GRANT/GODDARD

IN-27176 48.

Semi-Annual Progress Report

STUDIES OF THE ULTRAVIOLET SPECTRA OF ASTRONOMICAL SOURCES

NASA Grant NSG 5393

Covering the period from February 1, 1986 to July 31, 1986

In late July an observation showed neutral oxygen and sulfur emission at the position of Io. Studies of Jupiter, Saturn and Uranus are continuing.

An intensive program of observations of Comet Halley during the week of the Vega 2 and Giotto encounters was carried out by the International Ultraviolet Explorer (IUE) satellite observatory. NASA's primary space mission to study Halley in the vacuum ultraviolet, ASTRO-1, was postponed following the Challenger tragedy. The ultraviolet observations, which must be obtained from a platform above the Earth's absorbing atmosphere, provide a means of determining the temporal behavior of the primary constituents of the gaseous coma, H_2O and CO. However, due to the comet's small elongation from the Sun, observations with IUE during this period were extremely difficult and required several new techniques to be developed by IUE operations engineers. Thus, observations were made possible on March 9, 11 and 16, in addition to three shifts planned for the European team on March 12, 13 and 14. The program initially planned began on March 18 and continued to monitor the comet's activity through 8 July 1986.

All of the observations in March were made from the Goddard Space Flight Center by both the U.S. team and members of the European team who are collaborating on this program. The IUE Fine Error Sensor, used for target acquisition and tracking, was used in a photometer mode to provide nearly continuous light curves over an 8 hour observing shift, a unique capability relative to ground-based observers. During the encounter week, variations in brightness of a factor of two (in a region ~7000 km in radius projected at the comet) were found in a 24 hour period. At the time of the Giotto encounter this activity was seen to be near a minimum. Preliminary analysis of the ultraviolet spectra, which are qualitatively similar to those of other comets observed by IUE over the past six years, show similar day-to-day variations in both the gaseous emissions and in the continuum of reflected sunlight by cometary grains. The ultraviolet data can also be used to derive an estimate of the total gas production rate (assuming the gas to be primarily H_2O) even though the models generally used for this purpose assume a steady-state gas production which is clearly not the case for Halley. At the time of the Giotto encounter, the gas production rate was 5×10^{29} molecules/second (about 14 tons of water/second) with an uncertainty of about a factor of 2. Additionally, the IUE data provide column abundances of carbon, oxygen, sulfur, OH, CO, CS, C_2 and CO_2 to compare with the in situ measurements of these species by Vega 2 and Giotto.

Our paper describing the results of analysis of our observations of ϵ Eri, HR 1099, Procyon and Altair, has been submitted to the Astrophysical Journal. No referee report has been received as yet. The results were presented at Cambridge, England, by Murthy, and the results as well as a review were presented by Henry at the UCL IUE meeting in July 1986. Also,

the results were described by Landsman at COSPAR (at no cost to this IUE grant). We will be cooperating with Vidal-Madjar in October in an observation of β Gem, and will be submitting a proposal, on the next round, for further observations of late-type stars.

PUBLICATIONS

P.D. Feldman, Carbon monoxide in cometary ice, in Asteroids, Comets and Meteors II, ed. C.-I. Lagerkvist, B. A. Lindblad, H. Lundstedt and H. Rickman, Uppsala Univ., Uppsala, 1986, pp. 263-267.

P. D. Feldman, In-flight analysis of IUE cross-disperser scattered light, Astron. Astrophys., 159, 342, 1986.

W. B. Landsman, J. Murthy, R. C. Henry, H. W. Moos, J. L. Linsky, and J. L. Russell, IUE Observations of Interstellar Hydrogen and Deuterium Toward Alpha Cen B, Ap.J., in press, October 1986.

R. C. Henry, J. Murthy, H. W. Moos, W. B. Landsman, J. L. Linsky, A. Vidal-Madjar, and C. Gry, IUE Study of the Very Local Interstellar Medium, New Insights in Astrophysics, 8 Years of UV Astronomy with IUE, 14-16 July 1986, London, U.K.

J. Murthy, R. C. Henry, H. W. Moos, W. B. Landsman, J. L. Linsky, A. Vidal-Madjar, and C. Gry, IUE Observations of Hydrogen and Deuterium in the Local Interstellar Medium, submitted to Ap.J., August 1986.

W. Moos and Th. Encrenaz, Observations of Planetary Atmospheres and Aurorae with IUE, The Scientific Accomplishments of the IUE, 1986.

W. B. Landsman, J. Murthy, R. Henry, H. W. Moos, J. L. Linsky, A. Vidal-Madjar, and C. Gry, IUE Observations of Neutral Hydrogen and Deuterium in the Local Interstellar Medium, XXVI COSPAR, Toulouse, France 30 June - 12 July 1986.

M. C. Festou and P. D. Feldman, Comets, in The Scientific Accomplishments of the IUE, submitted 1986.

M. C. Festou, P. D. Feldman, M. F. A'Hearn, C. Arpigny, C. B. Cosmovici, A. C. Danks, L. A. McFadden, R. Gilmozzi, P. Patriarchi, G. P. Tozzi, M. K. Wallis, H. A. Weaver, IUE Observations of Comet Halley: 1. Evolution of the UV Spectrum of the Comet at the Time of the Vega and Giotto Spacecraft Encounters, Nature, 321, 361-363 (1986).

L. A. McFadden, M. F. A'Hearn, P. D. Feldman, H. Bohnhardt, J. Rahe, M. C. Festou, J. C. Bradt, S. P. Maran, M. B. Niedner, A. M. Smith and D. G. Schleicher, Ultraviolet Spectrophotometry of Comet Giacobini-Zinner During the ICE Encounter, Icarus, submitted April 1986.

P. D. Feldman, The Io Torus and the Jovian Magnetosphere, New Insights in Astrophysics, 8 Years of UV Astronomy with IUE, 14-16 July 1986, London, U.K.

P. D. Feldman, M. C. Festou, M. F. A'Hearn, C. Arpigny, P. S. Butterworth, C. B. Cosmovici, A. C. Danks, R. Gilmozzi, W. M. Jackson, L. A. McFadden, P. Patriarchi, D. G. Schleicher, G. P. Tozzi, M. K. Wallis, H. A. Weaver, and T. N. Woods, IUE Observations of Comet Halley: Evolution of the UV Spectrum Between September 1985 and June 1986, New Insights in Astrophysics, 8 Years of UV Astronomy with IUE, 14-16 July 1986, London, U.K.

PAPERS PRESENTED

P. D. Feldman, "Observations of Halley's Comet from Earth Orbit", American Philosophical Society, Philadelphia, PA, April 26, 1986.

P. D. Feldman, "Ultraviolet Spectroscopy of Comet Halley", American Geophysical Union spring meeting, Baltimore, MD, May 21, 1986.

G. E. Ballester, H. W. Moos, D. F. Strobel, M. E. Summers, P. D. Feldman, T. E. Skinner, J.-L. Bertaux, M. C. Festou, and J. Lieske, Detection of a Neutral Oxygen and Sulfur Corona Around Io Using IUE, AAS, Paris DPS meeting, Nov. 2-7, 1986.

G. E. Ballester, H. W. Moos, D. F. Strobel, M. E. Summers, P. D. Feldman, J.-L. Bertaux, M. C. Festou, T. E. Skinner, and J. Lieske, Detection of Neutral Atomic Cloud Near Io Using IUE, Second Neil Brice Memorial Symposium Magnetospheres of the Outer Planets, September 1, 1986.

P. D. Feldman, M. C. Festou, M. F. A'Hearn, C. Arpigny, P. S. Butterworth, C. B. Cosmovici, A. C. Danks, R. Gilmozzi, W. M. Jackson, L. A. McFadden, P. Patriarchi, D. G. Schleicher, G. P. Tozzi, M. K. Wallis, H. A. Weaver, and T. N. Woods, IUE Observations of Comet Halley: Evolution of the Ultraviolet Spectrum Between September 1985 and July 1986, ESLAB Symposium "The Exploration of Halley's Comet", Heidelberg, October 1986.