with nothing to show for the effort.

I believe that I have now found a convenient method for overcoming all of these obstacles which can be used by most amateur observers.

The method is simply to take short, guided exposures of the variable and its field using a good 35 mm camera, a fast 50 mm lens and one of the new fast color films such as high speed Ektachrome, or similar. By using a fast lens, high speed film and a sidereal drive for the mounting, the necessary requirements for data gathering can be met.

For example, in the case of Algol, a one minute exposure at f1.8 on high speed Ektachrome is excellent. Guiding effects become unimportant and the use of a motor driven mount keeps the star field location and orientation in the frame sufficiently the same for the entire series, so that optical distortions, vignetting, etc. can be ignored.

Short wave radio time signals are used to start and stop exposures. Since the exposure is so short in comparison to the period, the error due to using mid-time of exposure is so much less than other errors, that it can be ignored.

It is obvious that this method is usable only for timing eclipsing variables where the concern is with changes in brightness without regard for actual estimates of the apparent brightness in absolute terms.

Once the films have been taken and processed as slides, an ordinary slide projector and screen are used to develop the light curve. Each slide must be marked with the appropriate data, especially date and times for exposure.

surface of the eye.

In general, if we wish to find the illumination at a point, or more correctly, the luminous flux received by an object, we have to find the flux density and integrate over the area. Hence the limit depends on the area of the objective, which, for a circular aperture is πr^2, for the radius is directly involved.

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LIMITING MAGNITUDE SURVEY

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Address________________

Age____________________

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Aperture ....

Focal Length ....

F.L.(eyepiece) ....

Magnification ....

Faintest Star seen ....

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Hel. JD	O-C	E	n
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39704.708	+0 .315	+4650	26
39759.602	+0 .335	+4662	17

ments of best seeing can be utilized.

no real loss of detail because of the extra surface in the optical system... in moments of best seeing the projection system with a 4-inch objective gives resolution to at least one second of arc.

a chance to do valid experimental research on solar telescope design... Good seeing often comes after a cumulus cloud has just come off the sun. While it covered the sun it also stabilized the air column over the optical path.

There is much to be learned about the ways to shield the telescope tube, the mirror, and the shack from thermal distortion. Mere shields help. Better are the air-ventilated shields used by Bray in Australia. The Zeiss solar telescope is halfway between a plain screen and the Bray system.

With even partial thermal control by shields etc., the times of best seeing approach meridian passage. The idea that the air is best early in the morning may be a statement about optical design rather than about the atmosphere.

(Illustrated by 35mm color slides of the solar telescope of the Joseph Meek Observatory in Haddam, Connecticut.)

CALCULATIONAL PROGRAMS FOR OBSERVERS, by John W. Northrip

Certain calculational procedures have been worked out for such problems as conversion from Julian day and fraction to date and time, predictions for time of observance of periodic phenomena, etc. Using these procedures calculational programs have been devised to use on desk calculators, the Underwood Olivetti Programma 101 desk top computer, and the Fortran Language. (General concepts and programming problems were discussed. ED)

LIMITING MAGNITUDE, by Roger S. Kolman

Previous to this effort, I have presented two papers to the AAVSO on limiting magnitudes for amateur telescopes. The first was in 1964 and described the curve obtained when the magnitudes seen by twelve observers were plotted against the linear aperture of the telescopes used. Comparing these data to the curve obtained with the conventional formula ($M = 9 + 5 \log D$; where M is the faintest star seen, and D is the linear aperture in inches), it was seen that a net translation of one magnitude upward would be required for the two curves to match. This would mean that the formula should be more along the lines of $M = 10 + 5 \log D$.

In 1966, after correspondence with Tom Cragg, another paper was written using the formula derived by Ira Bowen: $M = 2.5 \log D + 2.5 \log P + C$; where P is the magnification and C is a constant. In this form, the faintest star seen depends on the magnification up to the limit of useful magnification (about 40X per inch). This involvement of the magnification is, basically, a term which involves the contrast between the illumination on the eye from the star and the background "noise" from the sky.

Since this problem is of special interest to me, I have chosen it as the topic for my Master's thesis. I plan to approach it both mathematically and experimentally. The information I have at this time will be presented here along with a form for observational contributions which I hope will be forthcoming as I need much data for this project from as many observers as possible.

The problem basically is one of the amount of energy which will be required to stimulate the rods and cones of the eye and how the focusing of the incident light energy stimulates the eye.

If we arbitrarily choose a system of scaling the brightness of stars, we choose the standard which will be used. The convenient system which we are all familiar with is that of the magnitude. It has been determined by Fabry that the illumination at the earth's surface by a star of 1st magnitude at the zenith on a clear night is 8.3×10^{-7} lumen/meter^2. Since the magnitude scale has been set up in such a way that the ratio of successive magnitudes is the fifth root of 100 or approximately 2.5, the illumination produced by a star of magnitude m is

$$E_m = E_1 \left(\frac{1}{2.5}\right)^{m-1} \qquad \text{where } E_1 = 8.3 \times 10^{-7} \text{ lum/me}^2$$

Marriott has shown that the threshold for human vision is, in the laboratory (using white light), on the order of 4×10^{-9} lum/me^2, so solving the problem backwards for m, we come up with 6th magnitude for the accepted value. However, he had found that this limit varied from 0.8×10^{-9} lum/me^2 to 11×10^{-9} lum/me^2, or some persons can see stars substantially fainter than sixth magnitude. In fact, Russell found that under optimum conditions, star of magnitude 8.5 could just be seen.

When using the naked eye, all the light which is perceived is that parallel light which strikes the area of the fully open iris which has a diameter of about 7mm. When we use a telescope, however, the entire aperture (clear) of the scope gathers light, then focuses it on the pupil so that more photons strike the

surface of the eye.

In general, if we wish to find the illumination at a point, or more correctly, the luminous flux received by an object, we have to find the flux density and integrate over the area. Hence the limit depends on the area of the objective, which, for a circular aperture is πr^2, for the radius is directly involved.

This is the rationale behind the inclusion of the aperture in the formula.

Now, in this survey, I would like to investigate some of the factors which will affect the limit of our telescopes. The factors I chose were aperture, magnification, star field, and local conditions. In addition to this, I have requested the age of the observer, since the physiological conditions are important in the detection of faint objects. All of the material obtained will be plotted and the results will be used to see if a formula can be derived empirically.

It would be appreciated if fields would be used which are near the zenith, where the absorption due to the atmosphere is at a minimum, and that the eye be dark adapted for at least twenty minutes since the eye must adapt itself to a new field level. (The data required is given below. ED)

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LIMITING MAGNITUDE SURVEY

Name________________

Address________________

Age________________

Star Field used ....

Aperture ....

Focal Length ....

F.L.(eyepiece) ....

Magnification ....

Faintest Star seen ....

Local conditions (use "good" or excellent conditions for survey.) ....

Length of times eyes dark adapted before making observation. ....

Comments:

Send your report to: Roger S. Kolman, 1245 N. Kostner Avenue, Chicago, Illinois 60651.

NEW OBSERVATIONS OF SW CYGNI, by Lawrence Hazel

Last year I was fortunate in selecting to observe the Algol type binary SW Cygni, which has a period of about 4.6 days. Its primary eclipse is of 12 hours duration with a two hour period of totality at minimum. The magnitude range of this eclipse is from 9.3 to 11.8. Since this eclipse is of fairly long duration, an observing period of not less than six hours was found to be needed.

I had calculated times of minima from outdated 1909 elements given in the 1958 Moscow General Catalog of Variable Stars, but it was soon apparent that eclipses were occurring nearly seven hours after predicted times. With this information and more recent elements from Rocznik International Supplement provided by Marvin Baldwin, I determined new predicted times of future eclipses and set out to observe them. In all, I obtained useful data on three eclipses last year:

I. With respect to 1958 GCVS elements.

JD 2418440.693 + $4^d.5728386$ E

Hel. JD	O-C	E	n
2439640.667	+0^d.294	+4636	22
39704.708	+0 .315	+4650	26
39759.602	+0 .335	+4662	17

II. With respect to Rocznik elements.

JD 2438264.160 + $4^d.57302$ E

2439640.667	$+0^d.028$	+301	22
39704.708	+0 .047	+315	26
39759.602	+0 .064	+327	17

From these observations I have derived $4^d.57316$ as the new value of the period, which is 26 seconds longer than that stated in the 1958 GCVS. Leif Robinson recently provided me with four previous observations of minima from 1958 which are about 2.5 hours late. Apparently no other observations were made until last year when I found minima coming seven hours late. From the data available I have constructed an O-C diagram, which shows that the period change occurred in 1955, although a more accurate value could have been determined if there were observations between 1909 and 1958. Observations in the future are needed to confirm the large variation and to check the new value of the period.

A chart and eclipse predictions will be made available to anyone contacting me who is interested in observing this star. (Address: 1234 - 89th St., Niagara Falls, N.Y. 14304)

LIGHT CURVE OF BETA LYRAE, by Donald Henning

Beta Lyrae is an eclipsing binary with a period of approximately 12.9 days. It is a unique system and possesses strange properties that have plagued astronomers since its discovery by Goodricke in 1784. Perhaps the most remarkable property of the beta Lyrae system is its apparent steady increase in period of about 19 seconds per year. This change is evidently due to the rapid evolution of this system. Some astronomers speculate that this rapid evolution is due to the exchange of gas between the two components, which causes an envelope of gas to develop around the system. The components consist of a giant B8 star and probably an F star which is undetectable by spectroscopic analysis because of this envelope of gas obscuring it.

Many astronomers believe that the components are elongated, due to tidal forces, each in the direction of the other. This relationship is maintained by the equality of the period of rotation and revolution, which is known as synchronization. The effect of the ellipticity is conspicuous because the two stars are nearly in contact. Furthermore, the inner hemispheres of the stars are brighter than the outer. Beta Lyrae's gas streams cause: 1) variations in luminosity from cycle to cycle, 2) the unequal heights of maxima, known as the O'Connell effect, and 3) the asymmetry of the light curve.

At Hickox Observatory our group has been running beta Lyrae photoelectrically since April of 1967. In that time, we have obtained nearly 50 points for the composition of our curve. We used a 1P28 phototube with a ten inch off axis Cass. The phototube was used without a filter, being sensitive between 3,800 to 4,000 Angstroms.

The Hickox curve of beta Lyrae differs in some aspects from that of the Lick and Stebbins curve. In the Lick curve, the primary is asymmetric, i.e. the decline being steeper than the rise. The Hickox curve is also asymmetric with the rise being steeper than the decline, and the secondary decline being steeper than the rise. In the Lick curve, the depth of the primary is about .84 mag. and the secondary about .30 mag. The Hickox curve shows a depth of about .80 mag. for the primary, while the secondary is only about .30 mag. Neither the Lick or Stebbins curves give very definite information regarding the bottom of the secondary eclipse. The Hickox curve shows the bottom of the secondary definitely flat, with many points to validate this, but the bottom of the primary is questionable. The Lick curve shows the first maximum slightly higher than the second. Our curve agrees with Stebbins in that the second maximum is higher.

In conclusion, I would like to quote from the Henry Norris Russell Lecture in 1958. "Since the discovery of its changes of brightness, beta Lyrae has been observed by many hundreds of astronomers. The astronomical literature records more than 200 published investigations of this star. Several thousand spectrograms have been obtained at a dozen or more observatories; tens of thousands of photographic and photometric observations have been secured all over the world, and there must be in the files of observatories hundreds of thousands, IF NOT MILLIONS, of visual estimates of the light of this star. It is no exaggeration to say that millions of dollars have been expended during the past century and a half toward the solution of the riddle of beta Lyrae."

BUILDING A REPUTATION, by Richard H. Davis

A short discussion of the precautions necessary for success in observing grazing occultations was followed by the playing of a tape recording made on a grazing occultation expedition showing the disastrous results flowing from the failure to observe those precautions. (The tape recorded all conversations between the various members of the expedition as they approached Davis. And it was a COLD night. ED)

U GEMINORUM, by Ron Thomas, Thomas Cragg, David Brin

Three observed minima of U Gem on 26-8 December 1967 indicated to us that something unusual was happening. In studying other minima of U Gem it became clear that a period change might be taking place. At this time it was decided by the authors to study several aspects of this star. It is the purpose of this paper to present the following points about U Gem: 1) The light curves; 2) The period change; 3) Establishing a period for eruptions.

SECTION I - THE LIGHT CURVES

The light curves of U Gem present many unusual features, including the fact that no two eclipse(light) curves are exactly alike. There are, however, basic types of curves that make an interesting study. The first of these is the "clean eclipse." The pattern shown for this class has a quick drop and recovery with little scatter apparent (Type I). Type II has a quick drop and a slow and sometimes messy recovery. Type III has a slow, and sometimes messy, drop and recovery. The Type IV eclipse is similar to Type III except that there is no recovery observed within about 30 minutes. An eclipse that starts faint and is fainter than 14.4 throughout a 30 minute period centered on the predicted time of minimum is a Type V eclipse. The last and sixth type of eclipse is one that continually and rapidly changes brightness. There is no one point that can be called a minimum since two or more deep points usually appear on the curves that could be called the time minimum.

These classifications are based on the shapes of the light curves that we possess.

In determining the times of eclipses light curves of types I and II are desirable since there exists a well defined point on the curve where the time of an eclipse can be precisely determined. Light curves of types III and IV produce usable times of minima but they are not as accurate as those of types I and II. Eclipses of types V and VI are not usable since no one place on the light curve can be easily defined.

There were two criteria used for determining the time of the eclipse minimum. Timings for eclipse cycles 0 through 2217 came from an article by Krzeminski on U Gem in the October 1965 Astrophysical Journal. The criteria used by Krzeminski is as follows: The time of minimum is taken to be the time midway between the times of the half-way point of the drop and the half-way point on the recovery. The observed minimum of eclipse cycles 2,961 through 13,040 is established by taking the faintest point on the light curve after the initial drop.

There appears to be no appreciable error introduced by combining these methods of determining the times of minima. The evidence to support this comes from SLF 4 and SLF 6 runs on the GE 225 computer. The two runs considered first cycles 0 through 2217, which gave a certain period change. The second run considered cycles 0 through 12,531, which gave virtually the same results as before.

Results of Error Analysis of Criteria

Program	Cycles	Change in Period
SLF 4	0-2217	-0.266×10^{-6}
SLF 6	0-12531	-0.258×10^{-6}

The difference in the "Change in Period" is eight parts in 10^9. This difference is too small to be considered in this paper. Therefore the times under both standards have been combined and worked on together.

There is one other aspect concerning the light curves that merits attention. This phenomena is the shape of the curve versus the time after an eruption. The hypothesis advanced by Thomas Cragg is that the eclipses approach a type V light curve as time progresses between eruptions.

At present we have only enough data to cover four eruptions with a sufficient number of light curves to draw any conclusions. The general pattern is that the curves go from types I and II to type III fairly quickly and then eventually to type IV and occasionally to type V. The pattern spends most of the time in type III curves. Very few of all the eclipses are of type I, most of them being type III. The data derived is definite support of Thomas Cragg's hypothesis. However, more data is needed in order to draw a definite conclusion.

SECTION II - THE PERIOD CHANGE

In studying the period change of an eclipsing binary star, the principal consideration is the O-C versus the time after initial epoch. For this study we used the O-C versus the number of cycles after the initial timing. This made it easy to get the program on the GE 225 computer at San Fernando Valley State College in Northridge, California.

In U Gem some 13,200 cycles had elapsed by May 1968 since the initial epoch of 4 December 1961. In

October 1965 Krzeminski published 2437638.82704 + 0.17690591E with ±.00004 as the allowable error. At the present time we have observations of 110 eclipses. These observations are from the October 1965 Astrophysical Journal and six observers of the AAVSO. The eclipse cycles 0-2217 came from the Astrophysical Journal and the remainder from the AAVSO.

The approach used in studying the period change is a straight line fit through a series of points. To do this it was necessary to get each observed timing in the form of an integer number (E) paired with its O-C. The integer number is the number of cycles between the initial epoch and the particular eclipse. This enabled us to make a graph of O-C vs cycles. With this information it was possible to program the GE 225 computer (mentioned earlier) to work the problem. The program used takes a set of points on a graph and finds the best fitting straight line through them. This is the Straight Line Fit (SLF) program. The results of this analysis are shown below.

Results of SLF Analysis for Eclipses

Program	Cycles	No. of Eclipses	Change In Epoch	Change In Period
SLF- 2	2961-12531	26	.0241	-.00000273
SLF- 4	0-2217	27	.000062	-.000000266
SLF- 6	0-12531	53	.0021	-.000000258
SLF-14	0-13040	110	.0038	-.00000125

As additional eclipses were included the calculated line approached more closely to the true "best fitting" line through the points on the O-C vs Cycles graph.

To determine the change of period we used SLF-14 for the final result since it had the greatest number of observations. The new period is 0.17690466. The new epoch is 2439944. Combining these we get the new elements: Time of Minimum is given by 2439944.6197 + 0.17690466 E.

It also was decided to use the SLF program in analyzing the points on the O-C vs Cycles graph between eruptions. The eclipses that occurred between successive eruptions were studied as individual groups. This procedure yielded some interesting results:

Results of SLF 13 Analysis
(A SLF for points on the O-C vs Cycles graph between eruptions)

Cycles	No. of Eclipses	Change In Epoch	Change In Period
215-531	6	.00006	-.00000007
621-819	4	.00047	-.00000082
1691-2064	5	.01104	-.00000646
2081-2217	9	.00299	-.00000130
6562-8027	16	.00040	-.00000038
8050-8659	18	-.22848	+.00002674
8681-9224	21	-.13816	+.00001529
10073-10260	4	3.807	-.00037841
10401-11061	15	-.1445	+.00001169

In the data derived, nine cycles are listed, of which six produce negative period changes. The algebraic sum of the nine eruptions also is negative, implying an overall negative period change which we got from SLF 14.

SECTION III - ESTABLISHING A PERIOD FOR ERUPTIONS

In the 1958 edition of the Russian Catalogue of Variable Stars the average interval of eruptions is listed as 102.96 days. This value is arrived at by use of an averaging technique. The exact details of the averaging technique is not known by the authors, but it probably is similar to ours, described below. In doing a similar study with data on 44 observed eruptions we found the mean interval for eruptions to be 115 days. The averaging technique we used is as follows:

1) Listing the dates for eruptions in numerical order of Julian Date.
2) Calculating the interval between observed eruptions.
3) Looking at these values and deciding whether one or more eruptions may have been missed. (The shortest interval between eruptions was 67 days and the longest was 150 days.)
4) Calculating the total number of eruptions (observed and probable missed ones).
5) Calculating the total time interval.
6) Dividing the time interval (5) by the number of eruptions (4). The result is the mean interval of eruptions.

We used this method as opposed to the one discussed in Section II (the SLF program) because of the extreme irregularity of eruption time intervals.

In this paper we merely attempted to analyze the observational data of U Gem. With the information we have at this time we feel that the results are sound. More data will either confirm or disprove our results. With a star of U Gem's character of irregularity we must admit we have no final word on it. Only time and additional observations will tell the future of this star.

POSSIBLE ECLIPSE WEATHER 1970, by Cyrus F. Fernald

A cooperative project on the study of weather conditions in the vicinity of Perry, Florida is being carried out by David W. Rosebrugh, St. Augustine; Cyrus F. Fernald, Longwood; and M.K. McKinnon, Panama City.

We can draw the following conclusions, based on 1968 weather, from 22 February to 22 March:

Period 1968	% Sky Cloudy	% Days clear around sun
7 March--	0	100
6-7-8 March--	33	67
4-10 March, week centered on 7 March--	43	57
22 Feb - 22 March--	43	58

The weather on 7 March was clear in Panama City, Longwood, and St. Augustine, following a storm on the 5th and 6th.

We now have four independent figures, three of which were reported before.

Report Date	Basis	General Conclusion
1 November 1966	National Weather Records, Perry & Tallahassee, Fl.	50% favorable
17 December 1966	Tyndall AFB, Panama City	64% favorable
10 April 1967	McKinnon,Fernald,Rosebrugh	62% favorable
29 March 1968	McKinnon,Fernald,Rosebrugh	58% favorable

60% favorable seems a reasonable overall estimate. This is better than the 40% estimate for the 1963 eclipse at Athens, Maine, and the eclipse was observed there.

PLANS FOR SOLAR ECLIPSE 1970, By Russell Maag

The Astronomical League is preparing for a cooperative observing effort during the time of the eclipse on 7 March 1970. We have enlisted the aid of several professional solar researchers, as well as many outstanding amateur solar workers. Our committees and chairmen include:- Advisory, Dr. Gordon A. Newkirk, Jr.; Instrumentation, Robert E. Cox; Observing Site Location, Leonard B. Abbey, Jr.; Ephemeris, David Dunham; Ways and Means, Gene Tandy.

The main headquarters will be at Fort Stewart, Georgia. This will be the control center for all League operations. Plans now call for a minimum of 25 observing stations from Mexico to Nantucket Island.

A-SPOTS FROM 1950 TO 1965, by Ralph N. Buckstaff

When observing the Sun, most everyone looks at the large groups. I found very little study had been done on the A-Spots, so decided to see what these orphans were doing.

We see only one side of the Sun, therefore the solar meridians are changing from day to day. I wanted an instrument to find the true longitude of the spots and devised one by getting an aluminum circle, and divided it into 360 degrees. I attached this circle to a square wooden block base with a metal shaft so it could be rotated on a chart showing the degrees as marked off on a Stonyhurst chart. On the face of the circle I marked the degrees from 0 to 360. By taking the central meridian of the Sun from the Nautical Almanac I could set the circle each day on the 0 meridian on the Stonyhurst chart, this would give me the exact position of the spot I was observing.

I then used the cards on which I had recorded all the spots observed since 1950 and found their true position by using this instrument. These spots were then plotted on a large map which I made showing the entire surface of the Sun. The map being marked off in degrees of longitude and latitude. I did this with all the A-spots I observed through 1965, which I found to be 497 in these 15 years.

It made an interesting pattern with the most A-spots in the N.E. quadrant and the least in the S.W. There were three regions, two south of the equator and one north in which more than one spot appeared in exactly the same longitude and latitude. There were twelve regions in the northern hemisphere in which two spots appeared one degree or less apart; and ten regions, five in the north and five in the south,