

THE POSSIBLE EXISTENCE OF INTERSTELLAR POLYCYCLIC AROMATIC HYDROCARBONS  
(PAHs) IN COLLECTED INTERPLANETARY DUST PARTICLES

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Extraterrestrial dust particles which are 3-50 microns in size are routinely collected in the stratosphere and are now available for general laboratory study (Brownlee *et al.*, 1977; Walker, 1985). These grains represent true interplanetary dust particles (IDPs). The particles have been studied using a number of analytical techniques, including transmission and scanning electron microscopy, which provides morphological and mineralogical information down to scales on the order of 100 angstroms; noble gas and secondary ion mass spectrometry, which can be used to study elemental and isotopic abundances; and infrared transmission spectroscopy, which provides information about the molecular structures present. The study of IDPs is of great interest since they may contain "primitive" interstellar material that has been protected from alteration since the formation of the solar system.

IDPs are generally found to be of one of two varieties, either hydrous or anhydrous (Sandford and Walker, 1985; Bradley and Brownlee, 1986). Both types have "chondritic" elemental abundances and contain carbon as an important component. The hydrous IDPs tend to be compact objects that consist largely of layer-lattice silicate minerals like smectites and serpentines. The anhydrous particles tend to be more porous and appear to be mechanical mixtures of submicron silicate grains (mostly pyroxene and olivine) that are imbedded in an amorphous matrix. Both types of IDPs contain a wide variety of disequilibrated mineral components, implying that the particles have not been seriously altered since their formation.

This contribution will address issues associated with the carbon containing components of IDPs which occur in a variety of physical forms (Bradley *et al.*, 1984), including amorphous mantles and matrix material. The amorphous material is not elemental carbon, but contains minor amounts of oxygen and nitrogen, suggesting the presence of more complex compounds, possibly in the form of hydrocarbons. The presence of hydrocarbons within the IDPs is suggested by the existence of a weak 3.4 micron absorption feature in the infrared spectra of some of these particles (Sandford and Walker, 1985), and the presence of weak bands in the 5-8 micron region of a spectrum taken from an IDP acid residue (Sandford, 1986). The exact form of the hydrocarbon phase(s) in IDPs is not presently known.

The amount of material in each IDP is small (about 1-10 ng), precluding the chemical techniques normally used to analyze carbonaceous samples. If the hydrocarbons in IDPs are similar to those found in meteorite acid residues, they consist of a complex polymer with a bridged aromatic structure and functional groups like COOH, OH, and CO (Hayatsu *et al.*, 1977). Many of the meteorite acid residues also exhibit deuterium enrichments (Yang and Epstein, 1983) similar to those seen in the IDPs (McKeegan *et al.*, 1985). In the IDPs, these deuterium enrichments are found to be correlated with the presence of isotopically normal carbon, implying a hydrocarbon carrier.

It is useful to compare the observed properties of the hydrocarbon phase in IDPs with those expected for polycyclic aromatic hydrocarbons (PAHs), since these molecules may be present in the interstellar medium (Leger and Puget, 1984; Allamandola *et al.*, 1985) and may act as the "building blocks" from which the meteoritic polymer is formed. Despite the lack of knowledge of the

exact form of the hydrocarbons in IDPs, there are three areas where the consistency of this possibility can be checked.

First, the vibrational spectra of IDPs can be compared to those attributed to interstellar PAHs. Unfortunately, the infrared spectra of IDPs are dominated by silicate mineral bands and no strong evidence for the presence of PAHs in whole particle spectra has been seen (Sandford and Walker, 1985). The Raman spectra of IDPs, however, are dominated by features at 6.2 and 7.6 microns that are strikingly similar in position and profile to the most intense emission bands attributed to PAHs in the interstellar medium (Allamandola *et al.*, 1985; B. Wopenka, private communication). The source of the bands in the IDPs is believed to be the amorphous, low-Z material that surrounds the particles' constituent mineral grains. In addition to the suggestive match of these two bands, many of the IDP Raman spectra show emission at longer wavelengths which could be due to fluorescence or phosphorescence. PAHs are known to behave in this manner (Berlman, 1965).

The carbon correlated deuterium enrichments seen in the IDPs are also consistent with a PAH origin. In the past, deuterium-rich material in meteorites has been taken as an indication that these objects contain molecules that formed in dense molecular clouds at temperatures of about 10K (Yang and Epstein, 1983). However, it has recently been pointed out that free PAHs made up of 25 carbon atoms or less would be expected to preferentially lose normal hydrogen over deuterium during photoexcitation (Allamandola *et al.*, 1986). Thus, the carbon-correlated deuterium enrichment seen in some IDPs is not only consistent with the presence of modified interstellar PAHs, but may possibly provide a means of probing the identity of the smallest interstellar PAHs.

If PAHs do, in fact, exist in the interstellar medium then it would not be surprising to find similar material in the IDPs, since PAHs are known to be relatively robust molecules (Allamandola *et al.*, 1985) and the IDPs do not appear to have been strongly altered since their formation.

In summary, there is a strong possibility that the IDPs presently being collected in the stratosphere, particles that are probably from comets, may contain PAH-like molecules. If this is the case, then the organic molecules in IDPs probably represent interstellar molecules that have undergone relatively little alteration since their incorporation into the solar system.

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