Zodiacal dust properties inferred from observations

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Remote observations of the zodiacal light give us information on the physical properties of the interplanetary dust in the near-ecliptic symmetry surface. These include their local polarization, temperature, and composition, together with their heliocentric variations. Numerical and laboratory models of the interplanetary dust particles have been developed based on in situ measurements to interpret the remote observations of scattered and emitted light.

Though optically thin, the interplanetary dust cloud is visible through the faint glow of the zodiacal light. At visible wavelengths, the zodiacal light is predominantly originating from the solar light scattered by the interplanetary dust particles, inducing polarization. The zodiacal light also presents an infrared component due to the thermal emission from the dust particles. This presentation reviews the current knowledge of the zodiacal light properties and how it has been used to determine physical properties of the dust population in the interplanetary medium.

We show that a numerical model of solid particles constituted by spheroidal grains and aggregates thereof can reproduce the equilibrium temperature and light scattering properties of the interplanetary dust cloud. A good fit to the local polarization phase curve near 1.5 AU from the Sun is obtained for a mixture of silicates and more absorbing organic material (approximately 40% in mass) and for a realistic size distribution typical of the interplanetary dust particles in the 0.2 µm to 200 µm size range. The heliocentric dependence of the polarization value at 90 degrees of phase angle is interpreted as a progressive disappearance of solid organic (such as HCN polymers or amorphous carbon) towards the Sun.

Furthermore, measurements on analog dust particles lifted in microgravity conditions with the PROGRA2 light scattering experiment also reproduce such properties. The analogue particles correspond to a mixture of previously determined analogs for cometary and asteroid dust particles, including fluffy aggregates and compact particles. Five different organics to silicates ratios were generated confirming the interpretation of the heliocentric dependence of the polarization values. The best analog for the zodiacal light observations corresponds to a distribution of particles following a power-law with coefficients of (-3 +/- 0.5) for a size range of 10–100 µm and (-4.4 +/- 0.6) for a size range of 100–200 µm, with a constant ratio of (35 +/- 10) % in mass of fluffy aggregates versus compact particles and a decreasing content in organics with decreasing solar distance.

The results are then further discussed in the context of recent in situ measurements on cometary dust particles from the Rosetta space mission at 67P/Churyumov-Gerasimenko to assess the potential contribution of cometary dust to the interplanetary dust cloud.