THE RELATIONSHIP OF HCN, C_2H_6, AND H_2O IN COMETS: A KEY CLUE TO ORIGINS?

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Introduction: We consider production rates for hydrogen cyanide, ethane, and water in 21 comets characterized at infrared wavelengths, along with other properties such as seasonal, and evolutionary behavior, and evidence for multiple ice-phases within the cometary nucleus. We will present integrating themes that largely reconcile the seemingly divergent data.

Background: Several puzzling lines of evidence raise issues about the origin of HCN:

a. The production rates of HCN measured through rotational (radio) and vibrational (infrared) spectroscopy agree in some comets, but in others the infrared rate exceeds the radio rate substantially. Is prompt emission from vibrationally excited HCN responsible?

b. With its strong dipole moment and H-bonding character, HCN should be linked more strongly in the nuclear ice to other molecules with similar properties (H_2O, CH_3OH), but instead its spatial release in some comets seems strongly coupled to volatiles that lack a dipole moment and thus do not form H-bonds (methane, ethane). Is HCN formed from an apolar precursor?

c. The nucleus-centered rotational temperatures measured for H_2O and other species (C_2H_6, CH_3OH) usually agree within error, but those for HCN are often slightly smaller. Could this mean that HCN is not fully developed in the warm near-nucleus region?

d. ALMA maps of HCN and the dust continuum show a slight displacement in their centroids. Is this the signature of extended production of HCN?

We will present and discuss these and other points, and suggest ways to reconcile the seemingly divergent mixing ratios of HCN, C_2H_6, and H_2O in comets, including results from Rosetta for comet 67P/Churyumov-Gerasimenko .

Acknowledgments NASA's Planetary Astronomy, Planetary Atmospheres, and Astrobiology Programs supported this work.