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Spectroscopy of Comets

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Strategy

Observations of NH_2, [OI], CH, CO^+, CO_2^+, H_2O^+, and N_2^+ in optical spectra of comets represent ionization and dissociation products of virtually all of the volatile fraction of a comet nucleus, and can provide abundances of N_2, NH_3, H_2O, CH_4, CO_2 and CO. The primary objectives are to determine: 1) accurate production rates for the observed species, and 2) accurate relative abundances of condensates in a sample of comet nuclei. The ultimate goal is to constrain models of comet formation and chemical processing in the outer primordial solar nebula.

Progress and Accomplishments

Monte Carlo models of comet comae have been developed which include effects of multiple-step photodissociation, asymmetric gas flow, radiation pressure, and time-dependent outflow. Improved methods for extracting surface brightness profiles of NH_2 were developed and used to demonstrate that ammonia production rates can be determined from NH_2 spectra with relatively insignificant model dependence except in cases of highly active comets. A study of NH_2 in a diverse sample of comets indicated that the mean ammonia/water abundance ratio was ~0.1, with no significant variation among the comets. The apparent uniformity of the ammonia abundances among comets attests to a remarkable degree of chemical homogeneity over large scales (>1AU) in the comet forming region of the primordial solar nebula. A fluorescence model for the CN B-X band has been developed for determining the $^{12}C/^{13}C$ ratio in a sample of comets.

Projected Accomplishments

Calculation of photoabsorption rates of a set of cosmically abundant molecules relevant to comets has been completed using cross sectional data complete to Jan 1991, and a relatively high resolution solar EUV spectrum. The solar rates together with a bibliography will be published. A list of unidentified molecular ion features in the optical region of comet spectra is being compiled. The program to determine the NH_3 abundances from NH_2 spectra in an enlarged sample of comets continues. Abundances and the structure of the comet ionosphere are being studied both spectroscopically and with narrow-band images. The N_2^+/CO^+ ratio is being used to derive N_2/CO abundance ratios in a sample of comets. Both spectroscopic and narrow-band images of comet Austin are presently being analyzed. The carbon isotope ratios are under study in several comets.

Publications

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3. Kleine, M. 1990, **Spectral Synthesis of CN in Comets**, in *Workshop on Observations of Recent Comets (1990)*, eds. W. Huebner, P. Wehinger, J. Rahe and I. Konno, (San Antonio: Southwest Research Institute), p. 116.

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7. Wyckoff, S., Tegler, S. and Engel, L. 1991b, **Ammonia Abundances in Four Comets**, *Ap. J.*, **368**, 427.

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