Limit on the CH_4/CO Ratio in Comet Levy (1990c) and Comparisons with other Comets

H. A. Weaver
Space Telescope Science Institute

G. Chin
NASA Goddard

T. Y. Brooke
University of Hawaii

A. T. Tokunaga
University of Hawaii

T. R. Geballe
Joint Astronomy Centre

Near-infrared observations of comet Levy (1990c) were made on UT 4.3 and 5.3 Sep 1990 from the United Kingdom Infrared Telescope on Mauna Kea. A scanning Fabry-Perot interferometer in combination with a cooled grating spectrometer was used to make a sensitive search for fluorescent emission from the ν_3 band of CH_4 near $\lambda \sim 3.3$ μm. If CH_4 is a parent molecule released directly from the nucleus, then the 3σ limit on its abundance is $CH_4/H_2O \leq 0.0031$, assuming that the kinetic temperature of the inner coma is $\sim$50 K and that the CH_4 spin species are equilibrated at a temperature $\geq$50 K. Since *IUE* observations of CO in Levy indicate that $CO/H_2O \sim 0.04$ (Feldman *et al.*), we find that $CH_4/CO \leq 0.1$. Infrared spectroscopic searches for CH_4 in Comet Halley also yielded no positive detections (Drapatz *et al.*; Kawara *et al.*); the more sensitive upper limit from the latter observations is $CH_4/H_2O \leq 0.003$. Since $CO/H_2O \sim 0.05$ in Halley (not including the extended source of CO), the upper limits on the CH_4/CO ratios are almost identical for comets Levy and Halley. A marginal infrared detection of the CH_4 ν_3 band in comet Wilson yielded $CH_4/H_2O \sim 0.01 - 0.05$ (Larson *et al.*), but there was no positive detection of CO (Roettger *et al.*; an upper limit $CO/H_2O \leq 0.07$ was derived). If the identification of the feature in the infrared spectrum of comet Wilson is correct, then that would indicate a very high CH_4/CO ratio in this comet. Recent detections of CH_4 in three interstellar sources yields $CH_4/CO = 0.01 - 0.04$, when both gaseous and solid components are included (Lacy *et al.*). Thus, the limits obtained on CH_4/CO in comets Halley and Levy are consistent with an interstellar origin for these species, while the data on comet Wilson appear to be inconsistent with the idea that this comet is composed of relatively unmodified interstellar material. Recent models of the solar nebula (*e.g.*, Fegley and Prinn; Lunine *et al.*) can account for any of the CH_4/CO ratios derived above, if the various parameters that determine the molecular abundances are adjusted appropriately. However, it appears that a single formation site for all comets is excluded by the observations.