Abstract IT-5-1

DUST-GAS INTERRELATIONS IN COMETS: OBSERVATIONS AND THEORY

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Historically, the term comet has been given to the expanding atmosphere of neutral and ionized gas and dust surrounding a small icy parent body (the nucleus) which is in an eccentric orbit around the sun and which shows a head (or coma) and one or more tails. It is understood that evaporation of volatile ices from the comet's nucleus, the release of particulate material (dust), and the subsequent interaction between dust and gas in its immediate vicinity are responsible for the observed phenonmena. For comet P/Halley we do have spacecraft images of the dust distribution in this region. In general, however, the innermost coma serves as an unresolved "black box" source for the gas and dust observed remotely outside this region. The detailed connection between the icy parent body and the black-box source of gas and dust remains clouded. There is still an incomplete picture regarding the overall nature of the conditions and processes occurring in the innermost coma. Comet Hale-Bopp (C/1995 O1) was discovered far from the sun and is the largest and most productive comet, in the sense of release of gas and dust, in modern times. This, combined with continued advances in ground-based and near-Earth-based instrumentation, has permitted an unprecedented range and quality of remote observations of gas and dust to be obtained. Because it is typically unresolved, continued progress in our understanding of the important innermost coma requires a combination of observational evidence of gas and dust exiting this region and theoretical modeling which accounts for the basic physics and chemistry. Observations of comet Hale-Bopp which provide new insight into the interrelations between gas and dust in the coma are summarized. Theoretical modeling developments in the study of dusty-gas dynamics are also discussed. Particular topics include dusty-gas models, dust fading and fragmentation, the role of dust and gas jets, the day/night distribution of gas and dust, and extended sources of gas.

Abstract CT-5-1

A DUSTY COMA MODEL OF COMET HALE-BOPP

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We present a multifluid, hydrodynamic model for the gas, dust, and plasma flow in a cometary coma appropriate for comet Hale-Bopp at several heliocentric distances. The model accounts for three sources of gas release: sublimation from surface ices, transport of gas from subsurface regions through the surface, and release of gas from dust in the coma. The simulations are based on a spherically symmetric neutral coma model with detailed photo and gas-phase chemistry and dust entrainment by the gas. The model includes a separate energy balance for the electrons, separate flow of the neutral gas, fast neutral atomic and molecular hydrogen, and dust entrainment with fragmentation. The simulations allow a study of how certain features of a cometary coma, e.g., spatial distributions of gas-phase species and dust of various sizes, velocity and temperature profiles, change with heliocentric distance. Special attention is given to observations of hydrocarbons and sulphur species. A complete description of the model and results with comparisons to observations where possible is presented. In comparison with observations, the model can be used to characterize the environment surrounding comet Hale- Bopp and to aid in assimilating a variety of diverse observations of this bright comet.

Abstract CT-5-2

EVIDENCES FOR EXTENDED SOURCES AND TEMPORAL MODULATIONS IN MOLECULAR OBSERVATIONS OF C/1995 O1 (HALE-BOPP) AT IRAM INTERFEROMETER

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Comet C/1995 O1 (Hale-Bopp) has been observed on October 5, 25 1996 and from March 6 to March 22, 1997 with the Institut de Radioastronomie Millimétrique (IRAM) interferometer at Plateau de Bure (France). Millimetre lines of HCN, HNC, CO, H_2CO, CH_3OH, H_2S, CS and SO were mapped with spatial resolutions of 1.5–3.5 arc sec. These observations allow us to investigate whether these species are parent molecules or released in the coma by extended sources. There are clear evidences that SO is a photodissociation product. The observations also confirm that H_2CO is mainly produced by an extended source, in addition to a possible nuclear source whose relative contribution will be evaluated.

The molecular lines have also been hourly monitored with the five antennas of the interferometer in single-dish mode. The line velocity shifts show a periodic modulation linked to the nucleus rotation. The amplitude of the modulation differs from one species to another.

Abstract CT-5-3

GAS JETS IN COMET HALE-BOPP (1995 O1)

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We report the identification of gas jets in OH, NH, CN, C_3 and C_2. These jets are different from those present in continuum (dust) images. Data were obtained at Lowell Observatory with the 42″ Hall Telescope using a 2048 CCD camera during February, March, and April of 1997. The scale of the resultant images is 1.14″/pixel (2x2 binned). The new "Hale-Bopp" set of narrowband comet filters was used to isolate the continuum (at 3448Å, 4450Å, 5260Å, and 7128Å) as well as emission from OH, NH, CN, C_2 and C_3.

This is the first time OH and NH jets without an obvious optical dust jet counterpart have been identified in narrowband comet images. The gas jets of particular interest are those located on the night side of the coma of Comet Hale-Bopp (within $\sim$ 80,000 km or 80″ of the central condensation). The continuum images show varying jet structure, but restricted to the sunward direction.

We also confirm the existence of night side CN jets as reported by Larson *et al.* (1997 BAAS **29**, 1036). "CHON" grains have been proposed as an extended source for the CN and C_2 jets in Comet Halley (A'Hearn *et al.*, 1986 Nature **324**, 649; Schulz and A'Hearn 1995, Icarus, **115**, 191); our detection of jets in OH and NH is consistent with this interpretation for Comet Hale-Bopp. A qualitative and quantitative analysis of the gaseous jet structures will be presented.

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Abstract CT-5-4

INFRARED SPECTROSCOPY OF CO EMISSION IN C/1995 O1 HALE-BOPP AT THE NASA-INFRARED TELESCOPE FACILITY

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We used high resolution spectroscopy to target CO v=10 band emission, at 4.7 μm, in comet C/1995 O1 Hale-Bopp on 20 dates between June 1996 (R = 4.1 AU pre-perihelion) and September 1997 (R = 3.1 AU post- perihelion).

The observations used the facility Cryogenic Echelle Spectrometer (CSHELL) at the NASA-IRTF 3-meter telescope on Mauna Kea, and are part of our comprehensive program of compositional studies of comets. The instrument incorporates a 256x256-pixel InSb array detector having 0.2 arc-sec pixels, and sensitivity from 1.0 5.5 μm. It thereby combines seeing-limited spatial resolution with high spectral resolution (ν / $\Delta\nu$ 2 - 3 $\times$ 10^4 for the 1 arc-second slit width used for the comet observations). CSHELL has a 30 arc-second long slit, thus our observations yield detailed maps of the line-by-line excitation of volatile emissions in the cometary coma.

We present an overview of our CO observations, and examine Q(CO) as a function of position in the coma for select dates by comparing the intensity within a 1x1 arc-second aperture stepped along the (east-west) slit, and incorporating a Haser outflow formalism. Spatial profiles of the CO emission exhibit a central r^{-1} brightness distribution, indicative of a native source, superimposed upon a relatively flat underlying profile representing a distributed source of CO. The spatial distribution of CO will be compared with that of other volatiles, such as ethane and water, as well as with the dust continuum.

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