RAMAN OBSERVATIONS OF INDIVIDUAL INTERPLANETARY DUST PARTICLES; Brigitte Wopenka, Department of Earth and Planetary Sciences and McDonnell Center for the Space Sciences, Washington University, St. Louis, MO 63130 USA.

Laser Raman microprobe spectroscopy is a non-destructive technique that can provide mineralogical and molecular information at the micron scale. While the first Raman data on interplanetary dust particles (IDPs) were presented several years ago [1,2], this abstract reports the first systematic study of a representative set of IDPs belonging to different spectral infrared classes. Data were obtained on 20 IDPs (18 of the "chondritic"-type, and two (St. Elizabeth and Nugget) dominated by Fe-S-Ni in the X-ray spectrum), many of which have also been studied by other techniques [3-5]. Spectra were obtained with a RAMANOR U-1000 from 100 to 3500 relative (to the exciting laser wavelength of 514 nm) wavenumbers and a spatial resolution of ~ 1 μm. While spectra vary among different particles, they are generally identical for different fragments of a given particle.

Six different types of spectra can be seen among the particles studied. Fig. 1 shows representative spectra for each type and also lists all the other particles of a given type together with their IR classification. There is no obvious relationship between the Raman spectra (characteristic for carbon) and the IR class (based on the prevalent silicates). All particles, except four (type 6), exhibit the Raman signature of incompletely crystallized carbon. However, the degree of "disorder" seems to be different in different particles, increasing from type 1 to type 5, as evidenced by the relative strength of the two Raman bands at ~ 1360 rel. cm^{-1} and ~ 1600 rel. cm^{-1} (corresponding to wavelengths of ~ 7.35 μm and ~ 6.25 μm) and their width. Comparison with laboratory studies (Fig. 2) shows that, even for type 1 particles, the mean crystallite size of carbon is smaller than ~ 70 Å and decreases for higher types. It is not known whether these differences reflect intrinsic variations in the state of carbon or if they are due to heating during atmospheric entry. Raman spectroscopy has been used previously to explore the thermal history of H3 Tieschitz [6] and similar heating experiments on IDPs are planned. Second order Raman bands [7] may account for the broad feature between ~ 2200 rel. cm^{-1} and ~ 3300 rel. cm^{-1} seen in type 1 and type 2 particles. It is interesting to note that no Raman bands for silicates (typically strong Raman scatterers) are seen. This indicates that the silicate grains (known to be present from FTIR and TEM measurements) are coated with carbonaceous material. Thus the particles look black in the visible. Carrolton has a spectrum similar in overall shape to other particles from type 5, but shows unusual fine structure present in all measured fragments.

Spectra of type 3 particles are similar to those obtained on individual grains of C1 Orgueil [8]. They show a broad feature (enhanced "background") that can be ascribed to fluorescence. This fluorescence must be characteristic of the carbonaceous phase. For type 3 particles, it peaks around 3000 rel. cm^{-1}, corresponding to 6000 Å. As pointed out by Allamandola and Sandford (pers. comm.), there are several dusty celestial objects (e.g. the "Red Rectangle") which show similar broad red emission. An extreme example of laser induced fluorescence is observed in the IDP Viburnum shown in Fig. 3. The fluorescence found in this particle is centered around 5500 rel. cm^{-1} (corresponding to ~ 7200 Å), a region normally not scanned for other IDPs. However, the sharp increase up to 3500 rel. cm^{-1} observed in this particle is not seen in any other spectrum. Broad fluorescence features, like the ones seen in IDPs, could possibly be caused by a mixture of large polycyclic aromatic micro-crystalline hydrocarbons [9]. It is interesting to note that interstellar dust is characterized by prominent emission bands at wavelengths corresponding to Raman shifts from carbonaceous material [10].

[1] Fraundorf et al., LPSC XIII, 231, 1982; [2] Fahey et al., in Properties Interactions Interplanet. Dust, Giese and Lamy, eds., D. Reidel, p. 149, 1985; [3] Sandford and Walker, *Ap. J.* **291**, 838, 1985; [4] McKeegan et al., *GCA* **49**, 1971, 1985; [5] McKeegan et al., this conference; [6] Christophe Michel-Levy and Lautie, *Nature* **292**, 321,1981; [7] Nemanich and Solin, *Phys. Rev. B* **20**, 392, 1979; [8] Wopenka and Sandford, *Meteoritics* **19**, 340, 1984; [9] Wdowiak, in NASA Conf. Pub. 2403, p. A-41, 1986; [10] Allamandola et al., *Ap. J.* **290**, L25, 1985; [11] Lespade et al., *Carbon* **20**, 427, 1982.

RAMAN SPECTRA OF IDPs

B. Wopenka

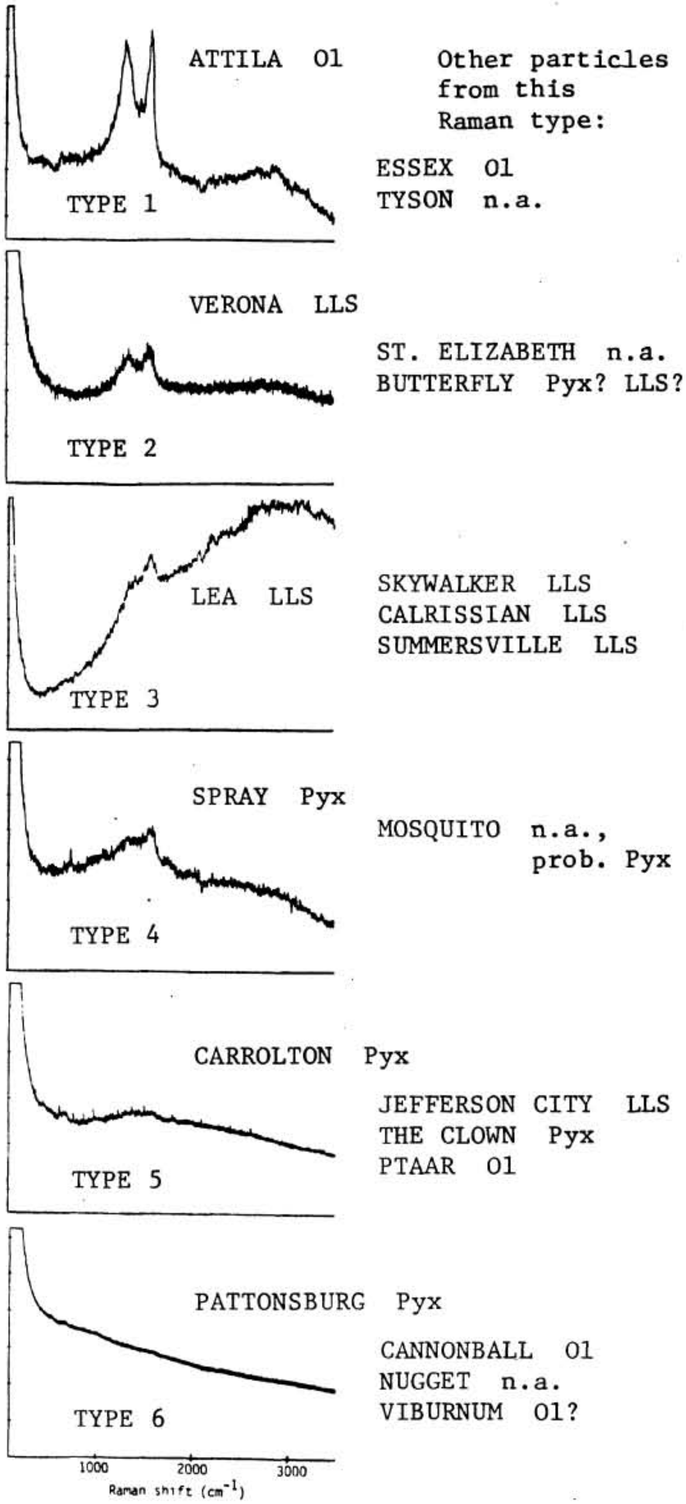

Fig. 1: Representative examples of Raman spectra of IDPs. Infrared classes: Ol Olivine; Pyx Pyroxene; LLS Lattice Layer Silicates (see ref. [3]); n.a. not analyzed by IR.

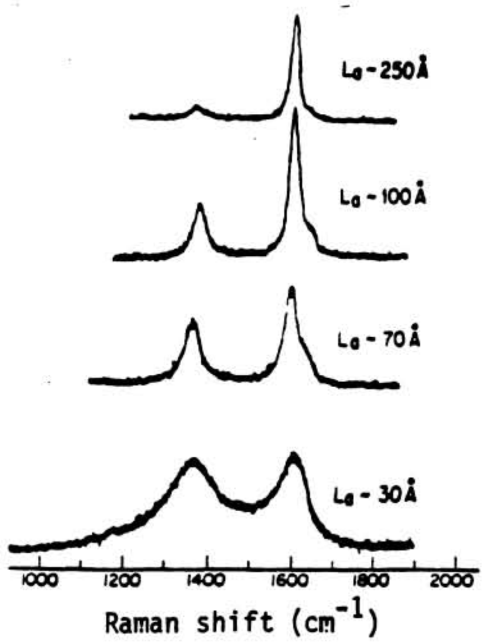

Fig. 2: First-order Raman Spectra of carbons of different mean crystallite size La. From ref. [11]. Since the molecular state of the carbon in these samples is not necessarily the same as in IDPs, the absolute values of the order parameter are probably not strictly applicable.

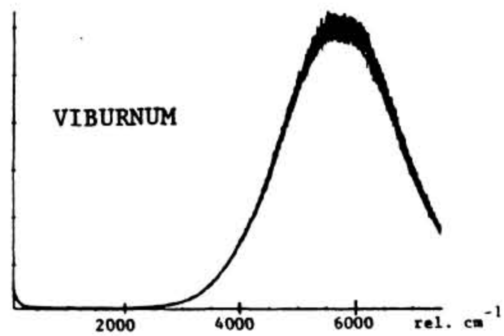

Fig. 3: Fluorescence spectrum of IDP Viburnum from 100 to 7500 relative wavenumbers, corresponding to wavelengths from 516 nm to 695 nm for excitation with 514 nm light. Maximum ~ 720 nm, FWHH ~ 130 nm. Spectrum is not corrected for photomultiplier and grating efficiencies.