A A V S O   A B S T R A C T S

Edited by R. Newton Mayall

PAPERS PRESENTED AT THE NANTUCKET MEETING, 14-15 OCTOBER 1966

The 55th Annual Meeting of the AAVSO met on the Island of Nantucket by invitation of Dr. Dorrit Hoffleit, Director of the Maria Mitchell Observatory, and the Maria Mitchell Association. Once more we met on this glorious small island 30 miles off the coast of southern Massachusetts. (The first time, a handful in 1930; and the second time in the Spring of 1958). Perhaps it was because of what everyone said about our last meeting there, a spring meeting, that the members turned out in large numbers for this meeting. There were about 125 registered, which made this one of our largest meetings.

It was evident that many had decided to make it part of their vacations, for they began coming to the island on the Sunday before the meeting. We had beautiful weather and good night skies where the Milky Way looked like clouds.

On Thursday evening many of us gathered at the Observatory for talk and observing, and coffee. We understand Clint Ford didn't get to bed until 3:30 a.m. Friday!

Friday night our evening lecture was held in the Atheneum, where Dr. Harlow Shapley regaled us with an illustrated lecture on the Subject: Cosmic Evolution. It is always delightful to hear Dr. Shapley, and he was in his usual good form this evening.

Bird Walks were arranged for those who wished to participate, on Friday and Sunday.

Saturday morning the business meeting got under way promptly at 9 a.m. and we were ready for papers a little before 11 a.m.

A buffet lunch was served in the home of Mrs. Leeds Mitchell, on Main Street, a charming structure built in the early 1800's. Mr. David L. Carson, the Island Naturalist, prepared the food -- much of which was donated by many of the Islanders.

Our dinner was held in the Jared Coffin House (now a hotel) where the dining room was virtually filled to the walls. After dinner Mr. Edouard Stackpole gave a delightful talk on the history of Nantucket. Mr. Stackpole is the Editor of the Nantucket Inquirer and Mirror which calls itself the largest newspaper in the world -- and I guess it is from the size of the pages.

Sunday morning and afternoon boats were loaded with happy people saying goodbye and expressing their thanks and saying what a wonderful meeting and what wonderful weather. Also we learned that one who was to leave Sunday was ensconced in the Nantucket Hospital. Cyrus Fernald was taken sick late Saturday night. After a few days he was on his way to their Florida home.

We had several far away members present. The Goods and DeKinder from Montreal; the Buckstaffs from Wisconsin; Robert Johnston, from Toronto; Dave Williams from Illinois; the Adamses from Missouri; the Anderers from Chicago; and Marjorie Williams from Washington, D.C., who was accompanied by Dr. Abdullah Kizilirmak, from Izmir, Turkey.

THE KNECHT OBSERVATORY, by Michael R. Meiley

The Dr. George Knecht Observatory is located on South Mountain, Allentown, Pennsylvania. It is approximately 1035 feet above sea level. Being on the grounds of the Lehigh Valley Amateur Astronomical Society it is used by the members of the organization and is also open to the public. The 12' motor driven dome shelters the clock driven 6-inch refractor. The objective was a donation to the Society from Dr. Knecht who made the lens in his younger years. His present age is 93, and he is a member of the Society.

AN OFFSET GUIDED PHOTOMETER, by Arthur J. Stokes

An astronomical photoelectric photometer has these essential components: a finding eyepiece, a focal plane diaphragm, a field lens, suitable filters for color band separation, and a phototube detector. The AAVSO Photoelectric Manual describes a photometer which has two slides, one having three different size diaphragm holes and the other having three color filters for the U.B.V. system.

A more complex photometer has been constructed to incorporate the following features: An offset guiding eyepiece mounted on a movable carriage, rotary discs for the diaphragms and color filters, a radioactive light source for standardization, and a refrigeration box for the phototube.

The offset guiding is accomplished by first setting the eyepiece carriage to the center position. Since the diagonal mirror for this eyepiece has a hole in the center, it is moved parallel to its surface so the hole is displaced from the optical center. This allows a star to be positioned on the optical axis of the system. Switching the mirror back, then allows the phototube to look out through the hole in the mirror, while at the same time the eyepiece carriage may be moved to some other, possibly brighter star in the field for guiding.

The diaphragm disc is located behind the offset mechanism. A second eyepiece and diagonal mirror allow centering of the star in the diaphragm. This diagonal mirror may then be rotated out of the field to allow the star light to pass through the filter disc to the phototube.

To allow positioning of the quartz lens at the proper point behind the diaphragm,it was necessary to mount this lens on the mirror assembly so that as the mirror moves up, the Fabry lens also moves into position. Quartz is used for this lens because of its greater transmission of ultra violet light.

Four different diaphragms are available covering field diameters of approximately 150, 75, 37 and 18 seconds of arc. These values are for a 112 inch focal length F 7 telescope system.

Five color filters are used. Three are for the U.B.V. system with a 1P21 type phototube and the other two are for a V and infra-red system using a 7102 phototube.

A small radioactive light source may be moved into the optical path of the system and is used to check the sensitivity of the phototube and amplifier.

The phototube and voltage divider are mounted in a hermetically sealed stainless steel housing with a sapphire window to admit the light. Thermal insulation for either dry ice or liquid nitrogen is provided by the styrofoam lining of the refrigeration box. Infra-red phototubes are practically useless without cooling because of the high photocathode emission at room temperature. Cooling to liquid nitrogen temperatures (-193°C) reduces the dark current on this particular 7102 photomultiplier from $7.x.0^{-8}$ amperes to about 5.10^{-14} amperes or roughly a million times.

With the completion of this equipment, the next part of the program is the determination of the color transformation coefficients for the U.B.V. system and also the V and IR system.

EPHEMERIDES OF THREE ECLIPSING STARS, by Joseph Ashbrook

XZ Andromedae (1^h $53^m.8$, +41° 52': 1950). Algol type, 10.2-12.2, eclipse lasts 7 hours. Chart was published in SKY AND TELESCOPE for November, 1963, page 306. During last five years the period has lengthened markedly, and new timings of minima are badly needed.

Predicted minima (Universal time):
November 4, $8^h.2$; 7, $1^h.4$; 11, $3^h.1$; 15, $4^h.8$; 19, $6^h.6$; 26, $1^h.4$; 30, $3^h.2$.
December 4, $4^h.9$; 8, $6^h.6$; 15, $1^h.5$; 19, $3^h.2$; 23, $4^h.9$; 27, $6^h.6$.
January 3, $1^h.5$; 7, $3^h.2$; 11, $5^h.0$; 15, $6^h.7$; 22, $1^h.6$.

RZ Cassiopeiae (2^h $44^m.3$, +69° 26': 1950). Algol type, 6.4-7.8, eclipse lasts 5 hours. Chart was published in SKY AND TELESCOPE for October, 1964, page 250. Variable period needs constant monitoring.

Predicted minima:
November 2, $4^h.3$; 3, $9^h.0$; 8, $3^h.8$; 9, $8^h.4$; 14, $3^h.2$; 15, $7^h.9$; 20, $2^h.6$; 21, $7^h.3$; 26, $2^h.1$; 27, $6^h.7$.
December 2, $1^h.5$; 3, $6^h.2$; 8, $0^h.9$; 9, $1^h.8$; 14, $0^h.4$; 15, $5^h.0$; 16, $9^h.7$; 21, $4^h.5$; 22, $9^h.1$; 27, $3^h.9$; 28, $8^h.6$.
January 2, $3^h.3$; 3, $8^h.0$; 8, $2^h.8$; 9, $7^h.4$; 14, $2^h.2$; 15, $6^h.9$; 20, $1^h.6$; 21, $6^h.2$; 26, $1^h.1$; 27, $5^h.7$.
February 1, $0^h.5$; 2, $5^h.2$; 8, $4^h.6$, 14, $4^h.0$; 20, $3^h.5$; 26, $2^h.9$.
March 4, $2^h.3$; 10, $1^h.8$; 16, $1^h.2$.

β Persei (Algol). (3^h $04^m.9$, +40° 46': 1950). Algol type, 2.1-3.5, eclipse lasts 10 hours. Famous for its period changes; excellent object for visual or photoelectric timings of minima. Visual observers are advised to use these comparison star mags. (which are photoelectrically measured V magnitudes by H.L. Johnson, from SKY AND TELESCOPE, July, 1965, page 24): gamma And, 2.10, zeta Per, 2.86; gamma Per, 2.94; β Tri, 3.00; δ Per, 3.03; α Tri, 3.44; kappa Per, 3.81; α Per, 1.80.

Predicted minima:
November 1, $9^h.7$; 4, $6^h.5$; 7, $3^h.3$; 10, $0^h.1$; 24, $8^h.2$; 27, $5^h.0$; 30, 1^h.
December 14, $9^h.9$; 17, $6^h.7$; 20, $3^h.6$; 23, $0^h.4$.
January 6, $8^h.4$; 9, $5^h.3$; 12, $2^h.1$; 29, $7^h.0$.
February 1, $3^h.8$; 4, $0^h.6$; 21, $5^h.5$; 24, $2^h.3$.
March 19, $0^h.8$.

These predictions are in Universal Greenwich time, 5 hours fast of EST. Thus Dec. 4, $4^h.9$ UT = Dec. 3, $11^h.9$ EST.

AAVSO observations of these stars should be reported to Mr. David B. Williams, 915 North Main Street, Bloomington, Illinois 61701.

1970 ECLIPSE, by Cyrus F. Fernald

Those of you who were with us at the July 20, 1963 eclipse on Lord's Hill in Athens, Maine, have probably been looking forward to March 7, 1970, and northwest Florida. Thanks to Dick Davis we have a copy of the U.S. Naval Observatory circular # 89 which gives the information necessary to plot a fairly accurate central line for this eclipse. Dave Rosebrugh and I have done this and find that Perry, Florida; Jasper, Florida; Waycross, Georgia; and Norfolk, Virginia are very close to the central line of totality. The noon point of the eclipse is in the Gulf of Mexico close to Yucatan. Hence, Perry would seem to have a slightly longer totality than points to the north east. I estimate about 3^m10^s for Perry which is some four times what we had in Athens.

On our trip west this spring Em and I stopped in Perry. The city is mainly a tourist resort. There is a paper mill some miles south of the city that is the main industry. There are 26 motels with some 500 rooms available. Very likely some of these will be gone by 1970, but it is a safe bet that more will take their places. Their apparent quality is all the way from standard on down. We didn't note any that looked exorbitant.

The weather prospects for the Perry area at Eclipse time are highly favorable, as Ralph Buckstaff will tell you. As I recall, we were told that the city has a convention hall projected for construction in 1967-8, and if so that should serve very well for a Friday evening lecture, and a Saturday afternoon post-mortem session. There are plenty of flat fields similar to what we had on top of Lord's hill for our observing sites. Some of the motels have open fields in their rear that would appear suitable.

Perry is something less than 200 miles from our Longwood home and observatory. That would seem to rule out having a meeting such as we did in 1963, based on Wilton, with Athens as the eclipse site only 47 miles away. If any of you want to visit us either before we leave for Perry, or after we get back, we certainly hope you will.

Now as to plans. Of course March 1970 is some 3.5 years away, so ideas can change. However, let's see how many of you think there is a good chance you will be with us in Perry in 1970. It seems to me that probably by the annual meeting in October 1969 our plans should be definite and very likely reservations should be made by then. We can tell better on that point when we have contacted the Chamber of Commerce in Perry, which some of our officers will undoubtedly do shortly.

Oh yes, one final thought. Don't forget the eclipse of June 1973, total in the central Sahara for some seven minutes.

OBSERVING A SECONDARY MINIMUM OF RZ CAS, by John J. Ruiz

RZ Cassiopeiae is an eclipsing variable of the Algol type. It has received, perhaps, more attention than any other variable of its type, including Algol. The period is about one day and five hours and the primary minimum occurs with dramatic suddeness reaching a depth of over 1.5 magnitudes in 2 hours. It has been observed visually, photographically and photoelectrically by many amateurs. I would like to mention in particular among the visual observers, Capt. Baldwin and Dr. Hampton, among the photographic observers Dr. Henry Specht and Richard Davis. Donald Engelkemeir, Arthur J. Stokes and myself have followed it for many years with the photoelectric photometer and have obtained numerous primary minima.

On the other hand the secondary minimum is very shallow and ill defined. It has been detected photographically and photoelectrically by very few observers. For years I have been trying to get a well defined minimum. In 1963 I got some results which were so unsatisfactory that I never reported them. I arrived at the conclusion that the secondary minimum had a depth of less than 0.1 mag in the blue. This year after several failures I obtained two complete minima and a partial one. Combining these results by reducing them to the same phase using the Moscow formula, (Helio.) of P.M. = J.D. 2,417,355.4233 + 1.1952519 E, I obtained a curve.

The depth of this secondary minimum is a little over 0.1 mag. The minimum occurs about $0^d.0108$ (= 0.26 hrs ±) after the mid point between the primary minima, indicating eccentricity of orbit. On two occasions I observed this minimum around midnight and followed it continuously from dusk till dawn (over seven hours).

I am not sure of the actual figure for the displacement of the secondary minimum as I have not as yet obtained or received notice of good primary minima this year. The computed epoch of the primary does not agree with the actual times. In this case I used a primary of Art Stokes of July 20, 1966 J.D. 2,439,327.697 and two very imperfect ones of mine J.D. 2,439,351 and 377 (Aug. and Sept. of this year). Stokes got an O-C of $-0^d.0410$ and I got O-C = $-0^d.0398$, but this result was obtained by the tracing paper method and I am quite sure that my judgement was influenced by Art's results which I knew before hand.

My secondary minimum by the K. - van W. method which is an analytical one, gave me this epoch:

(Helio) J.D. 2,439,385.6768 ± $0^d.0009$ (Should be rounded up to: 9385.677 ± $0^d.001$).

and by the tracing paper method:

(Helio) J.D. 2,439,385.676

Note the large probable error which is an indication of the scattering of the observations rather than their accuracy. I have seen observations of a primary minimum by Arthur Stokes with a P.E. of only $0^d.00008$, or ten times as small.

I am anxiously waiting for David Williams' report on this variable for this year so we may determine the eccentricity of the orbit from more accurate determinations of the primary minimum.

All observations were made with a yellow filter and a selected 1 P21 tube at a lambda eff. of 5300 Å which approaches the spectral band of the eye.

A VIEW OF T CORONAE BOREALIS (155526), by Roger S. Kolman

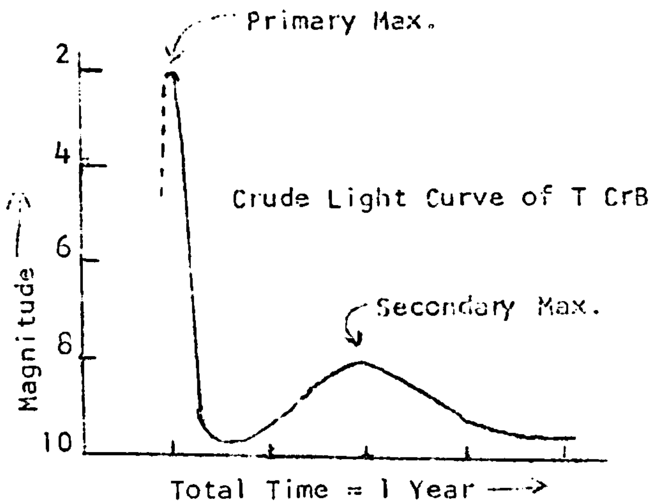
An old friend to AAVSO observers is T Coronae Borealis (155526), an old nova which first flared in 1866 and then recurred, nearly duplicating its 1866 record in 1946.

It is one of the very few old novae that can be seen with a small (2 or 3 inch) telescope at minimum -- being tenth magnitude at that time. T CrB is handily placed for viewing as it is only $1/3^\circ$ from epsilon Coronae Borealis and not far from another favorite of the AAVSO -- R CrB.

Physically, the star is a binary, as many novae have been shown to be. It is spectroscopic and has a period of 230.5 days. The star seen at minimum is of type M, with an absolute magnitude of about 0.0, this star being the source of typical long range variation. The seat of the great outbursts is a small blue star which is also responsible for slight flickering which has been reported. (Note the resemblance to

SS Cygni and V Sagittae, AAVSO Abstracts, Spring, 1966) This flickering is pronounced enough to be noticeable from one night to the next. They are generally in the range of 0.2 to 0.4 magnitude.

The two times that T CrB had major outbursts did present it as a spectacular object. Both times it has reached second magnitude, which makes it a naked eye object even in Los Angeles.



It is a typical nova as far as its light curve goes. That is, it follows the usual rapid rise followed by a slower drop back to minimum. (See light curve. Since the two outbursts were identical, the comments made here will apply to both maxima.) Once the star has reached minimum, it brightens once again to some level considerably lower than maximum. It then very slowly drops back to its original state.

Spectroscopically, things are very interesting. A shell spectrum came about quite early. This indicated that a roughly spherical shell of material was being ejected with a rather high radial velocity. This was followed by a rapidly developing emission spectrum. The lines then narrowed dramatically (this indicates selected energy states in which the particles were strongly quantized as opposed to the broad lines which merely indicate a clustering about some energy level). Coronal lines also made their appearance early. Absorption lines of great complexity made their appearance at the red end of the spectrum. This was due to the expanding cloud of ejected gas absorbing those lines of its makeup out of the continuous background. After this bright background decreased, the widening emission lines accounted for nearly all the light emitted. Finally, the M spectrum once again became dominant.

Now that it is at minimum, an inspection of the AAVSO Quarterly Reports shows a range from 9.8 to 10.3. Since the star is very well covered, the 10 day means generally carry a weight of five, which means top coverage. So, the variation is most certainly real. This variation does indicate that T Coronae Borealis, as an old nova, requires attention even at minimum.

As with other sciences, one of the great powers of astronomy is the ability to predict certain phenomena from a study of data and comparable cases available. Such was the case of T CrB before its 1946 outburst. Other recurrent novae had been seen and an analysis of T CrB data led Campbell and Jacchia to say in 1941 that it was a "possible recurring nova." In 1938, Gaposchkin said, "The star should be watched for variations...That it will prove to be a recurrent nova is not impossible." And so it came to pass!

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TENTATIVE LIMITING MAGNITUDE FORMULA, by Roger S. Kolman

Since presenting my first paper on limiting magnitudes at the St. Louis spring 1964 AAVSO meeting, I have had considerable help from many people, notably Tom Cragg, in presenting a better, more practical formula.

The formula for limiting magnitudes was created by a check on the faintest star seen by the naked eye, then expanded to telescopes on a strictly area basis. This is done on one grave assumption -- that the eye is as good an optical instrument as a telescope. Unfortunately, this is not a valid assumption. The eye is not as perfect as it is assumed to be. Two serious defects lessen the efficiency of the eye - spherical aberration and the inefficiency of the cones of the eye in accepting the light received by the eye. When using the naked eye in observing, the exit pupil is wide open, thus allowing the two aforementioned factors to be maximized in determining the faintest stars one can see. However, at the telescope the size of the exit pupil depends on the magnification -- the higher the magnification, the smaller the exit pupil. As the exit pupil is reduced, the less is the effect of these aberrations on our visual acuity.

Another argument against the empirical formula in use today ($M = 9+5 \log D$) is that of the empirical constant. Besides the aperture of the telescope, we must be concerned with conditions exterior to the telescope, such as location of the instrument, seeing, and transparency. Clearly the same results will not be obtained by the same observer with the same instrument in different locations -- say Chicago and Mt. Wilson. Of course it is ridiculous to even imagine this because we don't have identical conditions present at these two locations. Therefore, some kind of variable,let us call it the perennial "X", must be used to replace the constant 9.0.

Fortunately, some work was done on this subject before by I.S. Bowen in the PASP around 1948. Although I have not seen this article, Tom Cragg sent me the basic equation used by Bowen:

$$M = X + 2.5 \log D + 2.5 \log P,$$

where M Magnitude
X Some "constant" of sorts
D Aperture
P Magnification.

Mr. Cragg sent me his results using the 6" Brashear refractor at Mt. Wilson, his 12" Cave refl at his home and Claude Carpenter's 18" refl (now at Ford Observatory on Mt. Peltier). The results were very impressive. Using this formula, I checked the "constants" possible with the observations I used in the St. Louis paper. Although I would have liked to have used <u>all</u> the results from the earlier effort, I had to settle for but a few because of the need of knowing the magnification used during these observations. These data were known in only a few cases. The results may be seen in <u>Table I</u>.

The magnification factor is present with limitations. Obviously, one cannot contimue to add magnification <u>ad infinitum</u> and expect to continue to see fainter stars. Increased magnification may be employed only until the "seeing" disk of the star is seen. After this point, nothing is gained in adding magnification -- in fact we lose the fainter stars by pressing the limit.

Of course, the aperture factor must be included because light gathering power is a function of aperture.

Now we move to the constant. In reality, constant is not the proper term. Our "constant" is actually a more sensitive variable than the other 2 variables used in the formula.

Here is our "exterior factor" term. We may manipulate it as we wish, within certain limitations, to describe the conditions in which we are observing.

By knowing the conditions present while the observations in table one were made, a tentative table could be constructed which could assign a constant to different seeing conditions. (see Table Two)

TABLE I

Observer	Instruments	Magnification	Magn.	Const.
C.E. Anderson	10"	200	15.0	6.8
C. Carpenter	18	300	17.2	7.8
T.A. Cragg	6 refr	180	15.5	7.9
	12	164	15.5	7.3
	18	540	16.5	7.2
	100	500	19.0	7.3
C.B. Ford	3.5	112	12.4	5.8
	6	150	13.6	6.3
	10 refr	190	14.3	6.6
	10	160	14.7	7.2
	12 refr	200	14.5	6.0
	12	150	14.7	6.4
	12.5	150	15.2	6.9
C. Hurless	8	100	14.1	6.8
	12 refr	310	16.5	7.5
W.S. Houston	4 refr	180	14.6	10.1
R.S. Kolman	2 refr	85	12.2	6.7
	3.5 catad	160	13.5	6.1
	6	160	14.8	7.5
	8	160	13.5	5.7
	10	160	15.4	7.4
	12 refr	310	15.0	6.0
	12.5	330	15.6	7.6
	16	320	15.4	6.2
T. Osypowski	2 refr	85	12.2	6.7
L.C. Peltier	6 refr		14.8	
	12 refr	310	16.5	7.5
R.E. Wend	6	160	13.5	6.2

TABLE II

RANGES OF USEABLE CONSTANTS DERIVED AS RESULT OF THIS SURVEY

Observing Conditions	Constant
Excellent	7.4 or greater
Good	6.8 to 7.4
Fair	6.0 to 6.8
Mediocre	5.3 to 6.0
Poor	less than 5.3

Because of the variability of eyesight in amateur astronomers and the various degrees of seeing, ranges of constants were used instead of specific numerical constants.

These ranges are just preliminary. Because the few observers used were good ones, I can be fairly sure that the results were not due to wishful thinking in their estimates. Of course, there would have to be adjustments made for the average observer, but this formula is much more flexible than the rigid one which is now in use. Furthermore, any of the four variables may be found by merely holding the others constant. This makes it much more useful than the old form.

THE LIGHT VARIATIONS IN P CYGNI AND OTHER EARLY-TYPE STARS WITH BRIGHT-LINE SPECTRA, by Stephen P. Cook

Certainly, 201437a P Cygni must be considered one of the more erratic variable stars. Twice in the 17th century it burst out like a nova and attained 3rd magnitude before fading. Since 1670 it has been invariable at the 5th magnitude. Or has it? In 1952 Dr. E. Kharadze and his associates at the Abastumani Observatory began making regular observations of the brightness of P Cygni, and found variations exceeding 0.2 or 0.3 magnitude. In July, 1952, for example, a decrease of 0.2 was observed, with the brightness recovering in the following 10 days. Even more striking variations were recorded in 1954. It was noted that the variations were particularly noticeable in yellow light. (In November 1953, M.F. Walker of Mt. Wilson and Palomar Observatories, found no ultra-violet variation greater than 0.005 mag.)

Since a change of 0.2 or 0.3 magnitude should be observable, I began making regular visual observations of P Cygni in the latter part of July 1966. Normally P Cygni is of magnitude 4.80; however, on the night of 7 August (JD2439345.8) a drop of 0.2 magnitude was recorded. Similarly, on 1 September (JD2439370.7), an increase of 0.1 magnitude was noted. Since it is difficult for the eye to accurately record changes of such small amplitude, photoelectric examination is desirable.

P Cygni stars are characterized by high luminosities, extended atmospheres, and spectra with a continuous background in which the lines of hydrogen (the most prominent), helium, and singly ionized oxygen are present, both in emission and absorption. These stars are mostly of spectral type B; however, a few are of very early A. The bright lines in their spectra are always to the red side of the dark lines. Based on a parallax of $0\overset{''}{.}0007$ for P Cygni, its absolute magnitude is -6.0, making it an extremely luminous object. Surrounding this star is an extensive atmosphere that is expanding at a rate of roughly 400 km. per sec. In this respect, P Cygni resembles both novae and the Wolf-Rayet stars.

Apparently the variations in P Cygni defy classification. This star has been called "nova-like"; however, its high luminosity makes it difficult to place it in the ranks of these dwarfish explosive stars. With its high luminosity (absolute magnitude -5 or -6) and bright-line spectra, the erratic southern variable eta Carina is not unlike P Cygni. However, P Cygni stars are probably more closely related to the Be stars similar to gamma Cassiopeiae. The well-known changes of gamma Cassiopeiae during the 1936-41 period are typical of a B star ejecting a shell. Similar changes have been noted in a number of Be stars.

It is interesting to note that several of the stars with P Cygni-type spectra are variable, notably P Cygni itself, AG Pegasi, and S Doradus. AG Pegasi varies from magnitude 6.0 to 9.4. This star, in the 1820's, was of 9th magnitude -- three magnitudes fainter than at its maximum light in the 1870's. It is currently of 8th magnitude and decreasing in brightness. Progressive changes in its spectrum have been observed since 1920.

It may be that the changes of small amplitude recently observed in P Cygni are due to changes occurring in the outer levels of its atmosphere. Dr. Kharadze suggested that because of its high luminosity, P Cygni might suffer disturbances of the equilibrium between gravity and light or gas pressure -- at least in its outer layers. All in all, this star is a most interesting object.

I urge the amateur observer to keep an eye on as many P Cygni and Be stars as possible. It has been stated that all B-type stars with emission spectra might show signs of variability if carefully observed. Amateurs interested in making visual observations of P Cygni, can use the AAVSO "b" chart for RS Cygni.

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VARIABLE STAR OBSERVATIONS IN TURKEY, by Abdullah Kizilirmak

What is the best research program for a place where there are clear skies but very limited instrumentation? Our answer to this was to initiate a research program on variable stars.

In 1962, six people started the work in Ankara. We had a 15cm Coudé telescope. We prepared an observation program with the cooperation of Dr. E. Pohl of Nürnberg Observatory. The main purpose of our program was the observation of eclipsing variable stars. We have also included some physical variables to this program. First results of these observations were published in AN 288, 2/3, 1964.

Later, in 1963, I joined the faculty of the University of Izmir. First we set up a small observatory which was completed in 1965. We have a 6-inch Unitron Refractor. Our staff consists of five professional astronomers and a number of students. It is to be <u>noted that in Turkey today we do not have amateur astronomers</u>. We are continuing our cooperative programs with the Nurnberg Observatory. Our observations are limited to eclipsing variable stars only. Our results will be published in the AN. Up to now we have observed about 150 minima.

I would like to tell you a little about our observatory in Izmir. It is seated on Kurudag mountain 30km (19 miles) southeast of the city.

Geographic Latitude = $+38^{\circ}$ 23' 52" North
" Longitude = 1^h 49^m 03^s East
Height above sea level = 632m (=2100 feet)

The sky is exceptionally clear in Izmir. We expect, on the average, 240 observation nights in a year, from the study of 30 years of meteorological bulletins. One of our advantages is the availibility of 4 months of continuous clear skies, during the summer season, alone.

Besides the 6" refractor we are now getting a 16" Cassegrain Telescope and a photoelectric photometer with the support of NATO. Other projects are in the planning stage.

If any of you should come to Turkey, please visit our observatory.

THE X-RAY SOURCE SCORPIUS X-1, by George S. Mumford

The intense source of celestial X-ray emission, Scorpius X-1, has been identified by Sandage et al (Astrophysical Journal, in press) with a starlike object exhibiting all the spectral and photometric properties of an old nova. Photoelectric observations by the author at Kitt Peak National Observatory during September, 1966, indicated the object varied in visual magnitude from 12.42 to 12.14, with associated color changes. Average values of B-V = +0.13 and U-B = -0.86, locate the source in the color-color diagram above the black body line in the region associated with quasars and novalike variables. Members of the AAVSO whose telescopes reach 13th magnitude or better might be interested in keeping this star under surveillance.

This work is supported by the National Science Foundation.

DISCOVERY PROBABILITIES FOR LONG PERIOD VARIABLES IN VSF 193, by Dorrit Hoffleit

Van Gent and others (1) have published and applied formulae for determining the ostensibly true number of variables stars in a field from the number of times each variable has been rediscovered on n pairs of plates searched. Ordinarily such formulae yield significant results only when the stars are sub-divided into discrete categories according to apparent magnitude, amplitude and type of variability, and the plates searched are of uniform quality. Thus a search that may be satisfactorily complete for the Mira type stars with maxima brighter than a specified value, may be hopelessly inadequate for Algol stars which are at minimum less than ten percent of the time.

In VSF 193 in Sagittarius some 600 stars have been suspected of variability and the magnitude of each estimated on from 20 to 700 plates. 250 of the variables are now known to belong to the long period classes. A few more may still prove to be faint long period variables, but they are too hampered by the effects of optical companions in this crowded field for them to have been recognized as such.

The variables had been found by the positive-negative superposition method. 11 MF negatives (taken with the Harvard 10-inch Metcalf telescope) were compared each with one of four positives, and 11 Bruce plates (24-inch refractor) with one positive. In view of the multiple use of the positive plates, only four pairs of MF comparisons are independent. Let A be the number of long period variable stars actually found on these four pairs, and G the average number of times each was discovered. If a represents the probability of discovery of one variable on one pair of plates, and N is the total number of stars in the given category, then $N = GA/na$. Our problem is to find a, and this is readily obtained by trial-and-error from the relation

$$na/G = 1 - (1 - a)^4$$

where a must lie between 0 and +1, i.e., between impossibility and certainty of discovery.

Table I gives, in the first row, the total number of long period variables now known in VSF 193, grouped according to magnitude at maximum light. The second line gives the numbers found on all of the MF plates examined, and the third line the numbers found on the four independent pairs. Only the groups for magnitudes 12-15 contain sufficient stars to justify the computation for completeness of discovery. For them follow the inferred values of G, a, and N. The values of N, within their natural uncertainties, are the numbers of long period variables that would be expected from an exhaustive search of the MF plates. Comparing N with the actual numbers found in the second line of the table, we would conclude, surprisingly, that all long period variables discoverable on the MF plates have already been found! On the other hand, the contrast between the numbers in the first two rows indicates that the MF plates are not particularly efficient for this purpose. The Bruce plates, which account for the excess of the first row over the second, although covering only one half the area of the MF plates, reveal 50% more variable stars to the same magnitude limit. The major reason for this discrepancy is that many more optical companions are resolved on the larger scale Bruce plates (60''/mm as compared with 167''/mm).

TABLE I

Discoveries and Discovery Probabilities

Max. Mag.		10-11	11-12	12-13	13-14	14-15	15-16	16-17	Total
All known		1	3	24	121	88	12	1	250
Found on MF		1	2	13	87	67	5	0	175
Independent MF Pairs.									
	A	1	2	11	49	28	2	0	93
	G	1	1	2.00	1.408	1.179	1		
	a			.4563	.225	.109			
	N			12 ± 4	77 ± 9	76 ± 9			

The computations for completeness of discovery thus yield underestimates of the total number of objects to be expected. Such estimates are nevertheless useful, primarily for judging the feasibility of prolonged search, especially in crowded regions such as the one considered here. In high galactic regions, or surveys for which the image resolving power is good, the predicted numbers will bear a closer relation to the actual numbers of variable stars within specific magnitude intervals

(1) H. van Gent, Bull. Ast. Inst. Netherlands, Vol. 7, p. 27, 1933.

TWO ECLIPSING BINARIES IN SAGITTARIUS, by Susan Hess

The periods of two eclipsing binaries in Sagittarius were determined by visual estimation of their magnitudes on 445 photographic plates taken by the Harvard and Maria Mitchell Observatories. The first star (375) was observed to be an Algol type eclipsing binary with a period of $5^{d}\!.070043$. The second (322) was of the W Ursae Majoris type with a period of $0^{d}\!.685614$.

FOUR VARIABLE STARS, by Alice Avery Hine

The variability of these stars was previously discovered by Dorrit Hoffleit. I measured them at the Maria Mitchell Observatory, in the summer of 1966, by examining A, B, and MF series plates (Harvard) and NA plates (Nantucket).

Variable star DH 309 blended with a bright nearby star on NA plates, but the other observations yielded three maxima at JD 23950, JD 24760, and JD 26600. From the last maximum, which is especially well marked, until about JD 33000 there are no maxima. A possible explanation, suggested by Miss Hoffleit, is a beat frequency phenomenon, where high maxima and low maxima (too small to be distinguished from error scatter) have been observed, but not the expected return to high maxima. More plates, at large time intervals and of larger scale than NA plates, are needed to determine the period.

DH 310, measured on A, B, and MF plates, turned out to be a typical long-period variable with a symmetrical light curve, $P = 330^d$.

A third long-period variable, DH 384, has $P = 216^d$, from measurements of A, B, and MF plates. The scatter curve is slightly unsatisfactory, but a plot of O-C, or the difference between times of observed and computed maxima, against time of maximum, did not show a changing period.

All plates were examined for DH 252, a short-period variable whose apparent magnitude range is about 14.0-15.2. Many maxima were observed; those in long day runs set a minimum limit of about $0^d\!.3$ for the period, and those which were close together set a maximum limit of several days. The largest common difference obtained from nine short primary differences was about $0^d\!.44$. A reciprocal period, $P^{-1} = 2.2618$, was then worked out by trial and error. Other periods, obtained from the spurious period formula ($P^{-1} = 2.2618 \pm 1.0027n$, $n = 1,2,3$), were tried and discarded. The final result was $P^{-1} = 2.261787$, or $P = 0.486341$. The light curve shows a sharp rise and a gradual fall, and all observations agree remarkably well, from about JD 22500 to about JD 39000.

TWO VARIABLE STARS IN SAGITTARIUS, by Katharine Wood

The magnitude of DH Variable 238 was estimated on Harvard A, B, and MF plates and on Nantucket NA plates over a span of Julian Days from JD 2423908 to JD 2439299.

For JD 23900 to JD 33900, a period of 270^d seemed to fit quite well. However, this period of 270^d did not seem to work at all for JD 35700 to JD 39300. When I plotted $O\text{-}C_{max}$ versus the magnitude for these dates, there was no obvious curve at all. In fact, when $O\text{-}C_{max}$ of the observed maximum was plotted against the Julian Day of the observed maximum, the curve degenerated roughly with a straight line function after JD 35700. A parabolic curve was tried to see if possibly there was a secularly changing period, but no parabola could be made to agree with the points of the graph.

However, I did manage to fit a period of 263^d to the points for JD 35700 to JD 39300.

In both the earlier plates where a period of 270^d was found and in the later plates where a period of 263^d fitted, the light curve seems to have a sine curve and varies about $1^1/2$ magnitudes. An appreciable scatter may be due to the presence of another oscillation of light in the star, one of a shorter period which is superimposed on the longer period of variation.

I estimated the magnitude of DH variable 432 from JD 2423191 to JD 2439273. Since the star's magnitude range was between about 15.2 and the plate limit of 16, I estimated the magnitude on the NA plates only when the image of variable 432 was good.

The star is an RR Lyrae-type variable with a reciprocal period of 1.447743 /da. The light curve shows a sharp rise in light amplitude to maximum and a much slower sloping down to minimum.

While I was trying to find the correct reciprocal period for variable 432, I found a light curve that seemed to fit quite well for JD 26557 to JD 26594 with $1/P_o$ = 1.549. However, the light curve was reversed. This reversal of the curve which I would normally expect a short period variable to have indicated the possibility of $1/P_o = 1.549$ being a spurious period due to the stroboscopic effect of observing the star only at definite time intervals. In this case the spurious period came from regular nightly observations of the star.

The spurious period formula for spurious periods due to regular nightly observations is $1/P_1 = 1/P_o \pm n(1.002738)$. In the reverse curve case, this would be $1/P_1 = n(1.002738) - 1/P_o$. If we let n = 3, for the reverse curve, we have $1/P_1 = 3.008 \pm 1.549$. Using the minus value, we get $1/P_1 = 1.459$ which is very close to the reciprocal period I found of $1/P = 1.447743$ or to two decimal places, $1/P = 1.45$.

A LONG AND A SHORT PERIOD VARIABLE STAR IN VSF 193, by Stephanie Simer

This summer, I participated in a National Science Foundation summer program at the Maria Mitchell Observatory in Nantucket, Massachusetts. From the magnitude estimates made there, I determined the periods of two variable stars -- one with a period greater than 150 days and one with a period of less than 0.5 day.

DH Variable #229 at $18^h\ 21^m\ 31^s$, $-25^\circ\ 19'.6$ (1900) has a period of 193 days. The light curve obtained for this star shows a very steep rise to maximum light and a descending branch which is less steep. The amplitude of variation is about $1^m.5$ from $15^m.8$ to $14^m.3$. The star is usually at minimum light, with only short maximum phases.

The magnitude estimates of this star were hampered by two optical companions which appeared on the photographic plates. One of these companions was almost always blended with the image of the variable star. These were resolved on only 22 of approximately 250 photographic plates. These stars, the variable and its "closest" companion, hereafter indicated as upper and lower, both appeared to vary in light intensity. No period for either of them could be determined from just the 22 observations. The stated period of 193 days was determined for the stellar image which was perhaps always a blend of the images of the two stars, upper and lower. For this reason, the period may not be valid for just the single star. The second companion star was not as often blended with the image of the variable; hence, it was possible to obtain a period for the composite image of upper and lower.

The period was derived from estimates on the Harvard B plates, and was found to fit the observations from the Harvard A and MF plates. Due to the yearly observational gaps, only four plates from all of these indicate a period of 193 days rather than 386 days. The star may have a slightly changing period, but this needs further study.

In contrast to this long period variable, DH Variable # 427 at $18^h\ 21^m\ 21^s$, $-24^\circ 46'.6$ (1900) was found to be a short period variable star. This star has a period of $0^d.492531 \pm 0.000001$* (reciprocal $P^{-1} = 2.030328 \pm d^{-1}$). The star rises very abruptly from minimum to maximum light. The amplitude of variation is $1^m.1$ to $0^m.9$, from $15^m.2$ to $14^m.1$.

The scatter on the descending curve indicates that the star sometimes fades much more rapidly than at other times. This scatter is probably caused by different amounts of the image blending of star 427 and its optical companion; the star would appear brighter during any phase of variation when the amount of blending was the greatest. This companion star is resolved on only a few (less than 10) of the 65 Harvard A plates. These were not enough observations, therefore, to determine whether the companion varies at all. It is visible only at $15^{m}.7$ on any of the plates. The blending of the two stellar images affects the magnitude of the variable more at minimum light than at maximum light. For this reason, the star is probably fainter at both maximum and minimum than $14^{m}.1$ and $15^{m}.2$. If the blending were complete, the star would be $14^{m}.4$ at maximum and $16^{m}.3$ at minimum; the amplitude would be $1^{m}.9$.

The spurious period formula for short period variable stars was applied to this star. The light curves obtained from these derived periods placed minimum points under maximum points and were very irregular curves. Hence, it is assumed that this period of $0^{d}.492531\pm$ is not spurious. Many other periods, both longer and shorter were applied to the observations, but the results were also unacceptable light curves.

The star was never resolved from its companion on the Harvard MF plates and so they could not be used for the determination of the period. Only the Harvard A plates could be used for this determination. The companion was frequently unseen on these A plates and therefore, on many plates, it was impossible to determine whether or not the two images were blended.

The long day-run, JD 14870, does not perfectly fit the composite light curve of JD 23621 to JD 29876. If this difference is not accounted for by the blending of images, the star may have a changing period. More than 17864 epochs separate the two curves; the change would be very gradual. Only further observations will indicate whether or not this period is, in fact, changing.

There were no available spectral classifications for either of the two variable stars (229 and 427). The stars appear to be Mira and RR Lyrae type variables; however, only spectral classifications will confirm this.

* Each individual time measurement was accurate only to ± 2%. The total time observation was 15006 days; therefore, the period is in error ± 0.000001 day.

AN INVESTIGATION OF POSSIBLE DOUBLE CEPHEIDS, by Jean Warren

CE Cas is a visual binary both of whose components are Cepheids. A paper given in the October 1965 meeting of the AAVSO suggested that bright variable stars suspected of having multiple periods might be unresolved double Cepheids similar to CE Cas. Miss Warren investigated this possibility of duplicity in seven long-period Cepheids showing period changes. She examined the images of these stars on parallax plates taken with the long-focus refractors at Sproul Observatory and the Yale Observatory, but found no indication of elongated images or duplicity. Several other Cepheids with changing periods remain to be investigated.

Stars which have been investigated:

Star	No. plates checked	Observatory	Dates of plates
1. SU Cas	17	Sproul	Jan., 1922-Dec., 1925
2. RY Cas	4	Sproul	Oct., - Nov., 1933
3. zeta Gem	18	Sproul	Mar., 1915 - Dec., 1922
4. RX Aur	24	Sproul	Feb., 1929 - Nov., 1936
5. kappa Pav	17	Yale	Sept. 1927 - Sept. 1930
6. l Car	29	Yale	Jan., 1926 - Apr., 1947
7. η Aql	25	Yale	May, 1926 - May, 1946

FOUR VARIABLE STARS, by Linda Bothwell

A study of the variability of the stars, DH Variables 305, 308, 323, and 385, was made this summer at Maria Mitchell Observatory under the direction of Dr. Dorrit Hoffleit. Over three hundred Harvard and Nantucket plates, taken during the period 1924-1966, were examined. The following information was obtained from estimates of the stars' magnitudes.

Var. 308 at $18^h\ 25^m\ 15^s$ -21° 51!4 was found to have a period of 170^d and to range from magnitude 14.3 to 16.2. JD_0 was taken as 26564 and a total of ninety-one epochs was observed.

Var. 323 at $18^h\ 27^m\ 42^s$ $+23^\circ$ 49!0 is probably an irregular variable. Nancy Houk, of Warner and Swasey Observatory, Case Institute of Technology, Cleveland, Ohio, found its spectral class to be M 4-5. The estimates of magnitude compiled gave no indication that the magnitudes were in any way a function of time. Estimates in common were made by two different observers, Jean Anderson and Linda Bothwell, at different times. They showed a definite correlation and confirmed the small amplitude of variation. The range of magditude was from 13.9 to 14.6.

Var. 385 at $18^h\ 28^m\ 01^s$ -23° 37!0 most probably is irregular also. Again, Nancy Houk found the spectral class. It is M 6. The range of magnitude is from 14.1 to 14.9. Estimates on the A plates, made by both Jean Anderson and Linda Bothwell, correlated, proving the accuracy of the range and confirming the irregular nature of the star.

The work done on Var. 305 at $18^h\ 23^m\ 15^s$ -22° 36!8 is at this time incomplete. It is believed to be a short period variable with a period somewhere around 0.565^d. A period of 0.461^d was found to satisfy most of the data sufficiently well; however, the period appears to be spurious because rise to maximum is slower than decline to minimum. The star varies from 13.9 to 15.3 or less. More work must be done in trying to fit the data to a period in the neighborhood of one-half day.

THE AMAZING CI CYGNI, by Dorrit Hoffleit

The light curve of CI Cygni determined from Nantucket plates for the forty years 1926 - 1966 is presented. Confirming the period of 855 days determined by B. S. Whitney in 1953, the light curve looks much like that of an eclipsing binary with partial eclipses, with an amplitude of about one mag. from about 12 to 13 mag. pg. In 1937, however, a remarkable outburst reaching nearly 10 mag. occurred. A similar outburst had been noted in 1936 by Naomi Greenstein on Harvard plates taken in 1911.

The most amazing fact about his star is that it may be an X-ray source and the first X-ray star to show X-ray variability. I examined it at the request of Dr. Hugh Johnson. Unfortunately our plates show no remarkable variation at the extreme times bracketing the X-ray variation, although the gaps in our plate series would leave ample room for a 1964-1965 outburst such as the one observed for 1937.

RECENT GRAZING OCCULTATION DEVELOPMENTS, by David W. Dunham

An ordinary occultation occurs when the moon passes in front of, or eclipses, a star or planet. A grazing occultation occurs when an observer is in the right place to see a star appear to move along a line which is tangent to the Moon's edge; then the star will disappear and reappear repeatedly among lunar mountains and craters along the edge. Grazing occultations are visible only within about a mile of the predicted northern or southern limit of visibility of an occultation.

If several observers set up telescopes at approximately equal intervals across the band of visibility of a grazing occultation and make timings of the successive disappearances and reappearances, a profile of the moon's edge can be drawn, as each observer experiences a different depth of graze.

This observed profile can be compared with, or fitted to, a profile drawn from Dr. Watt's charts (The Marginal Zone of the Moon, by Dr. C.B. Watts, 1963, U.S. Naval Observatory Vol. 17 of Astronomical Papers; contains 1800 charts covering all possible librations to take the limb irregularities into account).

If there are enough observers, this fit can be made to $0\overset{''}{.}01$ or $0\overset{''}{.}02$ of arc, more precise than any other current method of lunar observations. This can be done even if the timings are accurate only to the nearest second since the accuracy depends primarily on the positions of the observers.

The first graze predicted and observed was made by Jean Meeus, in Belgium, on 20 November 1959 for the occultation of lambda Geminorum. The first really well observed graze was the one of Z.C. 398, observed from 12 stations near Davis on 18 February 1964. This has become a classic and with the help of an article in Sky & Telescope(July 1964)has helped stimulate world wide interest in grazing occultations.

Robert Chew has been avidly timing occultations of numerous faint stars. So far in 1966, he has made 270 timings.

The most interesting grazing occultations during the year have occurred in eastern U.S. On 25 January in Amherst, Mass., of Z.C. 3490, by the crescent moon. The most successful graze this winter was on 12 February when observers from Omaha and Kansas City observed the crescent moon occult the star Z.C. 2217.

Other grazing occultations this year were:

28-29 March	Z.C. 877	Norfolk, Virginia
28-29 March	139 Tauri	Wilmington, Delaware
22 April	13 Tauri	Southern Quebec and Central Maine

The graze of 13 Tauri was without question the most spectacular graze we have seen. The lunar profile was extremely rugged, making it even more interesting.

If you are interested in observing ordinary occultations, or grazes, in your area write to David W. Dunham, Yale University Observatory, Box 2023, Yale Station, New Haven, Connecticut 06520.

REPORT OF PROGRESS OF THE INVESTIGATION OF FAINT VARIABLE STARS IN THE SCUTUM CLOUD, by Margaret Harwood

My paper published in late August, 1962 (No. 8 of Volume 21, Annals of the Leiden Observatory) reported the results obtained from the investigation of 419 variables, the majority of which had been discovered at the Maria Mitchell Observatory.

There remained 295 unannounced variable stars, 8 of which were discovered by Martha Stahr and the remainder by John Heath. Of these, 189 have been measured and 3 more variables discovered by Virginia Swain, making a total of 192. This leaves 106 stars to be investigated. They are faint stars: the maxima for the majority lie between photographic magnitudes 14 and 16. They must be measured on the Harvard Bruce plates.

OBSERVATIONS OF SOME RR LYRAE STARS, by Lief J. Robinson

The periods of many RR Lyrae variables are subject to change. In some cases excursions from linear elements accumulate only to a fraction of the period; in others, residuals may, after decades, amount to several days. V. Zessevich has reviewed this subject in SKY & TELESCOPE for October, 1966.

It is not clear whether some period changes represent evolutionary trends or are merely random occurrences, called period noise. One thing is certain -- observations over many years are needed. Only then, possibly, will secular trends become apparent. But even if no definite answer is possible, timings of maxima will provide valuable checks on a star's elements. Some periods are so variable that it is unsafe to predict maxima even a year in advance.

Generally speaking, the long-term nature of the periods of galactic RR Lyrae stars is not as well determined as for similar variables in some globular clusters. Recently, B. Szeidl published O-C diagrams of 112 stars in M3, using data from the 1890's to the 1960's. From this material he and Dr. and Mrs. Detre have reached important conclusions. They find, for example, that the greatest period noise is exhibited by stars with periods between $0^d.48$ and $0^d.59$.

Does this same relation hold for galactic RR Lyrae stars? Probably, but available data is marginal for a test. Dr. Zessevich is publishing a book that contains the observational histories of about 200 RR Lyrae stars; from this we can expect some insight.

Even so, it is important to extend our knowledge as far as possible into the past. In this respect I have a program for observing RR Lyrae stars on Harvard patrol plates, which provide good coverage from 1900 to 1950, and often times adequate material from the mid-1880's.

To date, seven RR Lyrae stars have been investigated, all with typical former observational histories. Even at this time it is interesting to compare the interpretation of my data with that based only upon the previously available material. The table summarizes the result.

At left, under each star name, is the Julian day interval covered by the previous data. Below this line is the interpretation, indicating either a constant period, an abrupt change, or a continuous change. At right, on the first line, is the time span of the HCO data. On the second line is the interval covered by all observations, below which is the final interpretation.

In three cases (SZ Hya, AA Aqr, and BN Aqr) the interpretation of previous and of complete data is the same. For RX Cet and BO Aqr, my observations indicate only slight modifications. But for RU Cet and YZ Aqr very different conclusions are reached. Furthermore, had observations of SZ Hya and RX Cet begun only a few years later, the strongly variable nature of their periods would have gone unnoticed.

It appears that revised interpretations might be expected for about half of the stars investigated. Yet it is clear that three-quarters of a century might be inadequate to determine reliably the long-term nature of the periods of RR Lyrae variables.

PREVIOUS DATA		THIS PAPER
	SZ Hya	
25700 - 38000 = 12,300		15100 - 34100 = 19,000 (HCO) 15100 - 38000 = 22,900 (all)
Period break JD 26400		Same
	AA Aqr	
21100 - 37500 = 16,400		13100 - 34600 = 21,500 (HCO) 13100 - 37500 = 24,400 (all)
Period constant		Same
	BN Aqr	
21100 - 37900 = 16,800		13800 - 34600 = 20,800 (HCO) 13800 - 37900 = 24,100 (all)
Period lengthening		Same
	RX Cet	
25900 - 37900 = 12,000		11700 - 34300 = 22,600 (HCO) 11700 - 37900 = 26,200 (all)
Period break JD 28400		Period break 27300
	BO Aqr	
22600 - 37500 = 14,900		13400 - 34600 = 21,200 (HCO) 13400 - 37500 = 24,100 (all)
Period constant to JD 29000, then shorter		Period longer than average to JD 30300, then shorter
	RU Cet	
26600 - 38300 = 11,700		11400 - 34300 = 22,900 (HCO) 11400 - 38300 = 26,900 (all)
Period break at JD 28400		Period shortening
	YZ Aqr	
21100 - 37200 = 16,100		13000 - 33700 = 20,700 (HCO) 13000 - 37200 = 24,200 (all)
Period break at JD 27000		Period constant; period noise large.

C O N T E N T S

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