TRAJECTORIES OF SUBLIMATING INTERPLANETARY DUST GRAINS

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The equation of motion for interplanetary dust particles close to the Sun has been solved numerically taking into consideration the interaction with the radiation field of the Sun and the temperature distribution as a function of grain size and heliocentric distance for different materials.

Depending on the material and the sizes of the particles, the orbits stabilize at different heliocentric distances. The inward spiraling by the Poynting-Robertson effect ends with the total evaporation of the particles in the stability region.

The only exception are grains which are highly absorptive, e.g. magnetite, where the radiation pressure for certain grain radii is comparable to or stronger than the gravitational attraction by the Sun. If the perihelion distance is not less than 7.5 $R_\odot$, magnetite particles with radii ≤ 1 µm will attain hyperbolic orbits after considerable mass loss by sublimation. They leave the solar system as β-meteoroids.

The stability region of olivine grains (radius $a \simeq 1$-5 µm) was found to be in good agreement with observed IR-emission features at 8.7 $R_\odot$ and 9.2 $R_\odot$ (MacQueen 1968).

REFERENCE

MacQueen, R. M.: 1968, Astrophys. J. *154*, pp. 1059-1076.

DISCUSSION

Brownlee: There are many interesting effects which may change optical properties at elevated temperatures. For example; magnetitite forms in hydrated silicates at temperatures of only 400°C; submicron metal grains form in heated particles which are saturated with solar wind. The latter is a reduction process and is very common in lunar soils.

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Keller: Is it correct to assume that particles are in equilibrium even close to the Sun?
Schwehm: Yes; as far as I know from the literature this assumption is valid even very close to the Sun.

Burns: Are there regions of space or materials for which sputtering competes with sublimation?
Schwehm: In a recent paper (Mukai and Schwehm: "Interaction of grains with solar energetic particles", submitted to Astron. Astrophys.) we have discussed this problem in detail. We showed that from a certain heliocentric distance, depending on both the grain material and size, the mass-loss rate due to sputtering exceeds that due to sublimation. However, the sputtering lifetime of a grain is sufficiently greater than the Poynting-Robertson lifetime that the influence of sputtering on the total lifetime can be neglected.
Mukai: It should be mentioned that below 10 solar radii it is impossible to estimate the sputtering due to the solar wind because of lack of knowledge about the flow velocity and number density of solar wind particles in this region.

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