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

Edited by R. Newton Mayall

PAPERS PRESENTED AT THE FALL MEETING OCTOBER 10, 1953

The 42nd Annual Meeting of the AAVSO was held at the Harvard College Observatory October 9 and 10, 1953. All those who came from afar were greeted by one of New England's greatest assets -- the fall color. The foliage of trees, shrubs, and vines was especially beautiful, and it seemed as though nature held back so that her best dress would brighten everyone's spirits after a bleak year. If nature intended this, she was successful, for our meeting was full of action and the good weather added to everyone's outlook, notwithstanding that this probably was the last meeting to be held at Harvard Observatory. It was no shock that Harvard University, in its final report to the AAVSO Council, stated that all connection with the University would cease as of July 1, 1954; and it was with regret that our Vice President, Donald Menzel, and other members of the Observatory staff could not be with us as usual.

Most of the members made a last visit to the Agassiz Station, where the radio telescope was in operation. All had a chance to learn about it in detail; and our host was none other than the genial Bart Bok. Any doubts as to the AAVSO's future were dispelled as each member left Agassiz Station for their respective homes -- the Taboadas to Mexico, the Buckstaffs to Wisconsin via Fernald's in Maine, and many others from afar -- the sun smiling on one and all and the countryside bidding us to come again.

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Our customary pre-meeting evening lecture was given on Friday evening, October 9, by Dr. Albert P. Linnell, Assistant Professor of Astronomy at Amherst College. Subject: ELECTRONICS AND VARIABLE STARS. Dr. Linnell explained a photoelectric photometer with a clarity understood by all. He began at the beginning, from how it works in its simplest form, to the modern expensive complex tubes. Physical exhibits of tubes and other devices were available for inspection, and the general huddle around Dr. Linnell afterward indicated not only how well he treated the subject, but also the great interest among the members in the subject.

USES OF VISUAL OBSERVATIONS OF THE AURORA, by Donald S. Kimball

Visual observations have yielded important information on the frequency of occurrences, average cyclic variations, and general sequence of auroral forms. Analysis of the data has confirmed the theories regarding the association between auroral, geomagnetic, and ionospheric phenomena. To study the broader aspects of a display it appears necessary to rely upon visual observations. The geographical extent and description of the aurora at its southern limit (in the northern hemisphere) can be obtained only by visual observations because most auroral observatories are located in or near the auroral zone.

Specific data which can best be obtained visually are: deviation from the general sequency of forms (particularly glows, pulsating and diffuse surfaces); multiple arcs and bands; identical forms in the sky; location of southern and western edges of the auroral zone during a display; isolated rays; very narrow and/or red arcs; rapid changes in position and form; and descriptions of the aurora at its

most southern point. Data from 27 displays have been analyzed to show average hourly progress of the aurora and the shape of the auroral zone. The relation between an aurora's southern extent and geomagnetic activity shows a good correlation based on more than 4000 visual observations.

Observations from some great displays of the 19th century have been studied and indicate that critical analysis of such data can contribute to auroral theory. Some dates for which additional reports would be welcome are: April 22, 1836; Sept. 3, 1839; August 28 to Sept. 4, 1859, Oct. 24 and 25, 1870, and Feb. 4, 1872. Such reports may be found in scientific publications and newspapers of the day. I would welcome any such reports for the above or other great auroras. (Address: Donald S. Kimball, Yale Observatory, New Haven, Conn. ED.) Preparation is being made for the collection of world wide auroral observations during the next geophysical year -- 1957.

#### SPECIAL ANNOUNCEMENT, by Margaret W. Mayall

During the year 1952-53, the AAVSO passed another milestone in its history: the 1,500,000th variable star observation was received by the Recorder. From June 22, 1953 until the middle of July, a very careful tally was kept of observations received, in the order in which fate (in the form of Helen Stephansky, the AAVSO assistant) placed them on the Recorder's desk. When it appeared certain that the goal had been passed, an accurate count was made, and it was discovered that Curtis E. Anderson, of Minneapolis, was the lucky winner. On July 6, the second envelope opened was from Robert Adams, whose 179 observations brought the total up to 1,499,907. The next envelope contained 270 observations from Curtis Anderson, and his observation of Nova Herculis 1934 (DQ Her) made on June 10, was the winning observation. (Keep up the good work, Curtis! ED.)

#### BIRTH AND DEATH OF AN IDEALIZED SUNSPOT, by Harry L. Bondy

The ideal, exceptional sunspot group is accompanied by all the other well known solar phenomena. A highly magnetic region, detectable through the Zeeman effect, with photospheric faculae, chromospheric plages and flocculi, precede the birth of a sunspot. The large, active bipolar sunspot group is in the center of flares, eruptions, surges, increased radio frequency radiation, noise bursts, increased U.V., X-ray and corpuscular radiation -- the cause of terrestrial, ionospheric (S.I.D.), and magnetic (S.C.) storms. The coronal region above the group emits mostly the green coronal light, with the red and also the rare yellow spectral line, indicating maximal excitation. Associated prominences, extending to high latitude regions, follow the other phenomena and together with faculae, remain even after the last sunspot fades away. Corpuscular radiation from so-called M-regions may be the last feature of this giant solar eruption -- part of the fundamental solar cycle.

#### THE CAMPBELL MEMORIAL VOLUME, by R. Newton Mayall

The long awaited plates, plotted by David Rosebrugh, were received by the Recorder and turned over to me for final layout, pagination, and preparation of plates for publication. I am happy to report that these have been completed and are ready for the printer. There are 53 plates, containing 387 mean light curves of long period variables. (Sample plates were exhibited. ED.)

#### QUESTIONS CONCERNING LONG-PERIOD VARIABLE STARS, by Paul W. Merrill

(No more timely or important paper could have been presented at this meeting. We are grateful to Dr. Merrill for it, and because it will be published in full, it will not be abstracted here. ED.)

## PEP WORK WITH AE AQUARII, by Ronald Chiabotta

On the nights from September 3 through 11, 1953, I had the opportunity to study the actions of AE Aquarii photoelectrically, using the 24" reflector and the 61" reflector of Harvard College Observatory's Agassiz Station. The standard Johnson yellow and blue filters, and a comparison star of similar color and magnitude were used.

AE Aquarii is unique in that its behavior seems to be somewhat in between a flare star and the normal cluster type variable. The most noticeable characteristic is that this star is always active. The average amplitude of burst in yellow was .21 mag. and in the blue .31 mag. The apparent resting point was not constant and varied from night to night by several tenths of a magnitude. The form of the light curves obtained did not show a sharp rise and descent as other flare stars do; but instead showed a rather sharp rise, with the slope of the descent being much slower. In summary, the two most important facts appear to be: (1) the star is always active; (2) While not conclusive, the observations would suggest that AE Aquarii would come closest to the dwarf novae type of variable.

RADIAL VELOCITIES IN THREE RV TAURI STARS, by Helmut A. Abt  
(Paper originally presented at 1953 AAS meeting, Boulder, Colorado)

This is a preliminary report on some high dispersion spectra of three RV Tauri stars. All three stars are classed as members of the low-velocity group of RV Tauri stars. Two of the principal results of the velocity measures are that all three stars have double absorption lines at times and that the velocity curves are discontinuous. Observations of U Monocerotis over a time interval of about 200 days indicate that just before each light maximum a weak set of absorption lines appears displaced shortward. The lines increase in strength as they move toward the red, and then gradually fade. But before they disappear, a new set appears shortward and the sequence of events repeats. This is the same thing that happens in the case of population II cepheid W Virginis. The light curve was supplied by the AAVSO.

The displacements -- in millions of kilometers -- of the layers where the absorption lines are formed, were obtained by integrating the velocity curve and including the normal limb-darkening factor. Since we observe only velocities, we know nothing about the relative positions of any two different layers. The largest expansion observed during this time interval was 80 million kilometers. Since the mean radius of the photosphere is probably about 65 million kilometers, the expansion of the layers where the lines are formed is probably greater than a factor of 2. The largest displacement is associated with the deepest minimum.

Similar data for R Scuti show that the double lines exist primarily at light maxima. One of the plates (JD 2,436,578) had mostly single lines except for a few low excitation lines with longward components which were the remnants of the previous cycle and a few high excitation lines with shortward components which are the beginning of the new cycle. So three absorbing layers are seen, having three different velocities. No triple lines were found, however. The light curve was obtained from the AAVSO. The displacement curves again show that the largest expansion is associated with the deepest light minimum.

Spectra of R Scuti at two different times indicate that in the lower spectrum the lines are single. Many of the lines in the upper one are double, such as 4554 Ba II, 4563 Ti II, both the Mg I and Ti II lines at 4571, 4589 Ti II, and 4592 and 4602 of Fe I.

In AC Herculis, apparently, it frequently happens that lines from three layers are seen at one time. As with R Scuti, I didn't find any triple lines, but only many single lines and a few shortward or longward components. At light maxima the lines are double with about equal relative intensities. This light curve was also provided by the AAVSO. The largest displacements, which are associated with the deepest minima in this star also, amount to 135 million kilometers. Compared to a probable mean radius of 45 million kilometers for the photosphere, we obtain an expansion by about a factor 3.

The general spectroscopic behavior of these three low-velocity RV Tauri stars is therefore very much like that of W Virginis. We are led to conclude that RV Tauri stars and population II cepheids, or W Virginis stars, are essentially similar in behavior -- except possibly for the degree of regularity shown from one cycle to the next. This is the same conclusion that was reached by Arp on the basis of very different material. It is also suggested that the periods of RV Tauri and W Virginis stars be chosen in a like manner -- probably as the times between successive minima, rather than twice this quantity.

MARTHA, MARGARET, AND THE MOON, by John J. Ruiz

The light curve of u Herculis on which I have been working for the last two years is here presented. This variable is of the Beta Lyrae eclipsing binary type. The period is very short -- two days and one hour. The stars are very close together and are distorted by tidal forces. The secondary minimum is very pronounced, indicating that the stars are of about the same luminosity. These curves have been taken in two different wave lengths, one in the yellow part of the spectrum and the other in the blue. It is believed that this would help in making a better determination of the coefficient of limb darkening. An attempt will be made to determine the photometric elements. There are indications that the secondary minimum is displaced from the midpoint of the eclipse in the blue. The minima in the yellow seem to fall exactly where predicted. This point will have to be further investigated.

As far as I know, this is the first time an amateur has been able to make a complete set of observations of the light curve of an eclipsing variable with photographic equipment! (John's curves are beautiful; but what has that to do with Martha, Margaret, and the Moon? Obviously the title refers affectionately to our President and Recorder, respectfully, and they are the subject of John's delightful cartoons which are impossible to describe, but are extremely poignant bits of humor that title all his papers. Tit for tat, John! ED.)

ON ERRORS OF MEAN LIGHT-CURVES, by Dorrit Hoffleit

In the determination of mean light-curves of long-period variables, the amount of work involved should be geared to two main considerations: (1) the degree of accuracy intrinsic in the observations themselves; and (2) the ultimate purpose of the mean curves. Dr. Merrill's paper brings out some of the uses of the curves. When they are needed for planning astrophysical observing programs an accuracy to the nearest half magnitude would ordinarily appear adequate.

When Leon Campbell determined the mean curves to be published in the Campbell Memorial Volume, he first obtained the 10-day mean curves. For these he took straight-forward averages of all the observations within successive 10-day intervals. He then superposed the curves for all available successive light cycles to obtain one composite curve. The magnitudes of this curve at 10-day phase-intervals are the simple averages for all the cycles represented.

From time to time the Recorder hears criticism of this procedure. The chief objection is that before brute means are taken for the 10-day intervals, the observations by all the individual observers should be reduced to one "standard" system. In principle this objection is valid. Systematic differences between the results from different observers are inevitable, especially when red variables must be compared with a sequence of less red or even blue comparison stars. But are these systematic errors of sufficient magnitude to justify the considerably greater time and effort that would be involved in the determination of the means? Although he published little on this subject, Mr. Campbell was surely aware of the problem and must have given it considerable thought. I have looked into the matter only briefly, in order to glean some general impressions on the basis of which the acceptance of Mr. Campbell's work appears justified.

I have made a few spot-check intercomparisons for a few observers, based on the original data published in Harvard Annals, Volumes 104 and 107. Rarely does the systematic difference exceed  $0^m.1 + 0^m.1$ . In other words, while small systematic differences are indicated they are overshadowed by the much larger random (accidental) differences, so that the reality of the systematic effect may well be questioned. Usually the scatter of the observations by any single observer about his own mean light-curve for a particular star amounts to a few tenths of a magnitude. In the comparatively rare instances when the systematic errors exceed the average random errors, the application of systematic corrections should not be neglected. Such cases are not apt to escape detection, as the Recorder habitually plots all observations as they are received. In general, however, the procedure for obtaining 10-day means adopted by Mr. Campbell does not sacrifice any of the precision intrinsic in the original observations.

As long-period variables seldom repeat themselves in the shapes of successive light cycles, a mean curve based upon 10 to 20 cycles will rarely represent any one cycle exactly. While an individual 10-day mean curve may be determined to a precision of say  $0^m.1$ , the deviations from the overall mean curve may exceed  $0^m.5$  and vary appreciably with phase. A case in point is T Cassiopeiae, whose mean light-curve is based on the data for 16 cycles observed between 1922 and 1941. From a brief analysis of the data I find the following standard deviations:

- (1) The standard deviation of the observations by a single individual (J) about smooth curve-segments through his own observations is  $\pm 0^m.2$ .
- (2) The standard deviation of any one observation (by any observer) within any 10-day interval from the mean for that interval is the order of  $\pm 0^m.3$ .
- (3) The systematic difference between observer J and another prolific observer is  $0^m.1 \pm 0^m.1$ .
- (4) The standard deviation of a point on any one cycle (represented by its 10-day means) from the final light-curve depends on phase and varies from 0.2 to 0.5. Actual deviations as large as  $1^m.1$  are found. The largest deviations occur at the steepest portions of the light-curves.

In comparing the observations by J with those of one other observer, I found for two successive cycles almost complete agreement at maximum light, but an apparent large systematic difference at minimum. This indicated difference, however, depended on less than ten single scattered observations and was not confirmed by more extended observations or by observations of other stars in the same magnitude-interval. Such apparent trends of errors must be scrutinized with great care; for the application of spurious systematic corrections is both time-consuming and can cause more eventual harm than good. Unless the systematic corrections are well established, it is preferable to neglect them. To summarize, the procedure adopted by Mr. Campbell for what is now to become the Campbell Memorial Volume seems the most desirable from the standpoints of attainable accuracy of the accumulated observations, reasonable economy and efficiency in compromising time expended with accuracy and usefulness to astrophysicists. Procedures to be adopted in the future may eventually differ from his if needs for higher accuracy arise.

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