University of Kansas

Lawrence, Kansas 66045

I. PERSONNEL

There have been no changes in the research or teaching staff. A Teaching Assistantship was held by Lori Allen.

II. RESEARCH

A. Solar System Studies

Professor Armstrong and graduate students Mark Paonessa and Scott Brandon analyzed Voyager Low Energy Charged Particle (LECP) data from the two 1979 Jupiter encounters. Several important results were confirmed or established by this work and the collaborative efforts at other institutions, principally the Johns Hopkins Applied Physics Laboratory and the University of Maryland. Some of the salient results of this were:

(1) The discovery in the Jovian trapped radiation of molecular species H_2 and H_3 at energies of 1 MeV per nucleon. This established that electrodynamic processes do act to extract Jovian ionospheric material into the magnetosphere and accelerate it to great energies.

(2) The discovery of a hot plasma region extending from about 20 R_J to 60 R_J from Jupiter. The temperature is about 300 to 500 million degrees Kelvin and most of the particles are oxygen, sulfur, protons, and helium. This plasma-filled region, which mostly corotates with Jupiter, is the hottest plasma ever measured directly *in situ*.

(3) The discovery of a "planetary wind" emanating from Jupiter flowing away from Jupiter in the antisolar direction. This strong outflow of plasma and energetic radiation shows that planetary magnetospheres may act as sources of matter and energy for the interplantetary medium.

(4) The confirmation of strong radiation belt losses at the radial distance of the Io plasma torus. This may be due to Coulomb scattering of these high-energy particles on a denser, colder, low-energy plasma component in the torus.

(5) The discovery of selective charged-particle absorption by Europa—16–20-MeV protons are depleted while electrons and lower energy ions are not.

(6) The discovery of Jovian ion bursts at great distance from Jupiter—several hundred Jovian radii.

Many other projects in addition to Voyager data analysis are in progress. Armstrong is aiding the design of data handling and evaluation procedures for *Galileo*, the Jupiter orbiter and entry probe. He is performing a similar role for an experiment to be flown on the International Solar Polar Mission.

Work is also continuing on interplanetary solar particle observations made with the Interplanetary Monitoring Platform (IMP) spacecraft during the 1972–present time interval. One of Prof. Armstrong's students, Pat Briggs, is conducting a statistical study of these charged-particle fluxes, looking both at flare and nonflare particles.

Beard has continued working on the genesis of Type I comet tails by energetic electrons in fast shocks near the comet nucleus. The fast shocks occur in conditions caused by the effect of solar radiation pressure on the comet coma. A collaboration with M. Selby, K. Reaky, and others of Imperial College and Universitad La Laguna at Tenerife is under way 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, with NASA support, is finding a convenient representation of his and Dr. Irene Engel's (Annapolis) calculation of the Jovian magnetic field. He is also making a more exact representatin of the Earth's magnetospheric field in the near-Earth magnetotail—vital to an understanding of aurora, magnetic storms, and field line merging. This calculation is being applied to an interpretation of the observations of Saturn and Mercury's magnetic fields.

E. J. Zeller and G. Dreschhoff have been involved in a joint effort with Prof. Bruce C. Parker of Virginia Polytechnic Institute to study the relationship between trace chemical constituents in polar ice and solar activity cycles. Last year four firn cores were drilled, two at South Pole Station and two at Vostok Station in Antarctica. These cores are presently undergoing chemical analysis. Analysis of the 108-m firn core from South Pole Station, drilled in 1978, has been completed and the relationship between nitrate ion concentration and solar activity is being evaluated. Of particular interest are the occasional large nitrate concentration spikes which appear in the sequential analysis record for nitrate ion. Some of these spikes may be related to upper atmosphere ionization resulting from either supernova x rays or energetic solar flare particles. Attempts are under way to determine what events might cause these spikes.

In November 1980, the research team returned to South Pole Station to dig a deep snow pit for detailed sampling of the snow that accumulated during the past 75 yr. Data from the analysis of these samples will be compared with known solar activity records for this period.

B. Stellar and Extragalactic Studies

Bord and Dr. Richard J. Messina (McKinsey and Co.) have completed their investigation of the red and near-infrared spectrum of α Lyr (Vega). Careful examination of the line profiles of the Ca II line at 8542 Å and the O I lines at 7774 and 8446 Å on 15 Å/mm coudé plates obtained with the 2.1-m feed system at Kitt Peak has revealed no trace of violet-shifted emission features like those reported by Johnson and Wisnewski (Publ. Astron. Soc. Pac. **90**, 139, 1978). This result, taken together with other, similarly negative reports by various observers using different observing equipment, strongly suggests that the originally reported features were of instrumental origin.

Bord and Davidson continue their collaborative effort to identify heavy chemical elements in mercury-manganese (Hg-Mn) stars. Utilizing high-dispersion ultraviolet echelle data obtained with the IUE satellite and a statistical line identification program developed especially for use with IUE data with the help of Dr. Charles R. Cowley (Michigan), the long-wavelength (1850–3230 Å) spectrum of κ Cnc has been searched for evidence of such elements as gold, platinum, mercury, osmium, and iridium. *Preliminary* results for a majority of

echelle orders confirm the presence of mercury and platinum in the atmosphere of this star, but fail to support the identification of any other heavy chemical species, in particular Au I and Au II. Further work on this star involving shorter wavelengths (1190–2125 Å) is now in progress, and similar analyses are planned for a second chemically peculiar star, i CrB.

Shawl, with J. E. Hesser (DAO), is continuing his long project on the radial velocity of galactic globular clusters. Current support from NSF is greatly helping to speed its completion. All the image-tube spectra obtained with the CTIO 1-m spectrograph have now been measured; these measures will allow us to extract the best possible velocities for all the clusters observed (a number of which have no previously published velocity information). Work on the Fabry-Perot data is also continuing.

Shawl and R. E. White (Steward Observatory) have made progress on their project of determining globular cluster shapes, orientations, and center coordinates. With the aid of NSF, we have been able to obtain preliminary results for approximately 60 clusters. A by-product of this work has been the determination of precise coordinates for the optical centers of x-ray globular clusters; within the accuracy of the x-ray positions, the x-ray source is at the optical center of the cluster.

Shawl and P. G. Martin (DDO) are continuing their work on dust and the magnetic field in M31 by making polarimetric measurements of the M31 globular clusters. They are also completing work on their polarimetric study of dust patches in M3, M13, and M15. Preliminary results suggest a possible detection of polarized light from a dust patch in M15, while no detection has been made in the others. A manuscript is in preparation. They gratefully acknowledge the University of Arizona for telescope time.

Shawl, along with G. V. Coyne and R. E. White of Steward Observatory, has made a polarimetric survey of red giants in the globular clusters M3 and M13. Of the 40 stars observed in the two clusters, 13 stars seem to have statistically significant, although small, intrinsic linear polarizations.

III. TEACHING AND PUBLIC SERVICE

Undergraduate degrees were granted to Jim Kilian and Tod Woods. Woods spent his second summer as a student at Sacramento Peak Observatory. Another undergraduate, Bret Goodrich, was awarded a University of Kansas Undergraduate Research Grant to build a simple high-speed photometer for use on our 14-in. telescope. With the help of the Astronomy Associates of Lawrence, a campus-based amateur club, we have been able to continue our successful weekly public observing session; attendance averages 25 per week. In addition, they participated in National Astronomy Day by sponsoring films and numerous mini-lectures at a local downtown park. Armstrong presented a well attended public lecture on the Voyager encounter with Jupiter. Shawl continued his monthly astronomy radio program.

IV. VISITORS AND MISCELLANEOUS

We were fortunate to have numerous astronomers visit with us this past year:

T. Edwards (Missouri)
R. Gilliland (Colorado)
J. Liebert (Steward)
W. Lockwood (Lowell)
P. Martin (DDO)
K. O. Mikaelin (Oklahoma)
C. Peterson (Missouri)
T. Snow (Colorado)
D. Tholen (Arizona)

Armstrong with R. B. Decker (Johns Hopkins) and M. E. Pesses (Maryland), presented an invited review paper in Czechoslovakia on particle acceleration by interplanetary shocks.

Bord presented a paper entitled "A Short History of the University of Kansas' Observatory: The First Twenty Years 1919–1939" at the March 1980 meeting of the Kansas Academy of Science. He also delivered a public lecture on chemically peculiar stars at Washburn University and a colloquium entitled "A Search for Gold in Hg-Mn Stars" to the Department of Physics and Astronomy at Vanderbilt University.

Shawl delivered colloquia at Benedictine College and to the Physics and Astronomy Department at the University of Kansas, a short lunch-hour presentation at KPNO, and a poster session at IAU Symposium No. 85 on Star Clusters at Victoria.

V. PUBLICATIONS

Beard, D. B., and Ng, King H. (1979). "Possible displacement of Mercury's dipole," J. Geophys. Res. **84**, 2115.

Beard, D. B., and Cowley, S. W. H. (1979). "The absence of electric fields due to particle entry into the magnetosphere," Planet Space Sci. **29**, 1523.

Beard, D. B. (1979). "The solar corona," Astrophys. J. **234**, 696.

Beard, D. B., and Engle, I. M. (1980). "Idealized Jovian magnetosphere shape and field," J. Geophys. Res. **85**, 579.

Bord, D. J., and Messina, R. J. (1980). "Near infrared observations of α Lyrae," Bull. Am. Astron. Soc. **12**, 439.

Bord, D. J. (1980). "Mr. Pitt's telescope: a short history of the University of Kansas' 27-inch reflector," Trans. Kansas Acad. Sci. (in press).

Krimigis, S. M., Armstrong, T. P., Axford, W. I., Bostrom, C. O., Fan, C. Y., Gloeckler, G., Lanzerotti, J. J., Keath, E. P., Zwickl, R. D., Carbary, J. F., and Hamilton, D. G. (1979). "Hot plasma environment at Jupiter: Voyager 2 results," Science **206**, 977–984.

Shawl, S. J., and White, B. E. (1980). "Axial ratios, orientations, and center coordinates of galactic globular clusters," in *Star Clusters*, edited by J. E. Hesser (Reidel, Dordrecht), p. 481.

Zwickl, R. D., Krimigis, S. M., Armstrong, T. P., and Lanzerotti, L. J. (1980). "Ions of Jovian origin observed by Voyager 1 and 2 in interplanetary space," Geophys. Res. Lett. **7**, 453–456.

Burlaga, L., Lepping, R., Weber, R., Armstrong, T., Goodrich, C., Sullivan, J., Gurnett, D., Kellogg, P., Keppler, E., Mariani, F., Neubauer, F., Rosenbauer, H., and Schwenn, R. (1980). "Interplanetary particles and fields, November 22 to December 6, 1977: Helios, Voyager, and IMP observations between 0.6 and 1.6 AU," J. Geophys. Res. **85**, 2227.

Data Survey

(1) No. of faculty/staff: tenured or tenure-track 1 (M), 0 (F), post-doc 0 (M), 0 (F); res. assoc. 0 (M), 0 (F); other Ph.D's 0 (M), 0 (F).