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Final Report

OBSERVATIONS OF COMETS WITH THE IUE

NASA Grant NAG5-2141

Period Covered: December 1, 1992 - January 31, 1995

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Final Report

OBSERVATIONS OF COMETS WITH THE IUE

NASA Grant NAG5-2141

Covering the Period from December 1, 1992 - January 31, 1995

This is the final report for NASA grant NAG5-2141, *Observation of Comets with the IUE*, which began in December 1992 and was completed in January 1995. This grant continued our *IUE* program begun in July 1979 under grant NSG-5393 which terminated in September 1992.

We attach in Appendix A a complete list of publications related to IUE observations of comets from 1980 to the present. Publication numbers 51-53 appeared during the December 1992 - January 1995 period and copies of these are being forwarded to the NSSDC along with this report. Papers presented at recent scientific meetings are listed in Appendix B.

During this period we have concentrated our effort into two distinct areas, new observations of comets of interest and continuing analysis of the data from previous observations. Five comets were observed as given in Table 1.

Table 1. Observed Comets

<u>Comet</u>	<u>Dates</u>
P/Schaumasse (1992x)	March 1993
P/Encke	December 1993 - January 1994
McNaught-Russell (1993v)	March 1994
P/Tempel 1 (1993c)	July 1994
Machholz 2 (1994o)	October 1994

These observations were rather difficult to carry out because of the severe beta angle constraints imposed by the *IUE* spacecraft and the problem of the FES streak. Nevertheless, good data were acquired for all of these targets. Comet P/Schaumasse, although rather faint, was simultaneously observed by the Faint Object Spectrograph of the Hubble Space Telescope. Most notable was periodic comet Encke (with the shortest known period, 3.3 years) which was observed for its fifth consecutive apparition by *IUE*. A study of the secular variation of this comet's activity with time was carried out in collaboration with M.E. Haken and M.F. A'Hearn of the University of Maryland and the initial results were presented at the November 1994 meeting of the Division for Planetary Sciences of the AAS. Periodic comet Tempel 1 had also been observed previously by *IUE*, in July 1983.

The two "new" comets observed, regrettably, were not as active as anticipated. Comet Machholz 2 (1994o) showed little enhancement in activity even though its nucleus had broken into several distinct nuclei.

In the area of analysis, we have continued our study of the carbon emissions in several moderately active comets in collaboration with G.P. Tozzi (Osservatorio Astrofisico di Arcetri, Italy) and M.C. Festou (Observatoire Midi-Pyrénées, France). We have shown that the $\text{CI } \lambda 1931$ emission, which is due to resonant scattering from the ^1D metastable state of atomic carbon, is a measure of the production rate of CO from the nucleus of the comet, and we have derived the photodissociation rate into this state. This rate is considerably higher than values currently in the literature, based on earlier incomplete laboratory spectroscopic data. A paper on this result is in preparation.

During the course of this study we began to use the NEWSIPS reprocessed data being prepared for the *IUE* Final Archive. A serendipitous discovery, while examining the data, was the detection of the (1,0) band of the CO Cameron system at 1993 Å, at the extreme edge of the SWP camera, in the spectra of several comets. This band system, recently detected in HST spectra of comet P/Hartley 2 (Weaver, *et al.* 1994) is produced by photodissociation of CO₂ and hence provides a means of determining the CO₂/CO ratio in these comets. This should be a critical element in determining the basic chemical composition of the volatile component of the cometary nucleus. This work was also carried out in collaboration with Tozzi and Festou.

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Weaver, H.A., Feldman, P.D., McPhate, J.B., A'Hearn, M.F., Arpigny, C., and Smith, T.E., Detection of CO Cameron Band Emission in Comet P/Hartley 2 (1991 XV) with the Hubble Space Telescope, *Astrophys. J.* **422**, 374-380 (1994).

APPENDIX A

IUE Comet Publications 1980-1994

1. P. D. Feldman, H. A. Weaver, M. C. Festou, M. F. A'Hearn, W. M. Jackson, B. Donn, J. Rahe, A. M. Smith and P. Benvenuti, IUE observations of the ultraviolet spectrum of Comet Bradfield, *Nature* **286**, 132 (1980).
2. M. F. A'Hearn and P. D. Feldman, Carbon in Comet Bradfield 1979 ℓ , *Astrophys. J. (Letters)* **242**, L187 (1980).
3. P. D. Feldman, New insight into the physical state of solar system objects, in *The Universe at Ultraviolet Wavelengths: The First Two Years of IUE*, NASA CP-2171, 1981, p. 21.
4. W. M. Jackson, J. Halpern, P. D. Feldman and J. Rahe, Analysis of IUE observations of CS in comet Bradfield (1979 ℓ), in *The Universe at Ultraviolet Wavelengths: The First Two Years of IUE*, NASA CP- 2171, 1981, p. 55.
5. H. A. Weaver, P. D. Feldman and M. C. Festou, Water production models for comet Bradfield (1979 ℓ), in *The Universe at Ultraviolet Wavelengths: The First Two Years of IUE*, NASA CP-2171, 1981, p. 65.
6. P. D. Feldman, Ultraviolet spectroscopy of comets using sounding rockets, IUE and Spacelab, in *Modern Observational Techniques for Comets*, JPL Publication 81-68, 1981, p. 139.
7. H. A. Weaver, P. D. Feldman, M. C. Festou and M. F. A'Hearn, Water production models for comet Bradfield (1979 X), *Astrophys. J.* **251**, 809 (1981).
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APPENDIX B

Papers Presented

S.A. Budzien and P.D. Feldman, Solar Flux Variability Effects on the OH Coma from IUE Observation of Comets, presented at the Fall 1992 DPS Meeting, 12 – 16 October 1992, Munich, Germany, *Bull. AAS* **24**, 1006 (1992).

G.P. Tozzi, P.D. Feldman, and M.C. Festou, The Production of C(¹D) Atoms in Cometary Comae, presented at the Fall 1992 DPS Meeting, 12 – 16 October 1992, Munich, Germany, *Bull. AAS* **24**, 1019 (1992).

P.D. Feldman, The Abundance of Ammonia in Some Recent Comets, presented at IAU Symposium 160: *Asteroids, Comets, Meteors 1993*, 14 – 18 June 1993, Belgirate, Italy.

P.D. Feldman, J.B. McPhate, M.F. A'Hearn, L.A. McFadden, and M.E. Haken, The Evolution of the Coma of Comet P/Swift-Tuttle During November 1992, presented at IAU Symposium 160: *Asteroids, Comets, Meteors 1993*, 14 – 18 June 1993, Belgirate, Italy.

M. Haken, M.F. A'Hearn P.D. Feldman, Secular Variation in Comet P/Encke, presented at the Fall 1994 DPS Meeting, 31 October – 4 November 1994, Washington, DC, *Bull. AAS* **26**, 1120 (1994).