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I. PERSONAL

It was with sadness that we learned of the death of Dr. N. Wyman Storer on November 30, 1977. Professor Storer gave 36 years of loyal service to the University from 1935 to his retirement in 1971. His service continued after retirement with a series of lectures on topics of spherical astronomy the spring semester before his death. He contributed a great amount by providing the early training for a number of today's active astronomers.

During the 1978–79 academic year, Donald J. Bord (Benedictine College) was a Visiting Assistant Professor of Physics and Astronomy while Stephen J. Shawl was on Sabbatical leave at the Lunar and Planetary Laboratory in Tucson. Bord has been appointed Adjunct Assistant Professor for 1979–80. Other faculty members involved in astronomical teaching and/or research included Thomas P. Armstrong, David B. Beard, J.P. Davidson, Richard Sapp, Wesley P. Unruh, and Edward J. Zeller. Teaching Assistantships were held by J. Crisler, D. Hirschi and D. Tholen.

II. RESEARCH PROGRAMS

A. Solar System Studies

Professor Armstrong is participating in the analysis of Voyager 1 and 2 Low Energy Charged Particle Experiment data from the Jupiter encounters of March and July 1979. Some of the important new results from this experiment are the discovery of a very hot, 300–500 million degree plasma in the Jovian magnetosphere, the characterization of this plasma as consisting of significant sulfur and oxygen of presumed Ionian origin, and the discovery of a significant radial outflow of Jovian plasma beyond about 140 radii in the dawn magnetotail. Numerous features of charged particle absorption by the Galilean satellites were observed and are being analyzed. No evidence has been found for energetic particles coming directly from Io as a source during the near flux tube passage of Voyager I.

Other research activities under way include the science support of Project Galileo Energetic Particle Detector experiment, and of the International Solar Polar Mission. The analysis of particle acceleration in interplanetary shock waves was the dissertation topic of Dr. Robert Decker and studies of plasma heating by large amplitude waves was the dissertation topic of Dr. Mohammad Ahmadian. Other studies in progress are the systematics of solar flare particle events, charged particle motions and acceleration around magnetic reconnection regions, and plasma-insulator interactions.

Beard has examined the physical behavior of interplanetary dust and the origin of the solar wind with the purpose of anticipating the spatial distribution of dust and electrons near the sun and their consequent contribution to the F and K coronae. The minimum distance of closest approach of the dust to the sun before insolation vaporizes the dust is apparently 4.5 solar radii. Analysis of coronal observations reveals that the electron density is given by $r^{-2} \exp W/r$, where r is solar distance and the parameter W determined from fitting observations depends on solar activity. These results have stimulated current theoretical study of the effects of heat conduction and hydromagnetic wave absorption in the corona which give rise to the observed plasma acceleration. A collaboration with M. Selby, K. Reahy, and others of Imperial College and Universitad La Laguna at Tenerife is underway to determine the velocity of the zodiacal light and other physical characteristics of interplanetary dust viz. size, albedo and the inner limit to the spatial distribution.

Beard has developed further his theory of comet tails focussing attention on the competing ionization processes of charge transfer which cushions the solar wind and electron ionization which is necessary for Type L tail formation.

Beard and Dr. Irene Engle (Annapolis) have completed their calculation of the shape of the Jovian magnetosphere and the magnetic field within the Jovian magnetosphere. The presence of a large electric current in the equatorial plane significantly flattens the magnetosphere compared with Earth's magnetosphere and causes the field to be aligned more tangentially to the equatorial plane.

Beard is currently trying to improve the representation of Earth's magnetospheric field in the near Earth magnetotail region; this is important to an understanding of aurora, magnetic storms, and field line merging.

E.J. Zeller has been continuing studies on the effects of the solar activity cycle on the trace chemical constituents of south-pole ice. Preliminary results indicate that a record of past solar activity can be obtained from chemical analyses of ice cores drilled at South Pole Station in Antarctica. A 109-m core was obtained during his visit to Antarctica in the 1978–79 field season and this core is being analyzed for nitrate and ammonium ions in a joint effort with Prof. Bruce C. Parker at Virginia Polytechnic Institute. At present it seems most likely that the nitrate is formed in the upper stratosphere by auroral activity which is known to reflect the level of sunspot activity. This program is continuing with support provided by the Division of Polar Programs of the National Science Foundation, and E.J. Zellar and G. Dreschhoff returned to Antarctica in November 1979 to aid in securing four additional 100-m ice cores from various locations on the antarctic ice sheet. Attempts will be made to obtain detailed samples to determine the seasonal variability of nitrate in glaciological samples from the area of the Ellsworth Mountains in Antarctica.

B. Stellar and Galactic Studies

Bord continued his investigations of galactic x-ray sources in collaboration with L. Petro (MIT), A. Cowley (U. of Michigan) and D. Crampton (DAO). Photometric observations of Sco X-1 were made by Bord from Mt. Hopkins Observatory during the March 1979 World-Wide Watch organized by Petro. The data are now being analyzed to search for time correlations between short duration optical and x-ray flares. Preliminary results suggest the existence of a lag between the arrival times of the flares in the optical and x-ray regions, which, if confirmed, may provide information about the dimensions and/or self-absorptive properties of this source. In addition to the Sco X-1 work, radial velocity information for WRA977 is being assembled by Cowley and Crampton from high dispersion observations made by these workers, Bord and Petro. Although the coverage is not complete, the data appear to support the earlier photometrically determined orbital period of 22^d, which is at variance with the x-ray period of 35^d. Further observations of this object are being planned.

Bord and Davidson have submitted a proposal to NASA for

observing time on the IUE satellite to search for gold in chemically peculiar stars. The initial investigation will be confined largely to bright, sharp-line Hg-Mn stars having overabundances of platinum; an examination of Au/Hg and Pt/Hg abundance ratios is planned for stars in which gold is found in order to identify possible violations of the so-called "even-odd" effect typically found in solar-terrestrial abundance determinations.

Shawl has continued the collaboration with Hesser (DAO) on their radial velocity work on the galactic globular clusters. At this point, 81 clusters have been observed with the Fabry–Perot—13 of which had not been observed by Mayall and Kinman. Image-tube spectra have been obtained with the Yale 1-m telescope for 88 clusters, 23 of which were not observed by Mayall and Kinman. All Fabry–Perot data have undergone cross-correlation analyses which must now be converted to heliocentric velocities. The reduction of the image-tube spectra is underway with the ARCTURUS measuring engine at DAO.

Shawl and Hesser used with Fabry–Perot interferometer at CTIO in an attempt to observe the rotation of Omega Centauri. The observational technique, involving observations of the core and eight halo positions just outside the core radius, was devised to give high precision. Instrumental problems, however, prevented the realization of our goals. We could say, however, that the maximum rotation amounted to some 5 km/s at this distance from the center.

Shawl, in collaboration with R.E. White and G.V. Coyne of Steward Observatory, is attempting to observe intrinsic polarization around red giants in the globular cluster M3 and M13. *Preliminary* results of the observations of 16 stars in M3 and 24 in M13 show statistically significant polarization for 4 stars in M13 but none in M3.

Shawl and R.E. White (Steward Observatory) began a project to determine the axial ratios, orientations, and center coordinates for the galactic globular clusters. The program involves the analysis of cluster images from the Palomar Sky Survey and the ESO/SRC survey with use of the Kitt Peak IPPS. A major by-product of the technique is coordinates of the photometric center of the cluster with an accuracy of better than 1 arcsec. A subset of this work includes the x-ray clusters. We have obtained central coordinates for six of these clusters and have submitted them for publication.

Shawl and P.G. Martin (David Dunlap Observatory) began a polarimetric investigation of M31 using globular clusters as probes of the interstellar medium. Observations of the wavelength dependence of the polarization of the cluster S78 (= B42) are consistent with the low value of R (total to selective absorption) of 2.5 determined from photometric methods. The cluster Baade 327 was found to have a high polarization, 6.3%, and a high alignment efficiency for such a highly reddened cluster. Additional observations will be made for this project.

Shawl and Martin also began a polarimetric study of dust clouds in the globular clusters M3, M13, and M15. *Preliminary* results indicate a possible detection of polarization from intraglobular dust. Additional observations are contemplated.

Shawl continued his work on polarimetry of late-type stars monitoring the time and wavelength variations of the position angles for R Hya, X Her, g Her, and L_2 Pup. The interpretation of the observed changes in terms of physical models is not yet obvious. Some work was also done in collaboration with G.V. Coyne and I.S. McLean of the Lunar and Planetary Laboratory on narrow-band polarimetry of cool stars.

III. INSTRUMENTATION

Through a generous gift by Dr. and Mrs. Floyd W. Preston, the Department has purchased a Celestron 14 telescope. Present plans are to instrument it with a small photometer and spectrograph.

The photometer used on the 27-in. Pitt reflector has been redesigned and a dry-ice cold box added. The addition of a new DC amplifier should allow the system to be much more useful than in the past.

The Observatory's all-transmission-optics spectrograph used on the 27-in. telescope was refurbished by D. Tholen and is once again in working condition.

The 6-in. Clark refractor was dismantled pending completion of a new dome. Meanwhile, the battle-ship grey paint has been removed to restore the instrument's esthetic value!

IV. TEACHING

Undergraduate degrees were awarded to Ronald Schmidt, Brenda Beaumont Johnson, and David Tholen.

Graduate degrees in space physics were awarded to M. Ahmadian (Ph.D.), R. Decker (Ph.D.), and E. Wainwright (M.A.).

Bord supervised undergraduate James Kilian in an independent research project during the summer of 1979 designed to investigate the photometric properties of newly identified Am stars. Although plagued by electronic and mechanical problems throughout most of the summer, they anticipate resuming this effort in the fall of 1979 using a redesigned photometer/cold box assembly and a more versatile DC amplifier.

Davidson has continued the highly successful Astronomy Camp division of the MidAmerica Music and Art Camp. The Camp has been expanded into two two-week sessions and has attracted students from most parts of the United States.

The Department has continued its involvement with the Museum of Natural History in providing lectures about astronomy to school groups visiting the University and is presenting week-long programs in the summer for students aged 10–12 years.

V. MISCELLANEOUS

The department has been pleased to have had visits and astronomical colloquia presented by the following: David Alexander (Wichita State University), Mike Bird (Max Planck Institute für Astronomie), Kam-Ching Leung (Nebraska), Julie Lutz (Washington State), Arno Penzias (Bell Labs), and Vytenis Vasalunias (Max Planck Institute für Aeronomie).

Shawl and Bord organized an expedition to Brandon, Manitoba, Canada to see the total eclipse of the sun on February 26, 1979. Two busloads of participants, including individuals from as far away as Georgia, made the trip and were treated to an excellent view of the solar corona during the period of totality.

Bord served as a consultant for the Spencer Art Museum's program on "Urania: the Muse of Astronomy," which ran during the months of May–August 1979. Assisted by graduate assistants M. Paonessa, P. Briggs, and undergraduate Jill Kenton, he presented public programs on shadowstick astronomy, sundials, and eclipses. Bord also took part in a discussion "From Magic to Science" with Prof. Maxine Moore (University of Missouri–Kansas City) dealing with the historical relationship between astrology and astronomy. Shawl also presented a program with Dr. Stanley Lombardo of the classics

department called "Fabric of the Heavens"—a program using art, literature, and music to illustrate man's changing views of the universe.

An undergraduate student, Mr. Todd Woods, received an appointment as a summer student as Sacramento Peak Observatory.

Bord gave a public lecture to the Astronomical Society of Kansas City entitled "Symbiosis in Stars."

Beard gave lectures and colloquia to the Danish Institute of Space Research, the Max Planck Institute für Aeronomie in Lindau, the University of Bonn, the University of Vienna, the Max Planck Institute für Kernphysik in Heidelburg, among other places.

During the past year Zeller attended the Seminar on Solar Variability held at Boulder, Colorado in September and he also participated in the Second Colloquium on Planetary Water and Polar Processes held at the Cold Regions Research and Engineering Laboratory in Hanover, New Hampshire in October. He continues to be interested in composition, structure and dynamical properties of the Martian ice caps.

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