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2P

AROMATIC COMPONENTS IN COMETARY MATERIALS

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The Raman spectra of interplanetary dust particles (IDPs) collected in the stratosphere show two bands at about 1350 and 1600 $\Delta\mathrm{cm}^{-1}$ and a broader feature between 2200 and 3300 $\Delta\mathrm{cm}^{-1}$ that are characteristic of aromatic molecular units with ordered domains smaller than 25Å in diameter (see Fig. 1 and reference 1). This suggests that the carbonaceous material in IDPs may be similar to the polymeric component seen in meteorites, where this material is thought to consist of aromatic molecular units that are randomly interlinked by short aliphatic bridges (cf. reference 2).

The features in the Raman spectra of IDPs are similar in position, and relative strength to interstellar infrared emission features that have been attributed to vibrational transitions in free molecular polycyclic aromatic hydrocarbons (PAHs) (see Fig. 2). The Raman spectra of some IDPs also show red photoluminescence (see Fig. 1) that is similar to the excess red emission from some astronomical objects and that has also been attributed to PAHs and PAH-related materials. Moreover, a part of the carbonaceous phase in IDPs contains deuterium-to-hydrogen ratios that are far greater than those found in terrestrial samples (3). Deuterium enrichment is expected in small free PAHs that are exposed to ultraviolet radiation in the interstellar medium (1, 4).

Taken together, these observations suggest that some fraction of the carbonaceous material in IDPs may have been produced in circumstellar dust shells and only slightly modified in interstellar space. Since many, if not most, IDPs come from comets, this supports the view that cometary material contains "primitive" components which can provide clues about early solar system (and perhaps even interstellar and circumstellar) processes.

References

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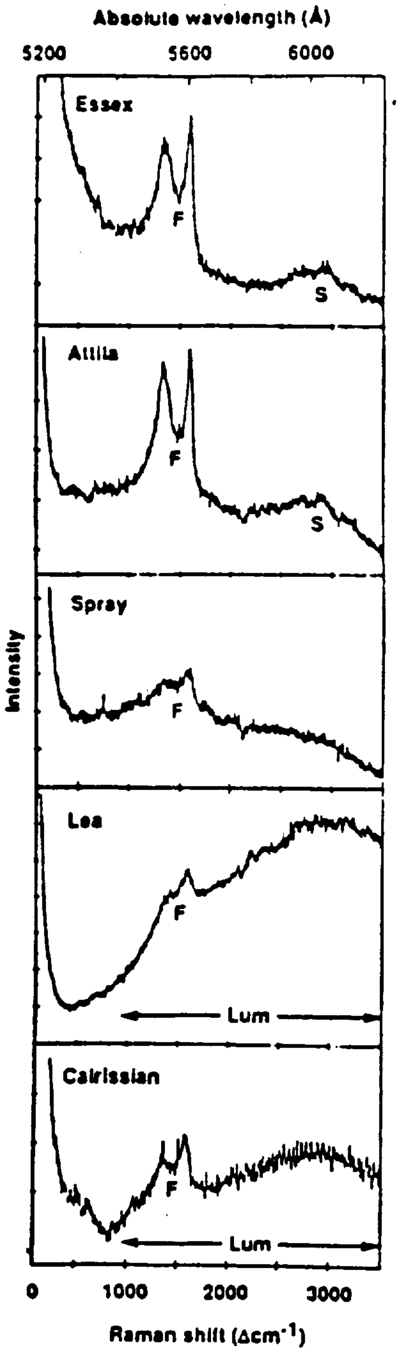

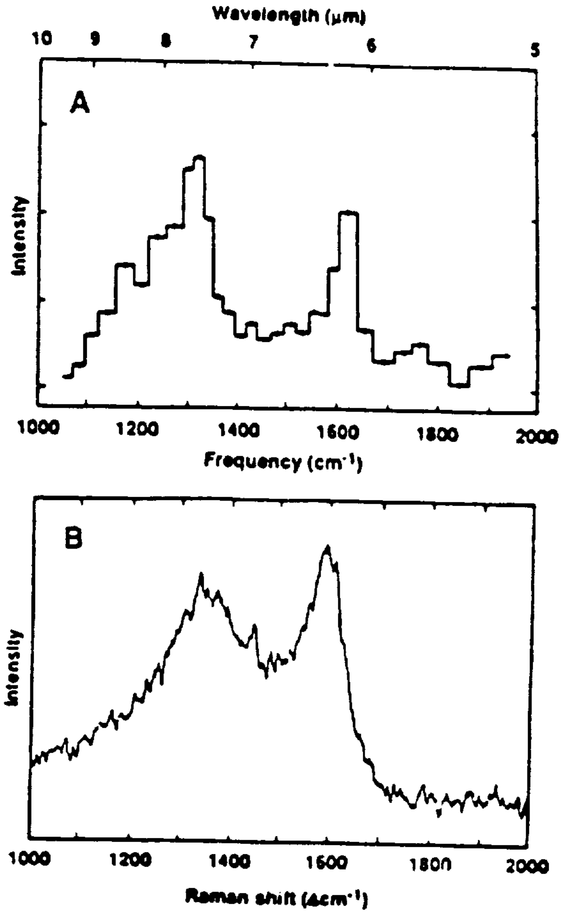

Figure 2 - Comparison between (A) the infrared emission spectrum of the Orion Bar [Orion data from reference (5)] and (B) the Raman spectrum of an IDP. Figure adapted from reference (1).

Figure 1 - Examples of the Raman spectra of IDPs. Many spectra are dominated by the Raman bands of disordered carbonaceous material (see the top two spectra), while others are dominated by red luminescence (see the bottom two spectra). The relative contribution from these two effects varies from particle to particle. The designations F, S, and Lum in the figure label the first- and second-order Raman bands and red luminescence, respectively. The large increase in counts near 0 $\Delta\mathrm{cm}^{-1}$ is from Rayleigh- scattered incident laser light. All the spectra shown were taken at a resolution of 5 cm^{-1}, and the sample was excited by the 5145Å Ar^+ laser line. The upper axis indicates the absolute wavelength of the observed emission; the lower axis indicates the Raman shift (Stokes lines) with respect to the exciting-laser frequency. Figure adapted from reference (1).