# Mixture of Aggregated and Compact Particles: a Model Consistent with Ground-Based Observations and Direct Studies of Comet Dust

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Analysis of the Stardust returned samples has shown that the comet dust contains not only fine-grained, loosely bound aggregates but also some silicate grains that are much larger than predictions of interstellar grain models. Many of these silicate particles are high-temperature minerals that appear to have formed in the inner regions of the solar nebula [1] that confirms large-scale mixing of the materials in the early solar system. These findings stimulated us to reconsider the most popular model of comet dust as aggregates of submicron particles and to develop a model consistent with Stardust findings, namely, a model where the comet dust is a mixture of aggregates of small particles and rather large compact particles.

Following [2] we presented comet dust as an ensemble of Rock (silicate), CHON (organic) and Mixed (average Halley-dust composition) particles. Also, we made our model consistent with the in-situ data, which revealed that in comet Halley, the "rock" particles were compact whereas other particles were fluffy [3]. As we noted above, the same regularity was found for the Stardust returned samples. Thus, the rock particles were simulated as a polydisperse mixture of silicate oblate and prolate spheroids with some distribution of the aspect ratio (multi-shaped spheroids). CHON particles were presented as organic Ballistic Cluster-Cluster Aggregates (BCCA), whereas Mixed particles were presented by the Halley-like composition BCCA. Such aggregates with monomers of the radius equal to 0.1 micron have been already successfully used to model the polarimetric and photometric observations of comets [4] and could qualitatively explain spectral and angular change in comet dust brightness, polarization, and thermal emission and was also consistent with the composition of the comet dust obtained in-situ for comet Halley [4, 5]. The size distribution of particles in our model was the power-law one with the power equal to 3 that is between the power obtained by Stardust DFMI measurements and the power obtained from the study of the tracks in the aerogel [6]. One more constraint was based on the cosmic abundances of the considered materials, namely, the mass ratio of silicates to carbonaceous materials was assumed to be equal to unity. For the computations we used the T-matrix codes for spheroids and aggregates of spherical particle (see http://www.giss.nasa.gov/~crmim/t_matrix.html).

## References

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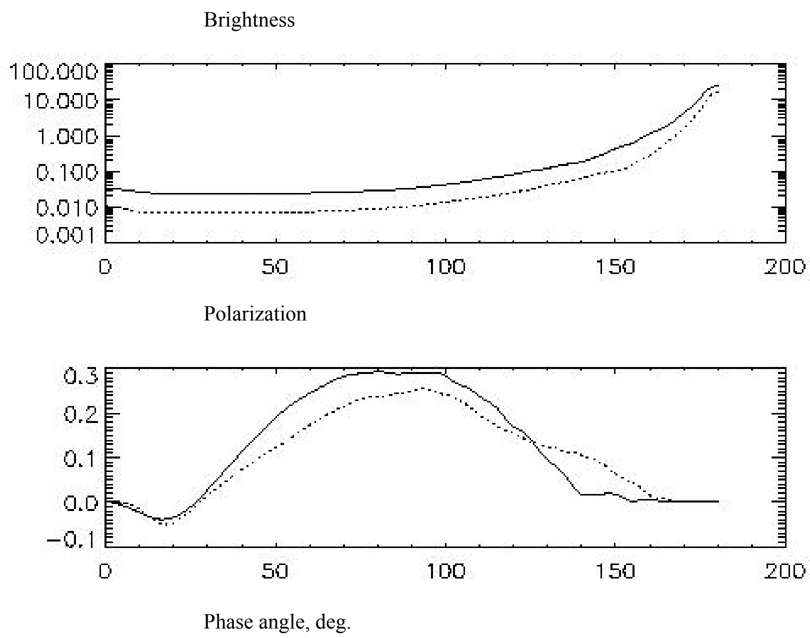


Figure 1 Calculated brightness and polarization for the model of the mixture of aggregates and compact particles. Solid line is for the red comet filter (0.6 µm) and dotted line is for the blue filter (0.45 µm).

The combined model allowed us to achieve not only qualitative but also quantitative fit to the observational data (see the review of the observational data in [7]) with the following characteristics (Figure 1):
- low geometric albedo of the particles (within 1-3%);
- correct brightness trend;
- red color that is not changing with the phase angle;
- correct trend and values of polarization;
- red polarimetric color that increases with phase angle.

Also, the best fit was achieved at the following ratio of the number of particles in the mixture: Rock : CHON : Mixed = 0.26 : 0.33 : 0.44 that is consistent with the results for comet Halley [2, 3].