Organic Matter in Space
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Chemical diversity of organic volatiles among comets: An emerging taxonomy and implications for processes in the proto-planetary disk

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Abstract. As messengers from the early Solar System, comets contain key information from the time of planet formation and even earlier – some may contain material formed in our natal interstellar cloud. Along with water, the cometary nucleus contains ices of natural gases (CH_4, C_2H_6), alcohols (CH_3OH), acids (HCOOH), embalming fluid (H_2CO), and even anti-freeze (ethylene glycol). Comets today contain some ices that vaporize at temperatures near absolute zero (CO, CH_4), demonstrating that their compositions remain largely unchanged after 4.5 billion years. By comparing their chemical diversity, several distinct cometary classes have been identified but their specific relation to chemical gradients in the proto-planetary disk remains murky. How does the compositional diversity of comets relate to nebular processes such as chemical processing, radial migration, and dynamical scattering? No current reservoir holds a unique class, but their fractional abundance can test emerging dynamical models for origins of the scattered Kuiper disk, the Oort cloud, and the (proposed) main-belt comets. I will provide a simplified overview emphasizing what we are learning, current issues, and their relevance to the subject of this Symposium.

Discussion

Irvine: Could you say a little bit more on the ortho-para ratio? I gathered from your data that you're saying you believe that ratio is primordial in comets.

Mumma: It seems to be primordial. If you look at Comet Halley over the space of December 1985 to March 1986, the ortho-para ratio did not change. It was around 2.5 on both dates, even though the comet had lost a huge amount of material representing about a 1-meter depletion in the surface. So this is one example where we see it not changing. I showed you an example of how we're trying to test whether this is reset in the coma. Unfortunately, the example I showed you had an ortho-para ratio of 3.0 to begin with, so at rotational temperatures higher than about 25 Kelvin I wouldn't expect it to change and it didn't. We also have other comets with ortho-para ratios of about 2.4 and a graduate student is working with me now on those data to extract the same trend curve. We do think it seems to be primordial, but let's see what happens in the future.

The face-changing (mask illusion) show at the banquet.

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