AMERICAN ASSOCIATION OF VARIABLE STAR OBSERVERS

ABSTRACTS

OF

PAPERS

PRESENTED AT CAMBRIDGE MEETING

16 OCTOBER 1971

CONTENTS | PAGE

187 Concord Avenue, Cambridge, Massachusetts 02138

AAVSO ABSTRACTS

Edited by R. Newton Mayall

The AAVSO held its 60th anniversary meeting at the Harvard College Observatory, 15 - 17 October 1971, at the kind invitation of the Observatory.

As usual the weatherman was kind to us and provided beautiful weather throughout the meeting. It was unusually warm for this time of year, a phenomenon which every one enjoyed.

Friday afternoon, the 15th, Dr. Dorrit Hoffleit conducted a symposium on The History of Variable Stars and the AAVSO. (Papers presented are included below.) In the evening Dr. Helen Sawyer Hogg of the David Dunlap Observatory, Toronto, Canada, gave a talk on Variable Stars in Globular Clusters - A Lifetime Fascination. (see below).

Saturday morning the usual business session was held, and papers were given in the afternoon. Our banquet was held in the Hotel Continental, following which Newton Mayall presented the 20th Merit Award to:

RICHARD H. DAVIS

for

His untiring loyalty and devotion to the Association, his competent and faithful service as treasurer for the past ten years, his valuable legal counsel, and service to the Solar Division.

October 16, 1971

After that Carolyn Hurless presented Margaret Mayall with a lovely crewell embroidery of the AAVSO star with the dates 1911 - 1971, made by Lynn Raynor. (It now hangs over a door at headquarters.) Then Dr. Owen Gingerich gave the 10 highlights of the year, which was a talk following the series originated by Dr. Harlow Shapley.

The announcement everyone had been waiting for was made by Margaret Mayall. Who made the 3,000,000th observation? It was made by Ernst Mayer of Austria. The usual telegram was sent to him.

And last, but not least, was a showing of the movie put together by Lewis Boss containing his pictures and some from Clinton Ford. This is a film showing members at the annual and spring meetings from 1926 - 1959, first shown at our 50th anniversary in 1961.

Sunday was a beautiful day to go to the country and quite a few went to Harvard's Agassiz Station and had a picnic lunch there together with cider and McIntosh apples. Headquarters was also open from 9 to 4, for breakfast and general inspection of our expanded quarters.

It is only necessary to mention one person who traveled the farthest to this meeting. He so far outdistanced anyone else, it makes the rest of them seem next door neighbors. Leonard Kalish came from Los Angeles, California and we hope he felt the trip was worth it. We were glad to have him with us.

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VARIABLE STAR OBSERVING IN AMERICA BEFORE AAVSO, by Joseph Ashbrook

The full history of variable star astronomy in America deserves book-long treatment, preferably by Dorrit Hoffleit. But meanwhile the story should be sketched of a few professionals and a few amateurs whose activities led toward the founding of AAVSO in 1911.

1971 - 1911= 60 years, and 1911 - 60= 1851, a good starting point for our story. This was only about a decade after Harvard Observatory's founding. In 1851, only about 30 variables had been discovered, and variable star astronomy, though well started in Germany and England, was still zero in the United States.

The first American specialist in variable stars appears to have been Stillman Masterman, amateur and farmer of Wells, Maine, who began observing in 1856, when he was 25 years old. Masterman limited himself to naked-eye stars -- possibly he had no telescope -- but he set a remarkable record. He managed to observe 46 minima of Algol in just seven years, before he died of consumption at the early age of 32. He was a man we would have been delighted to have in our ranks.

Stillman Masterman was an isolated figure. There were several reasons why variable star work started so surprisingly late in America. One was the absence of any reasonably complete and reliable atlas of even naked-eye stars until Argelander in Germany published his Uranometria Nova in 1843. This same

Argelander about 1840 introduced the step method of observing, the first effective technique when there are no good photometric magnitudes for comparison stars. Also, Argelander's group published the first really useful atlas of telescopic stars, the Bonner Durchmusterung, of which the first section appeared in the late 1850's. For the first time, fields of faint variables became readily identifiable. Thanks to Argelander, variable star workers in Europe were well equipped by the 1860's, and this vigorously expanding branch of astronomy finally crossed the Atlantic. One of the leaders in the American group of observers was Benjamin Apthorp Gould, the first American astronomer to get professional training in Germany, who founded the Astronomical Journal and directed Dudley Observatory in Albany. His variable star work was done in South America, however, to which he was called in 1868 to found Cordoba Observatory in Argentina. His first big task there was to chart all southern stars to magnitude 7 for an Uranometria Argentina. In this task, Gould and his helpers in 1871 - 74 discovered a dozen new variables, including the Cepheids T Monocerotis and l Carinae, the Algol star U Ophiuchi, and the red irregular U Hydrae.

Beginning as early as 1877 when he timed a maximum of Mira, Edwin F. Sawyer made a distinguished name by his variable star work at Jamaica Plain in Massachusetts. Sawyer lived long enough to join AAVSO in 1921. He carried out an interesting project in 1882 - 90 by determining the visual magnitudes of 3,415 stars between declinations 0° and -30° and brighter than 7, by interpolating each between stars that had been measured photometrically at Harvard. In this survey Sawyer found the Algolid R Canis Majoris and the Cepheids U Aquilae, Y Ophiuchi, Y Sagittarii, and T Vulpeculae, among other variables. Some amateur should undertake a carefully planned photoelectric survey along similar lines!

Seth C. Chandler was the dominant variable star worker of that time, whose interest began when he codiscovered the nova T Coronae Borealis in 1866. Though a versatile and distinguished astronomer, he remained an amateur. His three famous catalogues of variables show the growth of our subject; his first, in 1888, had 225 stars; the second, in 1893, had 260; the third, in 1896, had 393. Chandler lived in Cambridge, Massachusetts, just around the corner from Harvard Observatory.

The real hero of our tale is Edward C. Pickering, who became Harvard Observatory director in 1877, when he was 31. Trained as a physicist, his interests centered around stellar photometry, stellar spectroscopy, and celestial photography. He began by inventing photometers by which he measured the visual magnitudes of naked-eye stars.

From the stars he was fascinated by variables. In 1881 he published a remarkable paper showing that his photometric measures of Algol and U Cephei implied these were eclipsing binaries -- first solid evidence that such existed.

Pickering originated the idea of a photographic sky patrol. From the mid-1880's on, the sky was photographed with wide-field cameras at short intervals. This operation was continued into the 1940's, so that about 2,000 or 3,000 photographs are available for any variable star brighter than magnitude 10. Pickering also used these photographs for discovering new variables, by superimposing a positive and a negative of two plates taken at different times. This simple method was so effective that when Pickering died in 1919 some 3,400 variables had been discovered by his staff, whereas only about 200 were known when he became director at Harvard in 1877.

The scope of variable star astronomy was greatly enlarged by Harvard Observatory in that interval. Telescopes both in Cambridge and at the southern station in Peru took photographs that showed the globular clusters contained numbers of half-day Cepheidlike variables. By 1908 Henrietta Leavitt of Pickering's staff had discovered nearly 1,800 variables (mostly classical Cepheids) in the Large and Small Magellanic Clouds. From this came her publication in 1912 of the period-luminosity relation for Cepheids -- to this day a most powerful tool for measuring cosmic distances.

Edward Pickering was the most influential American astronomer of his time, and his enthusiasm for variable stars did much to spread interest in this field. Other centers sprang up at Georgetown College Observatory (Rev. J. G. Hagen), at Leander McCormick Observatory (C.P. Olivier), the University of Missouri (where Harlow Shapley did his first work), Princeton (R. S. Dugan), and the University of Illinois (where Joel Stebbins pioneered in photoelectric photometry.)

Pickering from the start worked hard to stimulate amateur work on variables, distributing instruction pamphlets and charts, and determining comparison star magnitudes. The campaign of regularly observing 17 Mira stars began in 1891. These observations were made partly by cooperating amateurs, partly by staff members (especially O. C. Wendell and Annie Jump Cannon.) The results for 1891 -1899 were published in Harvard Annals Vol. 37. Then came publication of similar results for 58 Mira stars in 1902, one of the new observers being Leon Campbell, who joined the observatory staff in 1899 and after the founding of AAVSO in 1911 was its central figure for 30 years.

This Harvard-centered cooperation grew, and shortly before 1910 was extended to all known long-period stars north of declination -25°. Many well-known amateurs took part, such as Frank Seagrave (Providence, R.I.), J. H. Eadie (Bayonne, N.J.), and P. S. Yendell (Dorchester, Mass.). The astronomy departments and students at women's colleges in the northeastern United States took an especially active role, especially at Vassar and Mount Holyoke.

The founding of AAVSO an October, 1911, was actually the outgrowth of the cooperative effort that began in 1891, with a shift toward greater amateur participation. The transition was smooth. Those personalities active in the early stage were also active in AAVSO, and headquarters remained at Harvard Observatory.

Thus, while October, 1971, was officially celebrated as the 60th birthday of AAVSO, it might with some justice have been called its 80th.

PERSONALITIES IN THE AAVSO, by R. Newton Mayall

When Dr. Hoffleit asked me to take part in this symposium she bludgeoned me with the statement that I was old enough to know all the people that were the backbone of the AAVSO, in the early days. The idea was to tell you something about these men and women. But then the Treasurer and the Director got into the act -- they both had some ideas as to what I should say. Therefore I'll try to put it all together.

As you know, our founding date was 1911, which makes this year our 60th birthday. If I remember correctly I made my first visit to Harvard Observatory in the spring of 1918. I met a short, somewhat pugnacious man sitting behind a large desk in the corner room of the old Building A. He was surrounded by books - on the walls, the desk and tables. At first I guess I was a little bit scared, but I soon found out I could talk to him and found him to be a kindly soul, for I was just a kid at that time. I found his name to be Leon Campbell, which didn't mean too much to me then. Well, the upshot of the whole thing was that he got me interested in variable stars and told me how to observe them. In fact, he loaned me a 3-inch telescope that had been given to the association by Signor Lacchini, of Italy, who was one of the first observers. (I might say here that our Director had the pleasure of visiting Lacchini and his family shortly before he died.) Leon Campbell was the first Recorder of the AAVSO (his real title was Recording Secretary). He gathered the observations, supplied charts, trained people in Observing, and many other details. Just as our Director is today, he was a very busy man -- a very much overworked person. But he seemed to enjoy his work.

From 1911 to the time I joined the AAVSO it had grown in numbers of observers. At my first annual meeting in Cambridge, I met quite a few of the members -- about 20 -25. I was a boy among men. I was not shy, neither was I forward; but one thing I found out about these men was that they would talk to me -- they never shoved me aside, as much as to say, "What's that kid doing here?" I was treated like any other AAVSO'er. It was this congenial spirit that pervaded the members, that always interested and impressed me. Therefore I want to describe some of them to you.

First,therewas William Tyler Olcott. It was he with Edward C. Pickering, the Director of Harvard College Observatory, who really started the AAVSO. Olcott had a telescope and before 1910 he had written several books on astronomy, including his famous <u>Field Book of the Skies</u>. In 1909 he visited Harvard and saw an exhibit of light curves of variables that Harvard had under observation. These intrigued him and he later wrote to Pickering asking if he could become a variable star observer. In January 1910 Pickering gave Campbell permission to go to Norwich, Conn. to initiate him in "the art of observing variable stars." His first observations were made in February 1910 and in the March 1911 issue of Popular Astronomy he published what was probably the first article of its kind, under the title ot "Variable Star Work for the Amateur with a Small Telescope" wherein he gave detailed instructions for locating and observing variable stars, together with charts. Shortly after that he got busy and the first report of the AAVSO was published in the November 1911 issue of Popular Astronomy. Thus was the AAVSO born.

There were only a few observers and Olcott took over the task of receiving and publishing the observations, for Campbell was being sent to Peru. Olcott did this until Campbell's return in 1915, when he took over the work.

Olcott was a lawyer, and the older members used to refer to him as "the idle rich," because he didn't work at the profession. His love was the stars. He was a tall thin man, well dressed, and sharp featured. He was the first secretary, a position which he filled until 1936.

Another quite congenial and impressive man was J. Ernest G. Yalden, a professor of mathematics at Brooklyn College. He was a tall thin man with a large brown beard, always sucking on a pipe, and was often referred to as "The Baron." He was always conjuring up mathematical formulae. He had an interest in navigation, and was very much interested in sundials.

In any group you should have a doctor present. We did in Dr. Charles Godfrey, a physician and surgeon from New Haven, Conn. He was a quiet man with a beautifully clipped gray beard, which certainly gave him the air of a gentleman -- and he was. Godfrey's beard did not provoke a nickname as did Yalden's.

We had a railroad engineer too. His name was Charles Y. McAteer. Our library is named after him for his generous gift of many volumes on astronomy. I remember him as the man who always came to meetings in a dark suit, a starched white wing collar, and a black tie. He was a quiet man, and our first librarian.

Then there was Charles Elmer, a court stenographer. He was a portly gentleman, wearing his hat askew, always joking. They used to say his astronomical life was 99% enthusiasm and 1% experience. He had more telescopes than anyone. But his one observation was always a source for humor. Later he became one of the founders of the Perkin - Elmer Corporation.

Elmer never could do anything unless Olcott, Yalden, and Campbell were around. This trio went to Southhold, Long Island, where Elmer had his summer home, to set Elmer's telescope. I would like to read you a short excerpt from the poem Olcott wrote about it: --

"What are they goin' to do tonight?"
 Remarked the simple soul.
"Just set the glass, just set the glass,"
 Replied the Baron droll.
"What do they want to set it for?"
 Remarked the simple soul.
"Nobody knows and he won't tell,"
 Replied the Baron droll.

For they're settin' Elmer's telescope,
And no one knows just why,
The owner just admires it, and prefers to save his eye;
So the experts keep adjustin', and they'll get it by and by.

David B. Pickering was a jeweler, and no relation to Edward Pickering. He was bald and bow-legged, and had a pipe organ voice that could be heard from here (the observatory) to Harvard Square. When he began to talk you listened. No one else could compete with Dave. He was our first President, 1917, 1918, and initiated the Nova Award for the visual discovery of a nova.

In 1921, Dr. Harlow Shapley became director of the Observatory. He became directly involved with the AAVSO. He was also one of our presidents. Probably some of the older members twisted his arm for he, throughout his tenure as director, invited us to hold our annual meetings at the Observatory, and what is more he and Mrs. Shapley provided bounteous teas for us on Saturday afternoons. I need not dwell on Dr. Shapley, for many of you knew him.

We have had many professional astronomers as members. Perhaps it is because they believed in the amateur that we have gone so far and have observers scattered all over the globe. But there are two that I want to mention -- Annie J. Cannon and Anne S. Young.

Miss Cannon was on the staff at Harvard and was an early member. Her love was the spectra of stars. She was full of fun and always doing something for us. Her love of the AAVSO was second only to her spectra. We had many good times at her home on Bond Street, which she called "Star Cottage."

Miss Young was Director of Williston Observatory at Mount Holyoke College. She was a tall, slim, gentle person. She did much to help and encourage young people, and she was our third President.

The ladies have always played an important role in AAVSO affairs. Among our presidents have been Alice Farnsworth, Director of Williston Observatory, Mt. Holyoke; Harriet Bigelow, Director of Smith College Observatory; Helen Sawyer Hogg, David Dunlap Observatory; Marjorie Williams, Director of Smith College Observatory; Martha Stahr Carpenter, Cornell University Observatory; and Dorrit Hoffleit, Director, Maria Mitchell Observatory. All have gained prominence nationally.

Of course our presidents have included many amateurs. While we are on this subject I might bring out one point. There has been only one secretary who is a professional astronomer -- Clinton Ford. He became secretary in 1948. For his devotion and loyalty to the association we owe a deep debt of gratitude. We have had only one professional astronomer as treasurer -- Willard J. Fisher, at Harvard, who served for one year. And as presidents we have had 12 amateurs. But in our 60 years we have had only two directors -- both professional astronomers.

What I am trying to point out here is that the AAVSO is really run by and for the amateur astronomer, with a little parental guidance from the professional thrown in here and there. That is the way our founders wanted it.

I have mentioned how the AAVSO got started, but Olcott's article in 1911 did the damage, for it was not long after that we had members on the west coast and in the midwest and Italy. There was J. H. Skaggs, who printed our Variable Comments for many years. And there was D. F. Brocchi whom most of you know as D.F.B. on your charts. C. F. Barnes, also on the west coast, was another printer who contributed much to our publications, as well as a general guide to the skies which he authored.

I'm not sure whether anyone ever saw these far away observers, but through their letters they made many lasting friendships. In the midwest we have Leslie Peltier. He was one of our early observers who has made a most enviable record, having made monthly reports, without interruption, since March 1918. He has made many contributions to the AAVSO and to his community. Many new comets bear his name.

We have had many members like Peltier, young men and women who have grown up in AAVSO, and gone on to higher fields of science. I would like to mention some of the young people of my day, and in what fields they are now working. Some of them you may know. The roll is long, and they were encouraged to pursue successful scientific careers. Among them we find Dr. Walter S. Baird (Physics); Dr. James G. Baker (Optics, Astronomy); Dr. Peter Millman (Astrophysics, Meteors); Dr. Donald Menzel (Astrophysics); Dr. Willem J. Luyten (Astronomy); Dr. Elizabeth Roemer (Comets); Dr. Martha Stahr Carpenter (radio astronomy); and Dr. Helen Sawyer Hogg (Variables in clusters). You will hear from her tonight.

Margaret and I have traveled widely, and we always try to meet with our members in foreign lands. In this way we bring the AAVSO to them. And this is very important. This summer we met with some of our German members at Manfred Dürkefälden's home in Hannover. The members came from as far away as Berlin. We had a wonderful time and found them to be just as all AAVSO'ers everywhere -- a great bunch of people.

When Mr. Campbell retired, it was said "The old era has now passed, but a new and brighter era lies ahead for the AAVSO." When I look at all those machines and punch cards in our expanded headquarters that statement is more applicable today.

In closing I would like to read another short poem, by Anonymous:--

Come join the A.A.V.S.O. and have a glorious time;
To watch the stars requires no sense,
Or intellectual eminence,
Or scholarship sublime.
For Jonesey's records give us hope,
Made with one six-inch telescope.

You need not have ten telescopes
As Charlie Elmer has,
Who with his instruments galore
Does nothing in particular,
And does it very well.
For Peltier's comets give us hope,
Found with one six-inch telescope.

PHOTOELECTRIC PHOTOMETRY IN THE AAVSO, by John J. Ruiz

It all began way back in 1949 when Dr. Kron, then at Lick Observatory, published an article in Sky and Telescope giving the workings of a photoelectric photometer (PEP for short) which caught the eye of an electrical engineer who was also an amateur astronomer. After many painful experiences, failures and disappointments, he finally assembled a PEP and started working on the variable 12 Lacertae. The data were published in the JRAS of Canada, September 1951. Other amateurs followed. I'd like to mention a few, starting with the youngest.

Robert Farmer of Houston, Texas had a fine outfit but, due to his work at Rice University, he did not publish any of his results.

Our own Dorrit Hoffleit had a 6-inch reflector which she turned over to her protegee, Frances Ruley of Nantucket, Mass. However, Frances never published any observations and turned to journalism instead of astronomy, at her college.

Arthur Stokes has a fine 16-inch reflector on a concrete pier good enough for a naval gun. He now has a newer type of amplifier that weighs less than a pound, instead of the 30 pounds or more of the old amplifiers. Art has made good use of his equipment and obtained good results with several variables, among them a number of minima of RZ Cas, and BV382, which have been published in several journals both domestic and foreign.

Our late friend Donald Englekemeir of Hinsdale, Illinois did good work on the flare star AD Leonis, published in PASP No. 423, 1959. His timings of Algol were published for several years in Sky and Telescope.

The present outstanding PEP observer of variables is undoubtedly Larry Lovell, who has done excellent work with his fine equipment.

There is a complete PEP outfit in California at the Ford Observatory on Mt. Peltier, but Clint informs me that it is not used at present as they prefer visual observation of faint variables, using the 18-inch Carpenter reflector.

Prof. Francis Reynolds of Clarkson College, Potsdam, N.Y. had a complete PEP outfit attached to his 10-inch reflector, but to my knowledge has not reported any work with his photometer.

Across the border in Mexico is the observatory of Don Domingo Taboada, in Puebla. He has a splendid outfit made by professionals. He has done some work on a few southern variables, including R Canis Majoris. His telescope is a polar refractor, similar to the one that stood for many years right here (Harvard) on Building A, but more elaborate. All observing is done inside a domed room away from the cold, or the mosquitoes.

Howard Landis, of East Point, Georgia, has done notable work with a photometer and amplifier of his own design. He uses an indicating meter instead of a recorder.

We are all indebted to Lewis Boss, first Chairman of the PEP Committee, and Donald Englekemeir, for the writing of the Photoelectric Manual which was first published by the AAVSO in 1962.

Now, I would like to mention one light curve that has an interesting story. It is the light curve of BV 382 in Cepheus. The period as given by the Bamberg observers from photographic observations was $0^{d}4832$. Arthur Stokes discovered that this was greatly in error. In fact the period was closer to double that figure, or $0^{d}9362$. One night, at the instigation of Art Stokes by long distance conversation, I was able to observe this star for about 8 hours continuously from sunset, when it was coming out of eclipse, to sunrise when it was going down into eclipse. There was no deepening of the light at the mid-point predicted by the Bamberg Ephemeris. This period was confirmed by the observations of the Italian astronomer C. R. Bartolini of Bologna, Italy.

Anybody entering this field (PEP) will be beset with many difficulties, frustrations and failures. It would be well to master the elements of physics and electronics. Also try to be friendly with the many gremlins that will try to frustrate you at every step and take great joy in giving you results which are meaningless. A whole night's effort wasted. But eventually you will come out with a beautiful curve that will make your foe pace up and down in dire gloom.

Finally after years and years of study and many disappointments you may achieve the degree of Doctor of Photoelectricity, which of course is abbreviated DOPE.

And here, for the record, is some of the work done by a few of our members:

Arthur J. Stokes - Hudson, Ohio

- RZ Cas - Many minima published in Sky and Telescope and the Russian Journal, Variable Stars
- BV382 - Sky and Telescope June 1965.
- R CMA; i Boo; 32 Cyg; and Nova Del. 1967 - IAU Commission 27 Bulletin (IBVS) 224 and 226.

Larry Lovell - Chagrin Falls, Ohio

- 1967 Light curve of beta Lyrae with A.D. Mallama, paper OTAA meeting of Western Reserve Academy.
- 1967 Light curve of Nova Del with D. Henning, Published Review of Popular Astronomy Vol. LXII, #549 and IBVS 224.
- 1967 Light curve of beta Persei with D. Henning and G. Gliba. Published IBVS 247.
- 1968 Light curve of beta Lyrae with D. Henning, paper in AAVSO Abstracts, Spring 1968.
- 1969 UBV photometry of beta Lyrae, No. 1. L.P. Lovell, and Dr. Douglas S. Hall, Dyer Observatory. Published PASP Vol. 82, 345.
- 1970 UBV photometry of beta Lyrae, No. 2. L.P. Lovell and D.S. Hall, Dyer Observatory. Published PASP Vol. 83, 493.
- 1970 On the periastron effect in beta Arietis. L.P. Lovell and D.S. Hall, Dyer Observatory. Published PASP Vol. 83, 493.
- 1971 Dimming of star light by atmospheric extinction With A.D. Mallama. Paper at OTAA meeting, Western Reserve Academy.

Howard Landis - East Point, Georgia

- Nova Delphini 1967.
- RZ Cassiopeia. Several eclipses.
- Algol. Published in Sky and Telescope, January 1971.
- For the past year, observations of stars of M, N, and S spectra.
- Did some work for Clinton Ford and Charles Scovil on the charts for Nova Ser, and Nova Aql.
- Measured 11 stars near M-32 for John Bortle.
- 1971 Worked on a program for Larry Lovell and D.S. Hall observing beta Lyrae in the UBV. To date he has made 30 observations for this program.

John J. Ruiz - Fort Lauderdale, Florida.

- 12 Lac. J.R.A.S. Sept. 1952; Bulletin of Astronomical Institute of the Netherlands, 12 November 1953.
- Annales d'Astrophysique. Tome 15 No. 2, 1952 p. 5.
- u Her. PASP Vol. 69, No. 408, June 1957.
- Pleiades. Sky and Telescope Nov. 1955.

RZ Cas. Numerous minima published in Sky and Telescope and IBVS.
BV382. In collaboration with A.J. Stokes (see above).

HISTORY OF THE SOLAR DIVISION, by David W. Rosebrugh

The work of the Solar Division has been a group enterprise. We have no ace observers comparable to the outstanding observers of variable stars. Observational consistency always has been of prime importance. If it could be achieved it would produce a group of sunspot counters all of equal ability. Because we have come so close to achieving it, there are no folk heroes among us.

To understand both the history and work of the SD we must start in Zurich, Switzerland, in the year 1848 -- 96 years before the SD got under way. In 1848 Rudolph Wolf started the so-called "relative sunspot numbers." He counted the spots and also the groups into which they are assembled. A single isolated spot also qualifies as a group. He multiplied the number of groups by 10, added the number of spots, and the sum was his so-called Wolf number or "counting" for the day.

Wolf used a 64 x 80mm Fraunhofer refractor with a focal length of 1100mm, and a polarizing helioscope to dim the sun's brightness to whatever degree was optimum. He did not count very small spots which were visible only when the seeing was good.

About 1882 Wolf's successors decided to include these very small spots and to count something extra for spots surrounded by penumbrae. This method of counting increased the Zurich daily countings and from 1882 to the present they have multiplied each daily counting by a factor, K, of 0.60 to reduce their current countings to the same scale as those of Wolf.

During World War II the time was ripe for us to set up a systematic program for counting sunspots, in this hemisphere. At the Annual Meeting of the AAVSO 6-7 October 1944 Dr. Harlow Shapley introduced Neal Heines to us. He urged the AAVSO to form a Solar Division. This was done and we were on our way, with Heines as Chairman.

No formal instructions were given, but we were told to "Use a small refractor as much like that in use at Zurich as you have available." This was good advice as we shall see later. Report blanks were not available at first, but some 30 or 40 of us simply went out and counted sunspots and groups. The first formal monthly summary, based on SD observations, was for December 1944.

A paper by Alan Shapley, in Popular Astronomy, lists 44 observers for 1945. Five of them are still active in the program -- Ralph Buckstaff, Thomas Cragg, Victor Estremadoyro, Cyrus Fernald, and David Rosebrugh. Herbert Luft's name does not appear in this 1945 American list, but he has a record extending back more than 4 decades of contributing to Zurich. He joined the SD of the AAVSO at an early date.

The observations of a group of 30 or 40 people cannot be handled as simply as those of Zurich. In essence Zurich takes a single observation of one man, usually Dr. Waldmeier, and multiplies it by the K-factor 0.60, and that is the Zurich number for the day.

In America we cannot take the arithmetic average of all observations submitted for one day, and multiply it by 0.60 or any other constant. We must allot each observer a scale constant K, the size of which depends on his apparatus, visual acuity, how good his seeing is, how carefully he observes, and his habits with regard to counting groups and very small spots, and perhaps other factors. Each observer's constant is applied to his daily observations before his countings are placed in the daily pool from which the American relative sunspot number for the day is determined.

The statistical method for allotting each observer a K factor, and 8 years later a reliability factor W, was worked out by Alan Shapley of the National Bureau of Standards.

Tying in the American results with the corresponding Zurich relative sunspot numbers involved quite a considerable amount of study on the part of Alan Shapley and has colleagues at the NBS. After the war, and when better equipment became available another tie-in was made necessary in 1952.

During Neal Heines chairmanship (1944-1953), almost all of the AAVSO side of the program was handled by him. He issued a Solar Bulletin and monthly summary sheets for our observations.

In 1953 Harry L. Bondy took over the Chairmanship from the ailing Mr. Heines, who died shortly thereafter. Bondy arranged to have an Instruction Pamphlet prepared for new observers. He issued an excellent series of Monthly Bulletins for SD members, and investigated some of the fundamental differences between the way Zurich makes its daily countings and the American method. Calculations of our daily and monthly sunspot figures were delegated to Rosebrugh and later to Dr. Sarah J. Hill of Wellesley College.

During Bondy's tenure (1953-1963) two studies were completed for Dr. Gleissberg of Constantinople (now Istanbul). We were trying to find out if there was any asymmetry in the apparent distribution of spots. There was an impression that more are visible west of the central meridian than east of it. Apparently this study was never completed.

In 1963, Casper Hossfield took over from Bondy. A new Instruction Pamphlet, and a Beginner's Kit for new observers were prepared. Hossfield selected Richard Davis to do the computing. Davis succeeded in putting the calculation of the American numbers on a computer. These computations are much more complete and informative than those which were formerly available. The aim of both Hossfield and Davis was to get observers to be accurate, and this is not a simple matter. All sorts of imponderables enter the picture. As Dr. Waldmeier says, "When is an agglomeration of spots, two or more groups? Some observers will count an object as a spot, others will consider it an ephemeral pore, and some will not see it at all." No solutions leading to increased accuracy seem to be forthcoming so far.

Sunspot counting suffers from some observational problems which are quite different from those that confront a variable star observer. Three of these problems are: -

1. There is no absolutely correct figure for the sunspot count on any one day or even at any one instant.
2. Sunspot counting suffers from what might be called a poor public image.
3. American observers using direct vision have used dark filters in the past. They chose a filter that gave a satisfactory brightness, whereas Zurich uses a polarizing helioscope that gives maximum brightness for the day in question.

There is one other perennial problem. How do we keep the observers informed as to how well they are doing compared to other observers and compared to the results of the group as a whole.

The Solar Bulletin is still being issued. Hossfield has added graphs showing monthly plots of the American and Zurich numbers. Another addition is the inclusion of members with electronic equipment who search for abrupt events, such as the Sudden Enhancement of Atmospherics (SEA), Sudden Enhancement of Signals (SES), and Sudden Ionospheric Disturbances (SID). Some 16 members are active in this work including one in Durban, South Africa and 15 spread across the United States.

Of late the SD has been issuing a monthly computer sheet showing each observer's computed scale for factor K, and his reliability or weighting factor W.

Under Hossfield the SD is quite flourishing, and Davis has just issued a 12-month computer summary from mid-1970 to mid-1971. It shows that 53 active observers made 4626 observations in a year. Sixteen of the observers did 66% of the work, averaging almost 200 days a year apiece. This seems an astounding record.

Now, what about the future?

For the past 19 months the SD has carried on a research program. The observational runs for the first two phases were completed 31 August 1971. Some tentative conclusions may be drawn. Others may not agree with these impressions, but here they are.

Phase 1 - As a practical matter, anyone entering the SD program now, who wishes to use a small refractor of reasonable price, must buy a Japanese telescope. Those that have been tested gave very good results, therefore the SD can assure anyone that suitable equipment is available at a reasonable price.

Phase 2 - An attempt was made to determine the telescope aperture and magnifying power that would give the most consistent observations in the American program. Small telescopes with powers lower than 90 were tested, and showed up best. This is in accord with Dr. Waldmier who says, "Foreign observations obtained with instruments -- not diverging too much from those in Zurich, can be adapted to the Zurich scale."

Phase 3 - This began on 31 August 1971. It is an attempt to develop a regimen which will give close correspondence with Zurich results every day. Zurich uses a 64x80, 1100mm f.l. refractor with a polarizing helioscope, and adds a few points daily when large umbrae and penumbrae are seen. The exact method Zurich uses to give this weighting to umbrae is unknown. The telescope used in the American research program is a 60x76, 1200mm f.l. Japanese refractor with polarizing solar eyepiece. A suitable scale of additional points for large umbrae and penumbrae has been drawn up. In addition the counting, made in Florida, for each day is moved back one quarter of the way toward the previous day's counting to allow for the 90° longitude difference between Zurich and Florida. Interesting results are expected.

THE AAVSO: PERSPECTIVES, by Wayne M. Lowder

The significance of the work of the AAVSO has increased rapidly in recent years along with the increasingly important role that variable star astronomy is playing in studies of stellar evolution. In thinking of the future, the primary emphasis should be ...more of the same! The AAVSO has a proud record of accomplishment, a significant purpose, and increasing productivity. With more resources and a better division of Labor, including more member participation in the work of the organization, I believe that we can look forward to a more complete fulfillment of the AAVSO's primary aims, the interpretive communication of the results obtained from the analysis of the raw observations to the professional community and the appropriate feedback to the amateur observers of the results of their labors. The recent initiation of the AAVSO Circular is an important step in this process. We can anticipate other possibilities: more AAVSO publications in the literature, perhaps even the initiation of a "Journal of Variable Stars" including papers from both amateurs and professionals, the formation of local chapters or some other mechanism for more widespread meetings, and an enhanced international role for the AAVSO as a clearing house for world-wide amateur observations.

The horizons for the amateur observer are practically unlimited. The value of the human eye as a photometer has often been underestimated, and with appropriate discipline and judgement the amateur in his role of observer and reporter can be an astronomer, providing accurate and reliable data to the scientific community. A glance at the new General Catalog of Variable Stars provides some indication of the immense task awaiting the dedicated amateur, for there are thousands of stars now going unobserved or observed inadequately that are suitable for amateur observation. New charts on many of these stars are being prepared. There are also many exciting special projects available to the amateur, including photoelectric photometry, visual and photographic nova and supernova search, flare star patrols, monitoring of the rapid irregulars, etc. The amateur observer need not be overly modest in his goals, for there is much to be done that he can do. There is no distinction between the amateur and professional astronomer in terms of making a genuine contribution to man's understanding of the universe of stars that surrounds and mystifies him, and that forever will challenge his imagination.

VARIABLES IN GLOBULAR CLUSTERS, by Helen Sawyer Hogg

It certainly fills me with nostalgia to return to the place of my graduate work (Harvard), and discuss the area of astronomy on which I have been working ever since. I was here in the 1920's. Harvard Observatory was a real beehive for work on variable stars, under Harlow Shapley. Then there was Leon Campbell, Annie J. Cannon, Antonia Maury on beta Lyrae, Margaret Mayall on spectra, Henrietta Swope, Cecilia Payne, Margaret Harwood on the Scutum Cloud, and my future husband, Frank Hogg, on Mira. And the wonderful Boris Gerasimovic from Russia. Everytime I walked through his office to get to the plate stacks beyond he would rise, bow, and put on his coat.

In the AAVSO there were David Pickering, Charles Elmer, William Olcott and others that some of us remember. There is a strong selection effect operating in AAVSO members -- a group of people who love their work with the stars and who have an enthusiasm for work which I think imparts a glow to one's life.

I arrived at Harvard Observatory via a course in astronomy at Mount Holyoke College where Miss Anne Young was a devoted teacher who made the stars come alive for me. She was one of the early pillars of the AAVSO. I later received an HCO fellowship of $600/year, and had the good fortune to work with Harlow Shapley on the objects which intrigued me most -- the globular clusters. Shapley was then the leading authority on them.

At that time the period-luminosity law had been recognized for only about a decade. Jan Schilt at the AAS meetings at Yale in 1927, raised the question as to whether or not enough Cepheids had been found in globular clusters to draw any conclusion about the validity, pointing out that conclusions were based on very few clusters out of about 90 known. I returned to Harvard to check and compile existing data. Now, 44 years later I am still at it.

In 1931 my husband was appointed to the staff of the Dominion Astrophysical Observatory, Victoria, B.C., and the 72-inch reflector, the second largest telescope in the world at that time, became available to me. For four globular cluster seasons, with the help of my husband and the generous cooperation of the Director, Dr. J.S. Plaskett, I worked with that instrument. In 1935 we moved to David Dunlap Observatory outside Toronto, where there was a new 74-inch reflector. I am still there, having pursued the compilation of variables in globular clusters and their photography all this time.

Now, in 1971, the number of clusters examined for variables is about 105 and the variables found nearly 2000 -- more than twice what there were when I began. Globular clusters are population II objects and the variables in them belong in that category. A rough rule is that about 90% of the variables prove to be RR Lyrae stars. The other 10% are a mixed bag.

It was obvious, right from the start, that some clusters were rich in variables, while in others they were almost entirely absent. The richest clusters are M3 with about 200, Omega Centauri next with about 170. The third place goes to a cluster in the deep south at latitude -82°, IC4499. Carlos Fourcade and Jose Laborde, in Argentina, have announced 130 variables and 41 suspected variables. In 4th and 5th place Messier 15 and 5 in the north.

Bailey in his classic work on Omega Centauri in 1902 showed that there are three types of cluster type variables, (a) with a sharp maximum and periods just over half a day, (b) with a longer period and less steep rise, and (c) a sine curve type, with periods around a third of a day. The c-type are now considered to be an overtone pulsation, and in recent years the a and b types have been combined and are known as ab.

Some 30 years ago, Dr. P. Th. Oosterhoff and I independently called attention to the curious distribution of periods in different clusters. Now it appears that the length of RR Lyrae periods in globular clusters is related to the metal abundance. Nicholas Mayall, W.W. Morgan and others have shown a substantial range in the strength of the metallic lines in globular cluster spectra, related to metal abundance. It turns out that with increasing metal abundance the RR Lyrae periods become longer and longer. And in fact the clusters with highest metal abundance have no RR Lyrae stars.

So the RR Lyrae periods, when found, are a contribution to our understanding of the cluster. In the last couple of decades a very intriguing field of research has been the period changes in the RR Lyrae stars. Among the many followers are Dr. Emilia Bleserene and Dr. Christine Coutts at Toronto, Dr. Kukarkin in Moscow, and Dr. Szeidl in Budapest. At the DDO we have one of the most long continued large scale series on M5 in existence. One reason for this series was that each night I worked, I wanted to begin just as soon as possible. Most of my clusters needed an 8 or 10 minute exposure, but I could begin on M5 which needs only a couple of minutes with the 74-inch. Dr. Coutts worked up this series and found that over a 70-year interval of the 66 stars she could study, 18 remained constant, 20 periods lengthened, and 12 periods shortened. I have just received a paper by Dr. Kukarkin and Mrs. Kukarkina of Moscow on the same cluster, agreeing very well with our results. There are 500 plates in Budapest being studied by Mr. Lovacs and when those observations are added on we'll know a lot about the period changes in M5. Another aspect of period changes was brought to light by Dr. Sidney van den Bergh who, last year, questioned whether if an RR Lyrae star is a binary, its binary motion might influence its period of light variation.

The next most frequent type is probably the W Virginis, population II Cepheids numbering several dozen with periods from a week to two weeks.

Another frequent type, perhaps ultimately more numerous than the W Vir is the bright irregular. For a person like myself who enjoys fitting a nice neat light curve to a star, these variables are frustrating nightmares. In recent years they have become less so, however. From the color magnitude diagram, it is obvious that these are in the region of the red giant branch and they are fluctuating in brightness without a regular period. I have become resigned to the fact that you cannot fit a square peg into a round hole.

There are a few of the type of variable which many of you are watching, in globular clusters -- the long period or Mira stars. For many years the three in 47 Tucanae with periods of around 200 days have been known, and cited as unusual. In the neighborhood of globulars there are field stars, such as R and S Scorpii near M80. In the last few years spectroscopic studies have been responsible for proving whether or not such stars are cluster members. The accepted test is if the radial velocity of the variable agrees reasonably well with that of the cluster. Many have been ruled out, including R and S Sco, but at present, Mira stars are proven members of at least 5 globular clusters.

A few examples of the RV Tauri stars in globular clusters have as one of their principal features the alternation of deep and shallow minima. This compounds the difficulty of period determination. In the case of the best known, Chevremont's variable in M2 (discovered 1897), the period remained unknown until the 1940's when I had acquired a sufficiently long series of plates to show what the star was really doing.

Now the most exciting type of variable -- the nova -- has been found in globular clusters. There are three examples. The first flared up in Messier 80, in 1860, and astonished observers. The whole appearance of that tight little cluster changed when a 7th magnitude star appeared in its center. This was before the days of celestial photography, but it stands as an encouragement to observers to take a quick look at a few clusters from time to time, but with this caution. Don't be fooled by one of the bright variables -- either Mira, W Vir, or long period, into thinking you have found a nova!

The second nova was recorded spectroscopically at this Observatory (Harvard) and found by Margaret Mayall on two spectrum plates, near NGC6553. Whether this was an actual cluster member remains in doubt. Unfortunately no one in the last few years has been able to locate the original plates.

The third was found in M14 by Dr. Amelia Wehlau in 1964 on plates I took in 1938. So far no more novae.

The variables in open (formerly called galactic) clusters are a complete subject in themselves. The difference in types is just what one would expect from the difference between Type I and Type II stellar populations. Not a single RR Lyrae has been found in an open cluster. A few years ago several were announced in NGC 188, but further investigation showed these to be W Ursae Majoris variables, a type of star whose light curve and period can easily be mistaken for a c type RR Lyrae. Many eclipsing and spectroscopic binaries have been found as cluster members, some long period variables as in the rich Perseus association region, and several Type I cepheids; but the most frequent type of variable is that associated with the clusters in nebulous regions - the T Tauri or RW Aurigae stars, and numerous flare stars as in the Orion region.

Now I would like to tell you about our project for continuing this work at Toronto. For a couple of years now we have looked to the southern hemisphere and Dr. Coutts and I have been granted time on the Michigan 24-inch Schmidt at Cerro Tololo, Chile. Now the University of Toronto has a telescope of its own in the southern hemisphere, on the Carnegie, Carso site at Las Campanas, Chile. The mounting was made by Ealing in Cambridge, Mass. The 24-inch primary mirror is Cervit, the secondary is quartz. The f-ratio is 15, the plate scale is 22."5 to the mm, very close to the scale at the Newtonian of our 74-inch. Over 200 plates have been taken. The image of the optical system is better than 0."5 and the seeing is frequently better than 1". Photographically 20th magnitude can be reached in one hour. You have all heard about the marvelous conditions in Chile. Dr. Rene Racine who was there last August setting up the instrument, says it is a whole new dimension in astronomy.

And also in the future - next August (1972) an IAU Colloquium on Variables in Globular Clusters and Related Systems will be held at the University of Toronto. (to honor the work of Mrs. Hogg. ED)

At your meeting with the RASC in Toronto (1964) I was a brief after dinner speaker. For that speech I thought I would be original and pass on some of the exam boners culled through many years of teaching experience. On reading Variable Comments I found Harlan Stetson had the same idea in 1924. It would take much too long to recount all my collection of boners, however, there are three which may have special interest for watchers of variable stars. Here they are:

1. A Cepheid variable is the most variable type of variable star.
2. Light Year. When there is a large amount of variable stars in the sky a light year occurs.
3. Mira is a newly-discovered selenographic feature being the sea of peace.

After reading that last statement it occurred to me that a very good salutation for members of the AAVSO and an ending for this talk might be "Mira be with you."

HIGHLIGHTS IN ASTRONOMY, by Owen Gingerich

1. The Apollo 15 mission to Hadley Rille on the moon, July 31 - August 2, with astronauts David Scott and James Irwin, showed that the primeval highlands regions of the moon have much more complicated chemical recycling than anticitaped.

2. The USSR Venera 7 soft-landed on Venus on December 15, 1970, telemetered back 20 minutes of data from the Cytherian surface, and disclosed a temperature of $475 \pm 20^{\circ}C$ and a pressure 90 times greater than at the earth's surface.

3. Princeton's Stratoscope II balloon carried aloft a high-resolution telescope for planetary studies on March 26-27, 1970; the results more recently announced include an unclouded pure molecular hydrogen atmosphere for Uranus.

4. The Harvard-Smithsonian Reference Atmosphere for the sun, published in July, delineates the temperature structure of the sun with greater precision than before, including a minimum of 4100°; other work there reveals a plateau at $20,000^{\circ}$ as the temperatures increase outward in the chromosphere.

5. The astonishing discovery of the unstable element promethium in the A-type star HR465, if substantiated, seems to require nuclear reactions and element production at the surface of this star.

6. In the past year radio astronomers have doubled the number of known interstellar molecules, finding new ones at the rate of one a month. The list from September 1970: CH_3OH, CHOOH, NH_2, CHO, CH_3CN, OCS, CS, CH_3C_2H, HNCO, SiO, CH_3CHO, H_2CO, HNC.

7. Speckle interferometry, a brand-new spectrographic-computer technique to unscramble the seeing images of stars, has enabled the 200-inch Hale Telescope to get closer to its theoretical resolution with observations of the diameters of Betelgeuse, Antares and Aldebaran, and the splitting of the Capella double star system.

8. The nearly giant Gum Nebula in Vela and Puppis has been recognized as a fossil supernova remnant associated with the Vela pulsar; the explosion dates from approximately 9000 B.C.

9. uhuru (the Swahili word for freedom) is an x-ray satellite launched December 12, 1970; among the many discoveries of this first true x-ray observatory are remarkable rapid pulsations in the source Cygnus X-1.

10. The quasar PKS 2251+11, located in a small compact cluster of galaxies, has been shown by James Gunn at Palomar to have the same high red shift as the cluster itself, thus apparently establishing the quasars as remote, cosmological objects.

11. Just for good measure, and of special interest to the AAVSO, are the infra-red observations of Nova Serpentis 1970, which revealed the rapid formation of a circumstellar dust shell about sixty days after the outburst.

VARIABLE X-RAY TARS,by Lewis J. Boss

Until recently astronomers have had to look at our universe through a natural atmospheric filter that allowed only a small part of the events occurring beyond it to be observed. The visible light which came through to us showed only a portion of the electromagnetic spectrum. Thirty-eight years ago when Karl G. Jansky found a hole in this filter by discovering that his radio receiver was responding to wavelengths from outer space a whole new world of electromagnetic phenomena presented itself and the existence of such previously unknown celestial objects as gas clouds and quasars radiating energy at radio frequencies was revealed. Even more recently another window into space has been made available that allows radiation in a different part of the spectrum to be studied. This comes from a new class of stellar bodies, more adequately described as X-ray stars, because their predominant radiation is X-rays, at enormously greater energies than their emission of visible light and radio wavelengths.

Although interstellar space is filled with radiations over the entire electromagnetic spectrum ranging from the extremely high frequency gamma rays and X-rays to the low frequency radio waves, comparatively little of this cosmic radiation pierces our atmospheric blanket and wavelengths shorter than 2000 angstroms (10^6 to 10^9 centimeters) are completely blocked. This accounts for the X-ray stars having escaped observation until rocket-borne instruments detected several bodies that were emitting intense amounts of X-rays. The need for instruments that could perceive X-ray radiation from sources many light-years away was apparent at once. If these stars radiated no more X-rays than does the sun the existing equipment was quite inadequate. If the sun were located at the distance of Alpha Centauri, only four light-years away, the strength of the X-rays now received from it at the earth's surface would be reduced nearly a billion times!

The X-ray spectrum is included between a tenth of an angstrom and 100 angstroms but most of the X-rays so far recorded have been in the vicinity of 20 angstroms or less and all at very high levels of energy. Because the higher the energy of the radiation the less the number of photons that can be expected from a source in space,it was necessary to develop Geiger type scintillation counter devices with sensitivities to X-rays increased from 100 to 1000 times those previously available.

The first observation of stellar X-rays was made on June 18, 1962, by a rocket carrying equipment of the required sensitivity. Peak altitude was attained at 140 miles above the surface of the earth and the observations were made through doors in the rocket's nose. As it turned on its axis a 120 degree band of the sky was examined, including the location of the moon, a body some scientists thought might be reflecting X-rays from the sun to the earth.

Signals telemetered back from the rocket-borne instruments gave no indication of any X-ray emissions from the moon, but from the direction of the constellation Scorpius there appeared to be a source of intense X-ray radiation, more than a million times the strength that had been expected from any cosmic source! Repeated observations and close study of the results verified that these emissions were indeed X-rays of from 2 to 8 angstroms wavelength, that they originated outside of the solar system and came from a location roughly in the center of our galaxy.

The tremendous amount of energy recorded led first to the idea that it might not be coming from a single star but from a group of thousands of stars near the galactic center. Calculations showed, however, that even such a large number of stars emitting X-rays at the solar rate could not account for the observed amount of X-rays detected.

Further surveys were made and eventually the position of the source was narrowed down to a two-degree arc in Scorpius.This suggested a stellar body and the evidence was so strong that the name Scorpius X-l was assigned to the source although optical identification of the body had not yet been made.

The area around the source was quite barren of conspicuous stars and for a while it seemed that it might be a neutron star having its material packed to an abnormal density. If our sun were compacted to a similar state it would have a diameter of about 12 miles! The surface temperature of such a body might be as much as 10 million degrees Centigrade, compared to the sun's 6000 degrees and enough X-rays would be radiated at one to 10 angstroms to reach the earth. Essentially this object would be radiating as a Planck black body having almost no visible light.

Continued study of the source cast doubt on the neutron star theory because of the large apparent diameter of Scorpius X-l and in March 1966 it was determined that the body was about 20 seconds of arc across and must, therefore, be visible as a star of the 13th magnitude. With this data observers at the Tokyo Observatory found and astronomers at Mount Palomar confirmed the observation of a faint blue variable of the 13th magnitude at R.A. $16^h\ 17^m\ 4^s.3$ and Dec. $-15^\circ\ 31'\ 13''$. It fluctuates in brightness by about a magnitude in a day's time and has a spectrum showing emission lines of hydrogen and ionized helium together with excitation lines of carbon, nitrogen and oxygen while a suspected absorption line seems to indicate the presence of calcium. It is estimated that Scorpius X-1 is some 1000 light-years from the earth and that it emits over 1000 times more X-rays than light, a heretofore unknown situation.

On December 12, 1970, Explorer 42, the first satellite equipped for X-ray astronomy was sent aloft from a position off the coast of Kenya, Africa. It now circles the earth in a very slightly elliptical orbit some 335 miles above the earth with its orbital plane inclined 3 degrees to the earth's equator. Explorer 42 goes around the earth once every 96 minutes and has already obtained a number of interesting and important observations on X-ray stars. The most information exists on Scorpius X-1, or course, as a faint blue variable, others being Cygnus X-1, X-2, X-3, X-4 and Taurus X-1 with its pulsing element the Crab pulsar Np 0532. Suspected X-ray sources include Lupus X-1, Norma X-1 and Cassiopeia (Cas A) but this as well as most other tentative sources are not yet precisely located.

Cygnus X-1, the second X-ray pulsar found, is a source in our Milky Way and was suspected as early as 1966. The best position to date is R.A. $19^h\ 55^m\ 59^s$ Dec. $+35^\circ\ 02'\ 52''$ (1950). No X-ray source other than Scorpius X-1 has exhibited such rapid and large variations, but the pulses are only a very small part of the X-ray emission, which is also the case with the source in the Crab nebula. Early this year information telemetered back from Explorer 42 revealed that Cygnus X-1 had a very short period, 0.073 second, and if this is correct then only about 20 percent of the total X-ray emission from the object is radiated in the peak periodic pulses. It is interesting to note that during a 10 1/2 hour interval between two observations last March the overall energy of the X-ray radiation doubled, thus qualifying the object as an X-ray variable. This source is not a radio pulsar nor is it marked by any visible body yet detected. There is apparently no remnant of a supernova close-by and the extremely short pulse period implies that it is quite young, maybe only about 10^4 years. A reasonable explanation for the very brief pulse period could be that it is a rapidly rotating collapsed star, again possibly a neutron star.

A cautious estimate of somewhere around 40 X-ray sources seems to be indicated by the Explorer 42 observations examined so far. Some of them are quite likely extragalactic and are associated with objects such as NGC 1275 or Perseus A, Seyfert galaxies NGC 1068 and NGC 4151, this last in Canes Venatici.The emissions from these objects are much weaker than either of the first two X-ray sources so far examined. The X-ray radiation found by Explorer 42 from NGC 4151 was only about one-tenth the strength of that emitted by NGC 1275 in the 1.2 to 24 angstrom band. No measureable X-ray radiation was found from 17 other Seyfert galaxies scanned by Explorer 42 including NGC 1068.

The advancement of X-ray astronomy is proceeding at a rapid rate and the improvements in instrumentation has increased the accuracy of resolution and measurement enormously in the last few years. Our present day techniques permit astronomers to place the position of an X-ray star within four minutes of arc and resolve the size of these objects to within 20 seconds of arc or less.

Designs now being considered call for launching, within the next few years, orbiting observatories with X-ray telescopes capable of covering the entire sky. It is surely feasible to look forward with keen expectations to what a clear view of the X-ray universe may disclose.

MUSIC OF THE SPHERES, by Carolyn Hurless

There have been many musician-astronomers. Mrs. Hurless spoke of some of them and ended her talk with a delightful tape recording of her own arrangement of William Herschel's "Mrs. Shafto's Minuet." A small portion of it was published in The Herschel Chronicle by C.A. Lubbock. Mrs. Hurless enlarged on it and arranged it for piano and violin. For the recording she accompanied a violinist from the Lima (Ohio) Symphony Orchester. (ED)

AN AAVSO OBSERVATORY IN MEXICO, by Walter Scott Houston

Slides were shown of the many telescopes, each in its own observatory building on the Puebla estate of Don Domingo Taboada. Mr. Houston also told of the great respect the Don commands in his community. (ED)

PECULIAR CHANGES OF SU LACERTAE, by Wayne M. Lowder

SU Lacertae (1900 coordinates: $22^h\ 19^m\ 10^s\ +55^\circ\ 00'$) is described in the 1958 edition of the General Catalog of Variable Stars as a Mira-type variable with a mean period of 308.1 days. In the 1969 edition, the mean period is given as 294.4 days with a note (presumably derived from a 1967 communication to the editors by P.N. Kholopov) to the effect that this period is probably increasing rapidly. Recent observations reported below tend to confirm this suggestion.

Since 1967, I have made 39 visual observations of this variable, covering the near-maximum phases of five cycles. The visual magnitude range is 10.3 - (13.8, with the four maxima of 1967-70 showing similar light-curves. However, the 1971 maximum was substantially fainter and broader than the others, the variable attaining only magnitude 11.8 and remaining within a few tenths of that figure for approximately 40 days.

The dates of maximum for these past five cycles, estimated from the slopes and shapes of the ascending and descending branches of the light-curves, are as follows: (1) JD 39860 or perhaps a few days later, mag. 10.5; (2) JD 40163±5, mag. 10.8; (3) JD 40480±5, mag. 10.3; (4) JD 40802±5, mag. 10.9; (5) JD 41134 ±5, mag. 11.8. The estimated intervals between the five consecutive maxima are thus ~303, ~317, ~322, and ~332 days, respectively. Although the observational data are too limited to define these intervals as accurately as would be required for a meaningful quantitative assessment, they do provide suggestive evidence for a continuously increasing interval between maxima during the past four years. Much fuller coverage of future maxima will be needed to establish the nature and extent of these apparent period variations, and in particular to determine whether or not there is a long-term trend in the mean period averaged over several cycles.

PROBLEMS ON DL CASSIOPEIAE, by Dorrit Hoffleit

A class of Yale students last winter under the direction of Dr. Barry Newell was studying the open cluster, NGC 129. This cluster contains a classical Cepheid, DL Cas. Günther at Münster in 1953 had suspected it of having a variable period because various authors in the past had obtained slightly different periods for it. Hence, with two of the graduate students, Dr. Newell and I visited Harvard Observatory to see what the Harvard plates might reveal. We obtained 1787 estimates from the AC plates, taken with a 1.5-inch Cooke lens between 1898 and 1953:

Hoffleit	1160
Newell	124
Stephen Danford	182
Herbert Falk	321
TOTAL	1787

The star, 9.7 - 10.6 mag (pg) is greatly overexposed on many of the plates and is also frequently affected by overlapping images from a nearby star, resulting in appreciable magnitude scattering. I computed the phases on the basis of a good approximate period and then obtained mean light curves over successive intervals of 1000 days. I then corrected the period on the basis of the deviations of the various mean curves from one-another. Over 1000 days a change in the fifth place of the period is not significant for this purpose. The one constant period, $8^{d}.00026$, that best represented all of the observations was independently determined and it is very close to the one given by Kukarkin in the General Catalogue, $8^{d}.00027$. However, the dispersion of the points on the steepest part of the ascending light curve appeared excessive; moreover, the deviations appeared to show progressive, non-linear changes in phase. Several changing periods (with parabolic or cosine terms) were therefore derived, which improved the dispersion; but the nature of the correction term was not sufficiently definitive.

TABLE 1. Dispersion in ascending phase for various trial periods and changing periods for DL Cas.

	P^{-1}	Phase correction	σ (ascent)	n	Interval in JD
A	0.124996	-	± 0.025	22	2414-41 $\cdot 10^3$
B	"	$-4\cdot10^{-10}(JD-27000)^2$	0.012	22	"
C	"	$+0.040 \cos^{\circ} .01(JD-27000)$	0.012	22	"
D	0.125000	-	0.031	22	"
E	"	$-3\cdot10^{-10}(JD-27000)^2$	0.016	22	"
F	0.125001	$-3\cdot10^{-10}(JD-27000)^2$	0.011	22	"
D'	0.125000	-	0.008	18	14-31
D'	0.124987	-	0.007	5	31-41

Phase + Epoch = P^{-1} (JD) + correction term

$$\sigma = \sqrt{\phi_A - \phi_0 / n}$$

where ϕ_A = Phase of observed ascent
ϕ_0 = Average phase of ascent
n = Number of 1000-day intervals represented

Since there is almost a twenty year gap between the last of the Harvard patrol plates and the present time, my student assistants at the Maria Mitchell Observatory and I obtained 28 additional plates this summer. These definitely confirm that the period is not constant from 1898 until the present. The smallest scatter in the ascending branch of the light curve (see Table 1) is obtained if we assume one constant period, $8^{d}.00000$ (!), for the interval from 1898 until 1931 and a slightly longer period, $8^{d}.00083$, for the later observations. PEP light curves by Arp, Sandage and Stephens in 1957, and by Osterhoff in 1959 were included in the analyses. Several maxima published by others also fit our results within the uncertainties from differences in the various magnitude systems adopted.

It is curious to note that the best periods obtained are so close to exactly eight days that even over a 50-year interval there are significant gaps in the light curves for every one eighth of the period, for observations made from a single longitude (i.e., observatory).

BLAZKO EFFECT ON AN RR LYRAE STAR, by Mary Pamela Bonnell

My work this summer at the Maria Mitchell Observatory concentrated on the study of the Coma Berenices region. There were only some 102 photographic plates of varying quality available, taken from May 1964 to June 1971. The general study of variable stars in the region included examining the plates on the blink microscope and reworking some already known variables which had shown some divergence from their published periods. Among these was TU Coma Berenices, an RR Lyrae star.

Located at $12^{h}8^{m}44^{s}$ $+31^{\circ}$ 32.6(1900) TU Comae Berenices ranges in photographic magnitude from approximately +12.7 to +14.1. It is spectrally classified as an A star due to its color index of $-0.03\pm.14$, and has a published period of $0^{d}.46086$.

From the eighty-six plates good enough to provide data I tabulated the Julian Day and magnitude of each observation. The first plotting of period phase against magnitude, using the value of the published period, gave a very inconclusive light curve. Subsequent reworkings of the graph with period variations led to a final value of $0^{d}.46182$, a difference of $0^{d}.00096$ from the published value, and which gave a well-formed light curve for the available data.

Kukarkin's General Catalogue of Variable Stars lists a reference to research done on TU Comae Berenices some years ago at the Astronomical Observatory in Cluj, Romania by Vasile Ureche. Basing his word on 349 observations from May 1959 to June 1963 Ureche found some evidence of a Blazko effect of approximately seventy-five days on the period of TU Comae Berenices.[1]

This phenomenon was first reported by S.N. Blazko, based on work with RW Draconis and XZ Cygni from 1905 to 1908. It is a periodic variation in the shape and amplitude of the light curve of an RR Lyrae star on the order of tens of days. Although this effect has since been found in a number of RR Lyrae stars, its cause is unknown. An interference due to two or more oscillations within the star was originally theorized, but recent work has indicated a more complex situation.[2]

Fitting the two groups of data together and using the improved period value in calculating a second light curve, I again found good agreement in the placement of the points on the curve. However, the degree of dispersion among this larger group of points could be evidence of varying amplitude and shape of the curve due to a Blazko effect.

In order to positively identify this phenomenon in the period of TU Comae Berenices, further observations and calculating time are necessary, and were, unfortunately, unavailable towards the end of the season at Nantucket. If possible, I hope to continue and conclude this study at Dartmouth College this year.

REFERENCES

1 Vasile Ureche, "Cefeida scurt periodica TU Comae Berenices," Studia Univ. Babes-Bolyai (Math-Phys.), 1965. Fasc. I S. 73-81.

2 John S. Glasby, Variable Stars (Cambridge, Massachusetts: Harvard University Press, 1969), p. 66.

(Miss Bonnell is from Vassar College, class of 1973; and an exchange student at Dartmouth College 1971-1972.)

V734 CYGNI AND MM SAGITTARII, by Karen B. Kwitter

During the summer of 1971, I was an assistant at the Maria Mitchell Observatory on Nantucket. We photographed several variable star fields, searching for new variables with the Rodman Blink Microscope, and examining plates and estimating magnitudes for previously discovered variables. At the beginning of the summer, I was assigned Variable V734 Cygni. I measured more than 400 plates, taken over a period of more than 50 years, and obtained a light curve. Combining points from different cycles, a reasonably good composite curve was obtained. Using this curve, I determined a tentative period between 300 and 320 days. Attempting to zero in on the exact period, values within this range were tried, with 310 days yielding the best results, though still not close enough to be considered the true period. The O-C curve, a plot of the difference between observed and computed maxima, is a function of time. There is evidence of a changing period, as indicated by the quasi-sinusoidal appearance of the curve. Were the period constant, the curve would be approximately linear, the phase error due to an incorrect period accumulating linearly with each cycle. Although I did do some reading on variables with changing periods, this was, unfortunately, as far as I was able to proceed with this star.

Working with the blink microscope, I was very quickly frustrated- examining plates in Sagittarius, near Variable Star Field 193, I noted 6 variables, all of which had already been discovered. At Dr. Hoffleit's suggestion, I examined plates for one of them anyway, MM Sagittarii. Making use of plates taken since the period was first published, I was able to revise Ponsen's value of 203 days, given in Leiden Annals, to 202.3 days.

In further work at the blink microscope toward the end of the summer, I noted two stars in Sagittarius which seemed to be variables. The variability of one of them, however, is doubtful, since the apparent variation is small, and the star is quite faint. Independent rediscovery is awaited before further work will be undertaken. The other new star seems to be an Algol-type star, an eclipsing variable, but again, this is as far as I was able to get, as the summer came to a close.
(Miss Kwitter is a student at Wellesley College.)

THREE VARIABLES, by Esther Hu

During the summer of 1971, I was an assistant at Maria Mitchell Observatory. Work was done in updating information on the suspected R Cor Bor-type star, V482 Cyg (Whitney, ApJ, 109, 538-9) at $19^h\ 55^m\ 54^s$, $+33^o42'$ (1900). Range of variation was from 11.8(pg) to below plate limit (approximately 15.5). The presence of a drop in the light curve at about J.D. 2432700-800 was confirmed, as well as establishing the existence of a secondary minimum following this major drop.

Among the new discoveries in Sagittarius are an R Cor Bor type, designated as B3 Sgr, $18^h\ 07^m\ 15^s$ $-25^o\ 48'$ (1900) and a recurrent nova designated B11 Sgr, $18^h\ 11^m\ 01.4^s$ $-28^o\ 11'\ 53''$ (1900). Both were located by means of a blink microscope designed and built by Dr. James Rodman.

The range of variation of the R Cor Bor star was from approximately 11.5 to below plate limit, as determined from data from the Nantucket (NA) and Harvard (MF, B, and A) plates. There was some difficulty in obtaining exact magnitude estimates from the MF plates when the star was at maximum, but this difficulty did not prove to be too serious in this type of star, since the portions of the light curve which are of major interest lie below maximum light output. Over a period from J.D. 2428400 to 41000 three primary minima were observed at J.D.'s 28400, 31400, and 41000. In the first two cases, each primary minimum was followed by a secondary minimum. The total time period of each instability was about 3 and 7 years, respectively. The third major drop in the light curve is still in progress. The last set of data (mid-August) placed this star at slightly below 13th magnitude, and apparently emerging from the primary minima. Unfortunately, this star is now located in a region of the sky which is inaccessible to telescopes at this latitude. Further observations to establish the existence of a secondary minimum would be of interest.

The star designated as B11 Sgr was found, upon further investigation, to be the emission line (symbiotic) object MHα 208-92: AS 299. Range of variation extends from a maximum of approximately 10 (observed on Nantucket plates around JD 36100) to about 13.5 in a slow drop (around JD 37800) with variations to 15 and a second rise to 11 at JD 39700 with drop to 14 at 40,400 followed by another rise to 11.5 as of 40,700. (Miss Hu is a student at Massachusetts Institute of Technology.)

CH CYGNI, by Michael Mattei

It looks as if CH Cygni has turned out to be a double star. How do we know this?

For three years now observations of CH show that it has a hot blue star which shows up very clearly in its spectrum.
In the summer of 1970 J. Shao found that the ultraviolet fluctuations were decreasing, and it looked as if CH went into eclipse.
Dr. Liller thought that the eclipse would end in a year to a year and a half, between September 1971, to November 1972. As it turns out CH is just coming out of eclipse at this time. It started some time after September 4, 1971.

The variations in the ultraviolet are most active when CH is half a magnitude brighter than a nearby comparison star. In the next three months CH should become as active as before. The next eclipse should take place in 1974. We'll be watching for it.

AAVSO REPORT 29: A PREVIEW, by Barbara L. Welther

Marsha Vetter and I have plotted almost 10 dozen stars for this report which covers the period

J.D. 2437595-2438295. To date there are 45 stars plotted with 1-day means, 34 with 5-day means, and 37 with 10-day means. There are also some stars which will be presented in tabular form. PROGRAM AVPLOT was modified for this report so that the tick marks fall on appropriate multiples of 10 days in each plot. Other minor functional changes were also made in AVPLOT and the auxiliary program, HEADER.

For the meeting plots of nine stars were selected to be shown. Among the most interesting stars plotted with 5-day means were R Lyrae and R Scuti. The former, a semiregular giant of late spectral class, shows an average magnitude of 4.5 with fluctuations between 4.8 and 3.9. Most averages comprised one to three observations. R Scuti, a supergiant of RV Tauri type, shows an average magnitude of 5.7 with fluctuations between 6.5 and 4.9.

To represent stars with 1-day means, three U Geminorum type stars were selected as well as Z Camelopardalis. U Gem, itself, is a dwarf nova which is simultaneously a close pair and an eclipsing binary. It shows an average minimum magnitude of about 14 with outbursts every 70 to 100 days of magnitude 9. SS Aurigae, classified as a U Gem type shows a minimum just under 15 with maximum of magnitude 11. UV Persei, also of this type, is of interest because out of 336 observations for the 700 day interval, it was seen only 13 times: once on J.D. 2437642 at 16.2, and a dozen times between J.D. 2438108-18 with magnitude ranging from 12.5 to 13.3. Z Camelopardalis, similar to the U Gem type, shows a minimum of 13 and a maximum of 11.

V Sagittae, similar to P Cygni, is a novalike variable which is also an eclipsing binary. During the period of these observations it shows stretches of 80-160 days of minimum magnitude fluctuating between 11 and 12. Between J.D. 2437975-8010 it brightens to 10, then fades and fluctuates around 11 until 2438195 whence in the space of about 2 weeks it dims to almost 13.

Nova Herculis 1963, similar to Nova Persei 1901, shows a decrease of three magnitudes within 100 days after maximum. After the outburst on J.D. 2438060, the AAVSO observations are as follows:

Date	$\bar{m}$	Comments
J.D. 2438067	4.00	First AAVSO Observations; seven days after outburst
2438160	6.93	100 days after outburst.
2438167	7.20	100 days after first AAVSO observation.
2438295	8.79	235 days after outburst; last date for Report 29.

For this star there are frequently more than 10 observations per day comprising the average.

Finally, perhaps the most interesting plot to date is that of the irregular variable, R Coronae Borealis, a star of high luminoisty and of high carbon content. The AAVSO has well documented its erratic changes in this period:

Interval	$\bar{m}$
2437595-7835	about 6.
2437835-7900	dips to 12.
2437900-7970	dips to 13.
2437982-8040	rises to 7.
2438040-8125	dips to 13.
2438125-8190	rises to 8.
2438190-8295	dips below 13.

Plots of these and the rest of the stars will be published as soon as the laborious tasks of editing and laying them out are completed. Meanwhile, another AAVSO assistant, Stephen Fantone and I are investigating ways to make the card-handling and plotting routine even more efficient than our present system.

SPACE SCIENCE EDUCATION, by George Lovi

Many amateur astronomers who actively pursue their hobby -- especially youngsters -- wonder if and how they can make it their career. It so happens that there is a made-to-order field for the amateur, the person who enjoys astronomy (some professional astronomers don't, believe it or not). This is space science education -- astronomy and associated physical science.

For more than a decade, the growth of popular interest in our space environment has been reflected in educational curricula. One of the most amazing developments along these lines (at least to someone like myself who went to school in the pre-Sputnik era) is the proliferation of planetaria in educational institutions at all grade levels, as well as in museums and science centers. However, one bottleneck has been the recruitment of qualified and willing personnel to teach astronomy and space science, as well as operate the often-associated planetaria. The writer is on the staff of Planetariums Unlimited, Inc., a Viewlex subsidiary in Holbrook, Long Island, which is one of the major suppliers in the field. We hold semi-annual workshops to help train and orient educators who either are now or soon will be in this field of endeavor. Spitz Laboratories, another leading company, does likewise with their annual summer institutes.

However, despite this, I have detected that there is a certain percentage of people involved in this work -- as is the case with any work -- whose heart just isn't in it. They happened to land in this field quite by accident, sometimes relatively unwillingly. Often a school superintendent "taps" a particular science (or other) teacher. Is it not better to have a true astronomy aficionado instead?

I therefore would like to urge young people interested in astronomy to consider entering space science education. Indeed, this is not limited just to youngsters. Often, adults already established in other lines of work can get into this area with relatively little additional college credits. Already some four or five colleges are offering majors and/or concentrations in this field; others are contemplating it or have active plans.

Finally, imparting on the general public, both in educational institutions and elsewhere, the importance of astronomy and space science is of critical concern today, what with the growing anti-science attitudes and cuts in research grants and other support that is so rampant today. Now that the glamour and "gee whiz" aspects of the space spectaculars has worn off, we seem to be returning to the myopic attitudes towards basic research before Sputnik when a Secretary of Defense described it as "finding out what makes grass green and fried potatoes brown." (If we really knew the true secret of what makes grass green we might go a long way towards solving hunger and starvation; and, for all we know, the stuff that makes fried potatoes brown may be encapsulating some wonder drug that might cure cancer -- after all, did not penicillin come from moldy bread?). It is here that the enthusiastic, dedicated space science educator can act as a press agent or ambassador to get a vital message to the public. And the need for such people has never been greater.

PEP LIGHT CURVE OF DV AQUARII, by Leonard Kalish

In the June, 1965, issue of Sky and Telescope, there was a brief note stating that a sixth magnitude star near Theta Capricorni had been found to be a variable. W. Strohmeier at Remeis Observatory had then analyzed a series of patrol plates and found that the star was an eclipsing variable with a period of 1.57 days. The star was given the temporary designation of BV623; later the permanent name of DV Aquarii was assigned.

Sky and Tel noted that the star was shown in Norton. I was intrigued by the thought that a star that had been thought to be constant for so many years now proved to be an eclipsing binary, and decided to time several minima to confirm the period. However, what began as a small exercise has turned into a major project as I learned more and more about the subject of binary stars.

The equipment used for the project includes an 8-inch Cassegrain reflector coupled to a photoelectric photometer of conventional design. The observations were made through a standard yellow filter(Schott GG 14)using an aperture of 2mm which allowed a field of view of 2 minutes of arc. The output was fed to a Heath chart recorder.

By the end of the 1965 observing season quite a number of observations had been collected and the process of reducing the data started. Three primary minima and two secondary minima were analyzed and confirmed Strohmeier's period of 1.575531 days. However, I also had observations on several nights that didn't seem to fall on the light curve. After considerable checking, a mistake in converting from Universal time to the Julian date was found; instead of just observations near the minima, I had covered parts of the total cycle. So I then decided to continue the observing program until the entire light curve was complete.

The task of collecting a sufficient number of observations took much longer than expected. Observing in Los Angeles proved impossible and trying to set up and operate the PEP equipment on field trips caused many difficulties. Then in 1967, a group of L.A. amateurs formed the Polaris Observatory Association and bought a site in the Lockwood Valley, 90 miles north of the city. So, for two years the observing program stopped while a permanent observatory was built.

Another difficulty was the labor involved in data reduction. The goal was to obtain about 500 observations and the task of converting each observation to the correct heliocentric Julian date and calculating the phase and magnitude difference became so burdensome that although the taking of observations continued, rolls of chart paper just kept accumulating. Fortunately, last year the firm I work for, TRW Systems, installed a time-sharing computer system and I was given permission to use the system evenings and weekends. Now there was another halt in the project while I tried to learn enough about programming to mechanize the data reduction process. Computer programs were written to calculate the magnitude difference, the heliocentric Julian date, and the phase of each observation. Other programs collected and summarized the data so that the final result was a listing of all 540 observations,sorted by phase and ready for plotting.

The light curve is that of a typical beta Lyrae type system. There is a primary minimum of 0.30 magnitude depth and a secondary minimum with a depth of about 0.15 magnitude. The interval outside the eclipses is not constant but displays a varying brightness.

Now that the light curve is complete, can we write finis to DV Aqr? The answer is no; in fact, the light curve may just be the beginning. There is a possibility that no solution of the light curve has yet been attempted to determine the physical parameters of the system. If this proves to be the case, there may be a great deal more to the story of DV Aqr.