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FURTHER REPORTS OF OBSERVATORIES

Flower and Cook Observatory, University of Pennsylvania

Personnel. Dr. William Blitzstein and Dr. William Protheroe were each promoted to the rank of Professor, effective 1 July, 1964. Dr. John E. Merrill resigned from the position of Adjunct Professor to accept the chairmanship of the Department of Astronomy at Central Methodist College, Fayette, Missouri. After completion of the New Zealand site survey, Mr. Frank M. Bateson was appointed Astronomer-in-Charge of the Mount John University Observatory operated jointly by the University of Pennsylvania and the University of Canterbury. Dr. Eva Novotny was reappointed Assistant Professor of Astronomy, effective 1 July, 1965. Mr. J. Pieter de Vries was appointed Lecturer in Astronomy, effective 1 July, 1964. Mr. de Vries will be in charge of expanding the program in celestial mechanics. Dr. William Buscombe was appointed Visiting Associate Professor for the term of his sabbatical leave from Mount Stromlo Observatory. He will conduct a seminar on selected topics in astrophysics.

The Pawling Fellowship was held by Yoji Kondo, George E. McCluskey, Jr. held a NASA Fellowship, Carlson R. Chambliss held a Harrison Scholarship, and Mrs. Beverly B. Bookmyer a Pepper Fellowship. Observing assistants included Allen Joel Harris, Edward J. Devinney, Jr., and Hassan Jamshidpour. At Mount John University Observatory, M. J. Rodgers was meteorological and observing assistant.

In May 1964, the Ph.D. degree was awarded to Mr. Igor Jurkevich and to Mrs. Bookmyer, and the M. S. degree to Mr. Harris and Mr. Chambliss.

Dr. Charles P. Olivier continued to serve as President of the American Meteor Society and Dr. F. B. Wood continued as Secretary of Section D (Astronomy) of the American Association for the Advancement of Science. Dr. Merrill continued as President of Commission 42 (Étoiles Doubles Photometrique) of the International Astronomical Union; Dr. Wood served on the Organizing Committee and as Chairman of the Coordinated Programs Committee of that Commission. Mr. Bateson was elected a member of the Council of the Royal Astronomical Society of New Zealand. He also served as member of the National Committee for Astronomy in New Zealand and will represent that country in its application for adherence to the International Astronomical Union at the Hamburg General Assembly. Bateson is a member of the New Zealand Solar Eclipse Committee and has been appointed Officer-in-Charge of the field operation of the New Zealand party for the May 1965 eclipse. Dr. Protheroe attended the Summer Meeting of the Royal Meteorological Society at Cambridge, England, in September 1963, and presented a paper on "The Motion and Structure of Stellar Shadow-Band Patterns," which was published in the *Quarterly Journal of the Royal Meteorological Society* **90**, pp. 27–47. He continued as Vice-Dean of the Graduate School of Arts and Sciences.

Mount John University Observatory. The three-year site testing program in New Zealand was completed. The final report was prepared by Bateson and appeared as Volume X of the *Astronomical Series of Publications of the University of Pennsylvania.* Work continued actively on Mount John, the site finally selected. Observers' quarters and a residence for resident and visiting astronomers were constructed. Power installations were completed. A temporary road was completed and detailed plans for a permanent one were drawn. A temporary water supply is in operation and plans for a permanent one are well advanced.

An 8-in. refractor and a 16-in. reflector were installed and a program of observation of intrinsic variables with the reflector was initiated by Bateson. This is a continuation of earlier work with the same instrument. Three telescopes, the personal property of Bateson, are on permanent loan to the Observatory.

Meteorological records on the site were continued; instrumentation for this purpose has been

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extended. Observations of the sky brightness around the solar disk were commenced, using a sky photometer supplied by the High Altitude Observatory, Climax, Colorado, erected on a mounting supplied by Mr. A. F. Jones.

The 10½-in. astrograph, long on loan to the University of Chicago for use at the McDonald Observatory, was dismantled, shipped, and erected on Mount John. We are grateful to the staff of the Yerkes and the McDonald observatories for relinquishing the telescope in advance of the expiration date of the loan and for packing and crating it for shipment.

During the year, the Mount John site was visited by Dr. Horace Babcock, Mount Wilson and Palomar Observatories, and by Dr. C. R. O'Dell, University of California. Limited tests were carried out by Babcock with his seeing monitor.

The 18-in. refractor, used at the former Flower Observatory, was completely renovated, tested, and shipped to New Zealand. The work was carried out by the Wilmot Fleming Engineering Company of Philadelphia. The telescope is to be used, in addition to other work, on a program of planetary photometry to be carried out in conjunction with the scientists from the Space Sciences Laboratory of the General Electric Company.

Scientific Programs. An operating agreement was drawn between the University of Pennsylvania and the Space Sciences Laboratory of the General Electric Company for programs of basic astronomical research of interest to both parties. The initial effect of this was the renovation of the 18-in. refractor and preliminary programs probably will be started with this instrument.

Various observers used the 15-in. horizontal refractor, the Pierce–Blitzstein pulse-counting photometer, and both broad-band and interference filters to observe Zeta Aurigae before, during, and after the 1963–64 eclipse. This was part of the international observing program; the interference filters used were those distributed to various observatories by Dr. K. Gyldenkerne, coordinator of the program. Observations were also made by Devinney in the 1.6μ region, using the 28-in. reflector and the infrared photometer. Kondo and Harris published a paper discussing these results, *Astron J.* **69**, 409, 1964.

Dr. Olivier wrote the section on astronomy for the Americana Annual. He published *A Catalogue of Fireball Radiants* (Flower and Cook Reprint No. 146), *The Second Catalogue of Hourly Meteor Rates* (published by the Smithsonian Astrophysical Observatory), The American Meteor Society Annual Report (Flower and Cook Observatory reprint No. 149), and "The Path of the March Bolide," *Sky and Telescope* **26**, 263, 1963.

Dr. Wood continued to maintain the card catalogue of eclipsing variables and finished the discussion of photoelectric observations taken at Mount Stromlo in 1957–58. Notes on these were published (1) "On δ Capricorni," with Gary Lampert as co-author, *Publ. Astron. Soc. Pacific* **75**, No. 444, 281, 1963, and (2) "The Eclipsing System AL Velorum," with R. R. Richardson as co-author *Astron. J.* **69**, 297, 1964.

Dr. Leendert Binnendijk continued his studies of photoeletric observations of W Ursae Majoris systems in two wavelength regions. Light curves and orbital elements of DK Cygni were published, *Astron. J.* **69**, 157, 1964. New orbital elements of RZ Comae were derived, using observations made by Broglia, *Astron. J.* **69**, 1954. He served as a member of the University Council.

Dr. Blitzstein continued studies with the aims of increasing the accuracy and efficiency of photometric observations at the observatory and also facilitating the reduction of the observations. Toward these ends, an analysis was made of the errors of a siderostat caused by incorrect positioning of the mirror gimbal. At the same time the regions for placement of counterweights were determined in which no vignetting of the beams of light would occur. Computer programs for the IBM 1620 and IBM 7040 were prepared or improved with the aid of Mrs. P. B. Savage, for the purposes of deriving helicocentric times, magnitude differences, and extinction coefficients for variable stars. A systems analysis of the Pierce–Blitzstein Photometer was continued by a number of measurements and tests. Pulse amplitude distributions were determined for both channels. Both carbon 14-phosphor and strontium 90 Čerenkov radioactive light sources were studied for reliability as standards for the photometers. An electroluminescent source was studied for suitability in the determination of the channel sensitivity ratio. Accurate resolving time measurements were made for both channels. The statistics of the photometer were analyzed and found to be close to the Poisson type, which is usually assumed to hold. Other miscellaneous measurements were made of the waveforms existing at various places in the electronic circuits and the variation of the sensitivity of the channels with line voltage and time.

A systematic study of atmospheric extinction at the Flower and Cook Observatory was begun. The accumulation of information was facilitated greatly by the computer programs mentioned above. Preliminary results indicate that the variability of extinction with time and direction is so great that steps must be taken to determine variations. Corrections must be made in the data processing for these effects in order to approach the ultimate accuracy possible at this location.

Observations of W UMa made in 1961 by K. C.

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Chou were analyzed by means of the computer programs mentioned above. Times of minima in two colors and light curve variations were derived. The results were published, *Astron. J.* **69**, 365, 1964.

Dr. Protheroe completed the analysis and discussion of his scintillation observations made in earlier years.

Dr. Novotny worked on calculations and programming for an evolutionary stellar model sequence and also on reduction of spectra from the eclipse of 20 July 1963. The latter work is being carried out jointly with Dr. Stanley Sobieski of the University of Massachusetts.

In connection with his studies of eclipsing systems, Dr. Jurkevich developed explicit expressions for $\partial\alpha^x(k,p)/\partial k$ in terms of the parameters of k and p. Tables of $\partial\alpha^x(k,p)/\partial k$ and $\partial\alpha^x(k,p)/\partial p$ are being prepared to the same accuracy as the tables of $\alpha^x(k,p)$ due to Merrill. He also is developing tables of special differential coefficients due to J. B. Irwin. The purpose is to eliminate the numerical differentiation used at the present time in the least squares adjustment of the elements of photometric binaries. Jurkevich also started systematic processing of observations made during the 1959 VW Cep campaign. Computer programs developed earlier are being used in this work. In this process a number of programs, which earlier had been found to be impractical with small machines, are being improved to the point where this restriction is being removed.

Harris developed computer programs for generalized linear least squares, for binary star ephemerides, for binary star phases, for Fourier coefficients in maxima of light curves, and for rectification of light curves using nine coefficients. He is in the process of developing improved programs for reduction and analysis of light curves of eclipsing binary stars. He has observed times of minima of V836 Cyg, using the 15-in. telescope, and calculated new light elements.

Kondo used the 15-in. telescope and associated equipment to make two-color photoelectric observations of BV 342, BV 328, BV 267, and BD+30°2163. In the case of BV 342, two times of primary minimum observed in 1963 were combined with others obtained in 1962 and with photographic observations published by the Bamberg Observatory to obtain improved light elements. The computation used the generalized least squares program developed by Harris. The observations of BV 328 showed no detectable changes and indicate that, if the star is variable, the period must be considerably longer than the published value of 0.60 days. New light elements were also determined for BV 267. The period is closer to 1.25 days than to the earlier published value; ranges are approximately 0.55 mag and 0.10 mag in both colors.

All the reductions used the DELTAMAG program developed by Dr. Blitzstein and Mrs. P. B. Savage.

McCluskey completed his two-color photoelectric light curve of RX Ari; about 1000 observations are available in each color. He also completed the light curve of UV Leo, with a total of about 1600 observations in the two colors. Preliminary reductions are available for both stars and solutions are under way. McCluskey also worked with Dr. Blitzstein to measure accurate resolving times for the Pierce-Blitzstein photometer by the "paired-source" method.

Mr. Louis Winkler observed a two-color light curve of DO Cas, found light elements, and made an orbital solution. He also made a three-color photoelectric study of sky background at various angular distances from the rising and setting moon and studied changes in these from the point of view of possible systematic errors in photoelectric photometry carried out near moonrise or moonset. Winkler also re-examined Dr. R. H. Koch's 1955–7 observations of AO Cas in order to study the possibility of relatively rapid changes in the light curve. Dr. Bookmyer completed a study of photoelectric observations of SW Lac. She discussed variations among the five light curves defined by her observations and compared these with earlier work. A possible correlation was found between the sine term and displacement of secondary minimum. Mr. James Gleim made two-color photoelectric observations of BV 382. He used the 28-in. reflector and the Elbow Photometer designed by Dr. Protheroe and Mr. Alan F. Petty and constructed by Mr. James K. Thorpe. Gleim also began observations of SW Lyn.

Devinney completed the modification of the infrared photometer for use with a lock-in amplifier to obtain a substantial improvement in the signal-to-noise ratio. The improved photometer was used by him in the 1.6μ region to observe the 1963–64 eclipse of zeta Aur. Chambliss made a calibration of the color systems of the 15-in. refractor–photometer combination. This included comparison with standard stars of the three-color broadband system normally used and of the system established by the above mentioned interference filters.

Petty initiated work on the systems design of a digitized photometer intended to record rapidly and accurately photometric observations on punched cards suitable for future processing on digital card reading computer installations. The three chief problem areas were (a) storage of data immediately ahead of the punch, (b) integration intervals up to 100 sec duration, and (c) overall data control and sequencing function of the system. These problem areas have been analyzed and a solution obtained for each. The time reference is such that

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the system will be adaptable to the New Zealand power grid as well as to that of the United States.

The program of observing eclipsing systems of relatively long periods (2 to 90 days) continued as a departmental program. In addition to ζ Aur, systems on the program included S Cnc, RS CVn, ZZ Boö, U CrB, BV 169 (Ser), DI Her, and Z Her.

Analysis of the observations of the 1963 solar eclipse was continued by Sobieski and by Novotny. Preliminary plans for observations to be made at the May, 1965 eclipse were initiated.

Acknowledgments. Various portions of these programs were supported by the National Science Foundation and by the National Aeronautics and Space Administration. The renovation of the 18-inch refractor was done under a work order from the Space Sciences Laboratory of the General Electric Company. The major portion of the work on the Mount John site was carried out with a grant from the Golden Kiwi, an agency of the New Zealand Government, to the University of Canterbury. The interference filters used in the zeta Aur campaign both here and at other participating observatories were purchased with a grant from the American Philosophical Society.

FRANK BRADSHAW WOOD, *Director*

Goethe Link Observatory, Indiana University, Bloomington, Indiana.

Personnel. Dr. Goethe Link (Honorary Director), Professors Frank K. Edmondson (Director and Chairman) and Marshall H. Wrubel (Assistant Chairman), Associate Professors James Cuffey (Assistant Director) and Hollis R. Johnson, and Assistant Professor Benjamin F. Peery, Jr. comprised the resident academic staff. Professor John B. Irwin resigned, effective 1 February 1964.

Dr. R. d'E. Atkinson has accepted an appointment as Visiting Professor, and Dr. Martin S. Burkhead has accepted an appointment as Assistant Professor, both effective 1 September 1964.

Mrs. Beryl H. Potter and Mrs. Delores J. Owings continued as full-time Research Assistants, and Mrs. Louise S. Peters served as part-time Research Assistant. Mrs. Sandra S. Butler and Mrs. Julia Hoar Fritz served as secretaries. Part-time secretarial services were performed by Miss Charlyne Finnell. The following students were part-time Teaching or Research Assistants: Ronnie Clay Barnes (1st Semester), Howard L. Cohen, David Dvorkin, H. Melvin Dyck, Myron Effing, Theodore D. Faÿ, John D. Fix, Richard C. Hall, Thomas H. Hall, David S. King, Daniel L. Klinglesmith, Joseph Michlovic, Carolyn J. Murphy, Heywood Sobel, Warren Sparks, Stephen Strother, S. S. Varma, H. John Wood, Hong Sik Yun.

Katherine Bracher and James G. Peters held NSF Cooperative Fellowships, and Douglas S. Hall held a University Fellowship. Edward Churchwell resigned his NASA Traineeship at the end of the first semester, and it was transferred to Ronnie Barnes for the second semester. Martha Safford held a NASA Traineeship for the full year.

Research. Cuffey has continued his work on variable stars in M53, including stars in the nucleus which are resolved on very short exposure plates with the 100-in. reflector.

Peery has successfully adapted an infrared image tube to the grating spectrograph at the Goethe Link Observatory. He is also working on a determination of the isotopic composition of *Zr* from *ZrO* bands in the spectra of S stars, based primarily on McDonald Observatory coudé spectra.

Johnson completed a paper "A Theoretical Study of The Excitation of Sodium in the Solar Photosphere," which will be published in the *Annales d' Astrophysique* **27**, No. 6, 1964. He is currently working on an attempt to construct a non-LTE curve of growth and thus to determine the influence of departures from equilibrium on abundances derived by spectroscopic means. As part of a larger study of the equilibrium of hydrogen in a simple atmosphere, he is also investigating the coupling of several interlocking equations of radiative transfer.

Wrubel published a paper "Construction of Stellar Models" in the proceedings of Course XVII of the International School of Physics "Enrico Fermi." Work done by astrophysics graduate students under Wrubel's supervision included the following publications: Vern L. Peterson and J. N. Bahcall, "Exclusion Principle Inhibition of Beta Decay in Stellar Interiors, (*Astrophys. J.* **138**, 437); Donald C. Schmalberger, "Depth Dependence of Turbulence in the Solar Photosphere (*Astrophys. J.* **138**, 693); and David Fischel, "On the Influence of the Chemical Composition on the Structure and Metal Index of Stellar Atmospheres" (*Astrophys. J.* **140**, 221–234). These were reprinted as *Goethe Link Observatory Publications* Nos. 54, 55, and 60. Work in progress by Wrubel and his students includes: sunspot models, stellar pulsation, colors of rotating stars, and selected topics of nucleogenesis. Computer programs developed by this group have been described in a series of *Research Notes.*

Positions and magnitudes of 1903 asteroids were published in 31 issues of the *Minor Planet Circulars.*

Teaching. Enrollment in the elementary course was 217 during the first semester and 220 during the second. Summer Session enrollmnt was 38 in A100 (Solar Syatem) and 16 in A105 (Stellar Astronomy). In previous summers these courses were given in alternation. Advanced courses given included: Astronomical Photography, Spherical Astronomy, Astrometry and Least Squares, Intro-

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