N91-25990

# HUT Observations of Carbon Monoxide in the Coma of Comet Levy (1990c)

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Observations of comet Levy (1990c) were made with the Hopkins Ultraviolet Telescope during the Astro-1 Space Shuttle mission on 1990 December 10. The spectrum, covering the wavelength range 415 - 1850 Å at a spectral resolution of 3 Å (in first order), shows the presence of carbon monoxide and atomic hydrogen, carbon and sulfur in the coma. Aside from H I Lyman-$\beta$, no cometary features are detected below 1200 Å, although cometary O I and O II would be masked by the same emissions present in the day airglow spectrum. The 9.4 $\times$ 116 arcsecond aperture corresponds to 12000 $\times$ 148000 km at the comet. The derived production rate of CO relative to water, 0.13 $\pm$ 0.02, compared with the same ratio derived from *IUE* observations (made in September 1990) which sample a much smaller region of the coma, 0.04 $\pm$ 0.01, suggests the presence of an extended source of CO, as was found in comet Halley. Upper limits on Ne and Ar abundance are within an order of magnitude of solar abundances.

The Hopkins Ultraviolet Telescope Project is supported by NASA contract NAS 5-27000 to the Johns Hopkins University.

# Ultraviolet and Visible Variability of the Coma of Comet Levy (1990c)

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Short-term variability of the coma of comet Levy (1990c) was detected and monitored (c.f. IAU Circular 5081) with the *International Ultraviolet Explorer* (*IUE*) satellite observatory during August and September 1990 including 24 hours of continuous observation on 18 September. The visible light curve obtained on this date with the *IUE* Fine Error Sensor (FES) shows two distinct maxima separated by 17.1 ± 0.2 hours. However, this period cannot properly match in phase the FES data obtained during eight-hour shifts on 11 and 13 September, and suggests a decrease in apparent period of ~0.5 % per day. A similar decrease is derived from a comparison with the period derived from ground-based data taken in late August (Schleicher *et al.*). The variation in the ultraviolet emissions of OH, CS, and $CO_2^+$ was also determined from 18 consecutive long-wavelength *IUE* spectra taken on 18 September. From the shape of the ultraviolet and visible light curves it is possible to determine the ratio of gas to dust outflow velocities. A sharp change in $CO_2^+$ brightness suggests that a sub-surface region of volatiles, including $CO_2$, may be responsible for the observed variability, although the origin of the decrease in period remains unexplained. CO was also observed, with a production rate ~0.04 ± 0.01 that of $H_2O$, but the long exposure time required for this measurement precluded any determination of CO variability. *IUE* observations made post-perihelion on 9-10 January 1991 showed no variability.

" BULK DENSITIES AND MASSES OF COMETARY NUCLEI ". Ignacio Ferrin, Astrophysics Group, Departament of Physics, UNIVERSITY OF THE ANDES, Merida 5101-A, VENEZUELA.

We have devised a method to derive bulk densities of comets from the observed values of the period of rotation, $P_{rot}$, and oblateness, $A = a/(a-b)$, where a and b, are the semi-axis of the nuclear ellipsoid.

For five planets and one comet the following law is capable of predicting the density with a mean error of only 8%:

$$\rho \text{ (+-8\% a.e.)} = 0.33 \cdot A^{0.58} \cdot P^{-0.17}$$

This means that we have identified the main physical variables that determine the oblateness (period of rotation and density).

We have applied this law to 9 comets for which we have periods of rotation an oblateness: Halley, Encke, Neujmin 1, Arend Rigaux, Giacobinni-Zinner, Temple 2, Iras-Araki-Alcock, Comas Sola and Kopff.

It is strongly concluded that comets are low density objects. For 9 comets in our data base, we obtain a mean density of 0.35 +- 0.11g/cm$^3$, and a mean mass of $2.5 \times 10^{17}$ g.

A plot of Mass versus Total absolute magnitude, gives a poor fit to the data. However, a plot of mass versus nuclear absolute magnitudes $V_N(1,1,0)$ gives a rather good fit, with the following equation:

$$\text{Log } M = 25.9 - 0.6 \cdot V_N(1,1,0)$$

Our result implies that the total mass of the Oort Cloud may have to be revised upwards, since 8 comets in our data set are periodic, and thus should have a mass smaller than that of new comets.

Our result also implies that we now have an accurate (+-8%) method to obtain the density of a comet, if we know the period of rotation and the oblateness of its nucleus. Both parameters can be easily obtained from nuclear observations at large distances from the Sun.

# COMPARISON OF A MULTI-GENERATIONAL MONTE CARLO COMETARY MODEL WITH OBSERVATIONS.

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A steady-state, multi-generational Monte Carlo model has been developed to examine the distribution of neutral coma species. The model follows the photodissociation steps through several generations of parent-daughter reactions.

Specifically, we look at the production of NH by the sequence:

$$NH_3 \rightarrow NH_2 \rightarrow NH \rightarrow N.$$

The model is compared with narrow band images of C/Austin, obtained at the MDM 1.3-m telescope on Kitt Peak.

Other model features include predictions of distributions due to a distributed source in the form of grains ejected from the comet nucleus, and subsequent photodissociation of the sublimated molecules. Also included, for specific molecules, is acceleration due to solar radiation pressure, and anisotropic ejection of the parent molecules from the nucleus.

WATER AND DUST PRODUCTION RATES IN COMET P/HALLEY (1986 III) FROM ULTRAVIOLET AND OPTICAL OBSERVATIONS: M.C. FESTOU, Soutwest Research Institute, San Antonio, TX, 78228, USA and Observatoire Midi-Pyrénées, 14 avenue E. Belin, F-31400 Toulouse, France.

Comet P/Halley was observed from September 1985 until July 1986 with the International Ultraviolet Explorer. The long wavelength spectrograph was used to monitor and measure the water production (via the OH emission) and the dust production (via its scattered light in the 2920-3020Å window) rates of the comet. The Fine Error Sensor camera was primarily used to acquire the comet in the instrumental fields of view; it also provided optical measurements of the brightness of the central coma at a time resolution far superior to that of the spectrocopic observations. One of the interesting aspects of those measurements if that, since the fields of view are small, of order 10 arc sec, the signals that were measured never integrated the activity of the nucleus over time periods larger than one to three hours. The two sets of observations are combined to derive a comprehensive picture of the evolution of the activity of the nucleus during the above-mentioned 10 month period. When necessary, visual magnitudes are used to complement the information given by our data sets. The short and long (secular) terms of the activity curves are separated. The contributions of the gaseous and the continuum emissions to the optical measurements are separated too. It is found that most of the time, the activity of the nucleus was smoothly varying. However, there are two well documented cases, namely on 18 March and on 10 April 1986, during which the nucleus activity was of 'explosive' nature, but of small amplitude, though. Water and dust production rates, the dust to gas ratio and the evolution of those parameters with heliocentric distance are given.

WATER PRODUCTION RATE OF COMET P/d'ARREST (1982 VII) AT ITS 1982 APPARITION: M.C. Festou[1], P.D. Feldman[2], M.F. A'Hearn[3]. 1: Soutwest Research Institute, San Antonio, TX, 78228, USA and Observatoire Midi-Pyrénées, F-31400 Toulouse, France; 2: Department of Physics and Astronomy, The Johns Hopkins University, Baltimore, MD, 21218, USA; 3: Astronomy Program, University of Maryland, MD 20742, USA.

Comet P/d'Arrest (1982 VII) was observed with the International Ultraviolet Explorer during the first 30 days following its passage through perihelion in 1982. During this long period, both the heliocentric and geocentric distance varied very little, allowing thus a quasi model independent comparison of the observations. As is well known from past visual observations, the gas production of that comet does not decrease immediately when the comet receedes from the sun. From our data set, it is possible to state that the water production was still increasing five weeks after perihelion passage. Since the visual data indicate a very sharp increase of the visual brightness during the last few weeks before perihelion passage, the light curve of that comet is exceptionally asymmetric. The continuum emission was only detected during the second part of the observations, still at a very low level. CS and $CO_2^+$ emissions were never detected. The short wavelength spectra only revealed the expected HI Lyman alpha emission. Water production rates and upper limits for the CS and SI production rates are given. A comparison of the dustiness of the comet with other periodic comets observed in nearly similar conditions is made. The water production measured in 1982, after the comet was back on its 1.30 AU perihelion orbit, was about ten times smaller than in 1976, when the perihelion distance was only 1.16 AU. Since the visual light curves in 1976 and 1982 did not differ much, it is inferred that the insolating conditions as a function of time were the same, except for the absolute values that were larger in 1976. In the light of those measurements, the change of the temperature of the nucleus with distance to the sun is discussed.