PACKING EFFECT OF FLUFFY COMETARY PARTICLES. T. Mukai[+], H. Fechtig[x], [x]Max-Planck-Institut für Kernphysik, Heidelberg, Fed.Rep. Germany, [+]Kanazawa Institute of Technology, Nonoichi, Japan.

As discussed earlier in a review paper (Fechtig, 1982) observations, both by in-situ measurements and by lunar crater studies, show that only a minority of interplanetary dust particles are of low mass density. Particularly, the dust experiment on the Helios spacecraft shows that low density particles have large semimajor axes, i.e. they are faster as the Helios spacecraft at the time of impact. The more numerous denser particles, however, have small semimajor axis, i.e. they are slower than the Helios spacecraft at the time of impact. (Grün et al., 1980; Grün 1981; Pailer et al., 1980).

This is a surprising observation since the experiments flown through the Asteroidal belt show that the Asteroid belt does not contribute the majority of particles to the interplanetary dust complex (Humes et al., 1974). One should therefore expect that the great majority of interplanetary dust grains are of cometary origin and therefore of low density type. If one assumes that Brownlee particles are of cometary origin, then one should expect loosely conglomerated aggregates whose building blocks are of the order of .1 μm in size.

In order to give a possible explanation of these observations we refer to results by Greenberg (1982) gained by laboratory simulations of cometary dust. According to Greenberg (1982) the building blocks of fluffy cometary particles shortly upon release from the comet nucleus are coated by a more or less complex material consisting of the elements H,C,N,O, thus forming so-called "birdsnests". This paper intends to explain the observations by assuming a gradual change in mass density.

Figure 1 shows an idealized fluffy particle of a radius s = 100 μm which

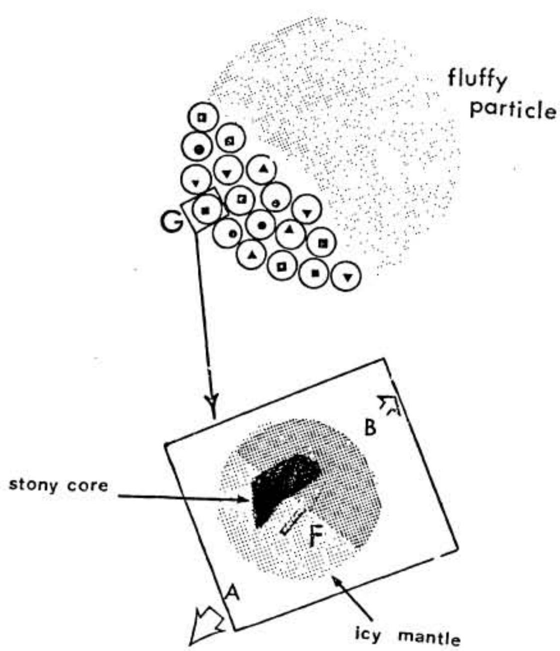

Figure 1: Idealized fluffy particle. Due to a spin motion of the fluffy particle, the side A of a grain G, which is building up the fluffy particle, is illuminated by the sun. On the other hand, the side B always stays in the shaded area. Consequently, an anisotropic sublimation over the entire surface of the grain G produces the reaction force F.

consists of many small spherical grains (radii s_g = 0.3 μm) with stony cores (density = 3 gcm^{-3}) and mantles (density 1 gcm^{-3}). Let us consider a grain G of the uppermost layer which is exposed to solar radiation. The temperature

T_a at the point A is slightly higher than the temperature T_b at the point B because B is located in a shaded region. Therefore an anisotropic sublimation occurs which produces a reacting force F acting from A towards B. This force produces a "packing effect" of the fluffy particle. After the mantles of the uppermost layer are completely sublimed, only the stony cores remain on the surface of the second layer. The next layer reacts the same way until a Brownlee particle has been formed and later even a compact grain can evolve.

The calculations assume that the mantle material sublimes within 2 AU sun distance at a constant rate of $10^{-13} gcm^{-2} sec^{-1}$. Outside of 2 AU sun distance no sublimation is assumed. For a particle with s = 100 μm released from Comet Halley it takes a total time of 10^5 years until the mantle material has completely sublimed. Due to the packing effect the density has continuously increased from 0.6 to 3 g/cm^3.

During this time the particle is continuously changing its orbit due to the Poynting-Robertson effect. The calculation shows that after $2x10^5$ years the particle heliocentric orbit is nearly circular.

References: (1) D.E. Brownlee (1978), in: "Cosmic Dust" (ed. J.A.M. McDonnell), John Wiley & Sons, Chichester, 295-336. (2) H. Fechtig (1982), in: "Comets" (ed. L.L. Wilkening), The University of Arizona Press, 370-382. (3) J.M. Greenberg (1982), in: "Comets" (ed. L.L. Wilkening), The University of Arizona Press, 131-163. (4) E. Grün (1981), Habilitationsschrift, Universität Heidelberg. (5) E. Grün et al. (1980), Planet.Space Sci. 28, 333-349. (6) D.H. Humes et al. (1974), J.Geophys.Res. 79, 3677-3684. (7) N. Pailer and E. Grün (1980), Planet.Space Sci. 28, 321-331.