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The following report covers activities from September 1998 through August 1999.

1. INTRODUCTION & PERSONNEL

Research in astronomy and the space sciences at USC is carried through in the Space Sciences Center and Department of Physics and Astronomy. Scientists whose research is reported below include: 1) Space Science Center: Dr. Darrell L. Judge, Professor and Director of the Space Sciences Center, Dr. C. Y. Robert Wu, Research Professor, Drs. Pradip Gangopadhyay, Andrew Jones, Howard S. Ogawa, & Geraldine J. Peters, Research Scientists, Dr. Fang-Zhong Chen, Postdoctoral Fellow, & Donald McMullin, Project Manager, and 2) Department of Physics & Astronomy: Drs. Werner Däppen, Melvin Daybell, Professors, Tom Hung & Chia-Hsien Lin, graduate students, and Dr. Gibson Reaves, Professor Emeritus.

2. RESEARCH

W. Däppen continued his research on using the sun as a plasma physics laboratory. To pursue this goal, he participates in state-of-the art solar modeling and the analysis of helioseismic data. Helioseismology is the first accurate ''experiment'' that puts strong constraints on the thermodynamic quantities of the plasma of stellar interiors. His own contribution to the field [the Mihalas-Hummer-Däppen (MHD) equation of state] is currently being used in collaboration with several international solar and stellar modeling groups. His most recent attention is devoted to the subtle thermodynamic effects of excited states in atoms and ions of the solar interior. Such effects have indeed been detected by helioseismology, and they have to be taken into account in the determination of the helium abundance of the solar convection zone.

H. S. Ogawa, M. Daybell, D. R. McMullin, P. Gangopadhyay, and D. L. Judge have continued their work on solar EUV irradiance observations from sounding rockets, the Shuttle, and satellites. Various instruments have been and are being utilized to obtain absolute solar EUV flux data. These include Rare Gas Ionization Cells (RGIC) to obtain absolute integral irradiance in a wavelength region shortward of the ionization limit of the working gas used, Double Ionization Cells (HDIC) to obtain photoionization rates of Helium and Neon, Free Standing and Film Deposited Photodiodes to obtain absolute flux within the wavelength band pass of the metal filter used, an Optics Free Spectrometer (OFS) to obtain spectral irradiance data in the EUV and soft X-ray region, a low resolution ($\sim$10Å) normal incidence spectrometer, and a solar EUV Monitor (SEM) to obtain absolute solar EUV irradiance that has been securing high quality data for two years aboard the SOHO spacecraft. High quality data from a complement of solar EUV instrumentation aboard the STS-95 (''John Glenn'') Shuttle flight is presently being analyzed. The calibration of SOHO/SEM is been determined from the data obtained from three sounding rocket underflights (1996 June 26, 1997 August 11 and 1999 August 18). A small change in efficiency in the first order channel and a less than 5% change in the efficiency of the central order channel have been determined and will be reported in a forthcoming paper.

D. L. Judge, D. R. McMullin and H. S. Ogawa recently published a paper on the results from the first two sounding rocket flights in the Journal of Geophysical Research. An early analysis of the data has been made and a short presentation was given by L. Floyd *et al.* 1999. The analysis suggests a small degradation in each channel of the CELIAS/SEM instrument due to responsivity change due to hydrocarbon buildup. The CELIAS/SEM data was also instrumental in providing data required to interpret the CELIAS/CTOF data that provided a direct evidence of the interstellar gas flow velocity (Moebius *et al.* 1999). The CELIAS/SEM central channel data also contain solar soft X-ray data. Currently work is being done to extract the 0.1–10 nm soft X-ray data from the SEM central channel.

G. J. Peters continued her study of short-term wind and photospheric activity in Be stars. In collaboration with D. Gies (Georgia State Univ.), she employed a cross-correlation technique using NEWSIPS *IUE* data to extract information on the nature of the photospheric line profile variability seen during 12 multiwavelength campaigns. Thus information on both wind and photospheric activity was derived from the same dataset. Three classes of variability were identified: 1) FUV flux and wind strength correlated, 2) the FUV flux varies cyclically but wind variability if present does not correlate with the flux, and 3) the wind strength cyclically varies but does not correlate with light variations. Evidence for nonradial pulsations (NRP) in low-order modes is found for Be stars in Classes 1 & 2. These results were summarized in an invited talk presented at IAU Colloquium 175, ''The Be Phenomenon in Early-Type Stars'' held in Alicante, Spain from 1999 June 28 - July 2. In a poster presentation at the same meeting, G. J. Peters also reported on long-term variability in the winds of λ Eri and 66 Oph during the lifetime of the *IUE* spacecraft. Evidence for cyclical variability on a time scale of $\sim$1 yr was found. Peters continued to serve as Editor-in-Chief of the *Be Star Newsletter*, a periodical published for the Working Group on Active B Stars of the IAU Division IV (Stars) in both paper (D. R. Gies, Georgia State University, technical editor) and electronic (http://www.limber.org/benews/, D. McDavid, technical editor) editions.

G. J. Peters also continued to investigate the circumstellar material in Algol binary systems. ORFEUS and NEWSIPS *IUE* spectra were combined to study the long-term disk &

photospheric variability in AU Mon. Peters collaborated with R. Polidan (GSFC) and D. E. Lynch (Global Science & Tech.) in a study of apparent bipolar flows in V356 Sgr & TT Hya, and M. Richards (Univ. Virginia) & P. Koubský (Ondřejov Obs.) in the completion of a multiwavelength study of CX Dra.

G. J. Peters and J. Grigsby (Ball Aerospace) completed an initial study of the Fe abundance in AV 304, a sharp-lined B0.5V star in the Small Magellanic Cloud, using spectra from HST/STIS. Twenty-two strong, relatively unblended, Fe III lines between 1890–1970 Å yielded an Fe abundance of 6.7 ± 0.2 or [Fe/H]$\sim$-1.0, which is proportionally even less abundant than the lighter elements in this star. This is the first determination of the Fe abundance in a star in an external galaxy directly from photospheric data. Peters & Grigsby also continued a study of the abundances of the Fe group elements in the ultrasharp-lined early B starsι Her, HR 1886, and HR 1887 using coadded high resolution *IUE* data, the Kurucz SYNTHE code, and Kurucz model atmospheres.

G. Reaves continues his study of the dynamics of asteroid orbits, concentrating on developing a fast and approximate yet adequate method for determining proper elements. Again, as in previous years, he served as an active member of the Lowell Observatory Advisory Board.

C. Y. Robert Wu has continued his work with F. Z. Chen, D. L. Judge, and other collaborators to obtain (1) temperature-dependent cross sections of allene, methylacetylene, and benzene in the UV region, (2) temperature-dependent cross sections of gaseous and liquid $H_2O$and D_2O in 1600–1800 Å region, and (3) ultrahigh resolution (FWHM = 0.003), high (555 K), and room temperature (295 K) absorption cross-sections of O_2 in the 834 Å region. The data have been applied in modeling various planetary atmospheres such as Earth, Saturn, Mars, Io, Titan, Jupiter, and Neptune and in the evaluation and modeling of the effect of the recent Comet SL-9 impact on Jupiter's atmosphere.

Wu, F. Z. Chen, T. Hung, and D. L. Judge have continued their studies of fluorescence produced through photoexcitation of CO in the 28-100 eV region. They have observed (for the first time) fluorescence processes correlated with excited electronic states of doubly and triply-charged molecules, which was possible because they employed the newest, brightest tunable synchrotron radiation source available at the Photon Factory, Tsukuba, Japan. Wu, Chen, and P. Scoggins have continued their investigation of the absolute solar photon sputtering/desorption yield of H_2O ices, D_2O ices, and CH_4 clathrate hydrates in the inner valence and core electron regions using intense tunable VUV photon source provided by synchrotron radiation.

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The publication list includes all papers published or submitted between 1998 September 1 & 1999 August 31 by permanent staff.

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