INTERPLANETARY DUST: THE INTERSTELLAR CONNECTION.

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Although not proven, there is the widespread belief that comets consist, at least in part, of interstellar material that was originally present in the solar nebula. Furthermore, there are strong arguments in favor of the view that much of the interplanetary dust complex is derived from comets. The main arguments supporting this view are based on mass balance,[1] analysis of the orbital parameters of meteors,[2] and the long known association between meteor showers and specific comets.

Laboratory measurements on interplanetary dust particles (IDPs) collected in the stratosphere have confirmed the view that many of the dust particles are "primitive" in the sense that they show striking enrichments of D/H relative to average solar system materials.[3] It has also been demonstrated that the mid-infrared absorption spectra of one infrared red class of particles show strong similarities to IR sources such as the , "protostar" W-33A.[3]

However, the laboratory studies of IDPs have shown that they represent a diverse set of objects. Three infrared classes have been identified and labeled olivine, pyroxene, and layer-lattice silicates because of the similarities in their spectra to terrestrial mineral standards. TEM observations confirm these assignments to first order. However, the TEM observations also show that particles in a given IR class can have significantly different structures when viewed at high spatial resolution. Five out of eight particles show D/H enrichments but three do not. Although we are in the midst of unraveling all this, we have the impression that different sources will be required to explain the diversity of particle types. As an illustration, we find that the IR spectrum of Comet Kohoutek cannot contain a large contribution from particles of the olivine class although this class accounts for ~one-third of all IDPs so far studied.[4]

The measurement of the orbital parameters of specific dust particles is essential to answering the question of sources. The observation of the IRAS dust bands reopens the question of the role of asteroids in supplying a significant fraction of the dust and part of the diversity we observe may be due to the fact that some of the dust is asteroidal and some cometary.

But we also consider it likely that comets themselves are quite diverse. In fact, it is known from meteor studies that the physical properties of dust in different showers (and hence different comets) varies considerably.[5] One of the major goals of the dust orbital determination and isotopic analysis program will be to find out if different particles whose orbits are consistent with a cometary origin show a great diversity of properties. This ability to sample *many* comets addresses an issue that a sample return mission to a given comet can never resolve.

Some fraction of interplanetary dust must consist of an interstellar component intercepted by the solar system in its motion through the local interstellar medium. Although calculations indicate that interstellar particles $\geq$ 10 μm would penetrate into the inner solar system,[6] there is no evidence for the existence of an appreciable flux of such particles. Precision orbital measurements of larger ($\geq$ 1 gm) optical meteors

show that $\leq 1\%$ of these have hyberbolic orbits. The same is true of smaller radio meteors ($\geq 10^{-6}$ gm). However, it has recently been shown[7] that dust derived from nearby stars will have 75% of their orbits with eccentricities ≤ 1.1 and might be difficult to distinguish from interplanetary dust based on orbital measurements alone.

Since measurements of the orbital parameters of particles in the 10μm size range have never been made, it is impossible to rule out the possibility that an appreciable fraction of such particles are interstellar. However, calculations based on estimates of the gas/dust ratio and the gas density of the local interstellar medium suggest that at most 1% of the dust flux in the 1 to 100 μm region could be interstellar.[8]

If an interstellar component exists, the small fluxes expected indicate that a very large detector will be required to identify them. It is partly for this reason that we believe that the space station collector should be planned to have an initial design size of 10 meters on a side. With such a size an interstellar component of $< 5\text{x}10^{-4}$ could be found in a year's operation. The intellectual rewards of such a discovery would be great, but the probability of success is uncertain.

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