Clementine Observations of the Zodiacal Light and the Dust Content of the Inner Solar System

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Using the Moon to occult the Sun, the Clementine spacecraft used its navigation cameras to map the inner zodiacal light at optical wavelengths over elongations of 3-30 degrees from the Sun. This surface brightness map is then used to infer the spatial distribution of interplanetary dust over heliocentric distances of about 10 solar radii to the orbit of Venus. We apply to these observations a model that assumes that the zodiacal light is due to three dust populations having distinct inclination distributions. These populations are: dust from asteroids and Jupiter-family comets having characteristic inclinations of ~ 7 degrees, a population of ~ 33 degree dust from Halley-type comets, and an isotropic cloud of dust from Oort Cloud comets and interstellar sources. From the best-fitting model we infer the relative contributions to the interplanetary dust cross section from asteroids, comets, and interstellar dust sources, as measured in ecliptic as well as at higher latitudes. When these results for the inner solar system are extrapolated out to the asteroid belt, we find an upper limit on the mass of the light-reflecting asteroidal dust that is equivalent to a 10 km asteroid, and a similar extrapolation of the isotropic dust cloud out to Oort Cloud distances yields a mass equivalent to a 30 km comet (although the latter mass is uncertain by a factor of ~ 500). Since the flow of interstellar gas and dust ultimately strips these wide-ranging Oort Cloud dust grains from the solar system, these finding suggests that the Sun and perhaps other stars may have vast but tenuous stellar dust tails.

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