minor species are often expressed relative to H_2O production. Targeting water lines from the ground at infrared wavelengths is a proven method for obtaining accurate H_2O production rates since in general multiple lines can be observed simultaneously. In addition, observations from the ground allow coverage over a range of heliocentric distances. To avoid the atmospheric extinction that prevents the detection of strong H_2O lines from fundamental bands, we target (weaker) lines seen in non-resonance fluorescence. The detection of these lines requires no specific geocentric Doppler-shift for the comet. This approach has been successfully used to detect water lines from the ground in comets since the early 1990s. The 2.9-micron spectral region is particularly diagnostic since a dense grouping of strong lines can be detected from several different hot-bands.

We have developed line-by-line temperature-dependent fluorescence models for seven hot-bands near 2.9-microns. Here we compare our models to high-resolution comet data obtained with the Near Infrared Spectrometer (NIRSPEC) at Keck 2 and the Cryogenic Echelle Spectrometer (CSHELL) at the NASA IRTF (R ~ 20,000 for both instruments). We discuss H_2O production rates, rotational temperatures, and ortho-to-para ratios for several comets within our current database (e.g. C/1999 H1 (Lee), C/1999 S4 (LINEAR), C/2001 A2 (LINEAR), and C/2002 C1 (Ikeya-Zhang)), and we predict line intensities and detectability limits for H_2O in comet 2P/Encke in November 2003.

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38.09

Modeling Formaldehyde ν_1- and ν_5-Band Emission in Comets

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We have conducted detailed studies of the abundances of parent volatiles in eight Oort cloud comets since 1996, using modern long-slit echelle spectrometers having sensitivity in the 1 – 5 μm region. These instruments (CSHELL at the NASA-IRTF, and NIRSPEC at Keck 2) have sufficiently high spectral resolution ($\nu/\Delta\nu \sim 2\times10^4$) to resolve individual cometary emission lines. Their small pixel sizes provide the high angular resolution required for an accurate measure of volatile abundances in the nucleus, as well as for detailed study of the spatial distribution of emissions in the coma.

We routinely characterize the volatile composition of observed comets through measuring the abundances of native ices (H_2O, CO, CH_3OH, C_2H_6, CH_4, C_2H_2, and HCN). Here we adapt a fluorescence model for H_2CO (Reuter et al. 1989 *Ap. J.* 341, 1045), originally developed for application to low-resolution spectra of 1P/Halley, to our existing sample of cometary spectra. Predicted line g-factors are highly temperature-dependent over the range expected in cometary comae (e.g., ~ 20 – 150 K). Therefore, we expect application of the model to provide an additional means of measuring rotational temperatures (and hence accurate formaldehyde production rates) in comets. Results for previously observed comets, and detectability limits for future known comets, will be presented.

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38.10

NIRSPEC observations of CH_4 in comet C/2001 A2 (LINEAR)

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We present high-resolution spectroscopic observations of the R0 and R1 lines of CH_4 near 3.3 μm in comet C/2001 A2 (LINEAR). The data were obtained using the Keck II NIRSPEC instrument located on Mauna Kea, HI. The observations were taken on UT 2001 9.5 July, 10.5 July, 4.4 August, and 10.5 August. We find that the relative abundances of H and C bearing volatile species are enriched relative to H_2O in both the July and August observing runs. On 12 July, A2 underwent an outburst, interpreted to be due to fragmentation of the nucleus, though no distinct fragment was actually observed. We searched for evidence of chemical heterogeneity between July and August, finding that the relative abundances of CH_4 and other hydrocarbon species varied between the two observing runs. We also compare CH_4 to other hydrocarbon species in A2 as well as other Oort cloud comets.

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38.11

Anomalous $^{14}N/^{15}N$ ratio in comets 122P/1995 S1 (de Vico) and 153P/2002 C1 (Ikeya-Zhang)

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High-resolution (R 60,000) spectra of the Halley-type comet 122P/1995 S1 de Vico (Period 74 years) and the "intermediate-period" comet 153P/2002 C1 Ikeya-Zhang (P 370 yr) were obtained with the 2DCoude spectrograph at the 2.7-m Harlan J. Smith telescope of the McDonald Observatory. These comets were within 1 AU from the Sun (0.66 and 0.92 AU, respectively). The spectra display CN (0,0) bands indicating an anomalous $^{14}N/^{15}N$ isotope ratio, in the sense that it is close to half the value in Earth's atmosphere (the so-called "Solar system value") and about half that obtained in comet Hale-Bopp from sub-millimeter measurements on HCN, generally believed to be the main parent of CN. Similar conclusions had been reached for C/1995 O1 (Hale-Bopp), an "old long-period," and for C/2000 WM1 (LINEAR), a "young long-period" comet.

As suggested by Arpigny et al. (2003), this apparent abundance anomaly points towards the existence of other unknown parent(s) of CN, with an even higher ^{15}N excess. Organic compounds like those found in interplanetary dust particles (IDPs) are good candidates. The similarity between comets of different dynamical ages is pointed out.

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38.12

Chemistry of NS and CS in Cometary Comae

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The most fundamental scientific reason for studying comets is to retrieve information on their origin, which gives clues of their relationship to interstellar and interplanetary material and implications for the formation of the Solar System. The determination of the basic parameters of the nucleus, its activity and composition is necessary to establish a unique description of the physical-chemical nature of the nucleus. The chemistry of both nitrogen and sulfur presents interesting problems in comets. In this work, we use a model of cometary coma with gas-phase chemical kinetics and gas dynamics in the inner coma region for two of the brightest comets in the past 20 years, C/Hyakutake (1996 B2) and C/Hale-Bopp (1995 O1), with the purpose to predict the abundances of nitrogen sulfide (NS) and carbon monosulfide (CS).

The determination of the abundance of each such species helps to constrain the sulfur chemistry and physical processes and hence their place and mode of origin of the nucleus. The model is applied at a heliocentric distance of 1 AU using a detailed photo and chemical reaction network including more than 100 species and over 1000 reactions. The collisional reactions have up-to-date rate coefficients from Le Teuff, Millar & Markwick (A&A 146, 157-168, 2000), while the photolytic rate coefficients were taken for minimum and maximum solar fluxes in order to estimate a lower and an