Three-Dimensional Shapes of Cosmic Spherules: Deformation of Dust Particles Molten in the Earth Atmosphere

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Observations have found that there are both oblate and prolate shapes in the cosmic spherules [1]. In order to study the origin of those shapes, we numerically solve the equation of motion and the energy equation of dust particles entering the Earth atmosphere [2], and calculate the ram pressure and the centrifugal force acting on the molten dust particles. Then we evaluate the magnitude of deformation of dust particles using analytic solutions for the shape of molten particles [3,4]. On the other hand, we measure the 3-D shapes, chemical composition, and structure of cosmic spherules collected from Antarctica ice. Finally, we compare the results of calculations with observations.

Our results show that there is a discrepancy between the calculated and the measured magnitude of deformation of cosmic spherules. Some of the collected cosmic spherules have a larger deformation than the calculation. The large deformation may be caused by different surface tension or viscosity. But it is unlikely because the chemical composition of observed cosmic spherules does not show such a large variation. Also, it is hard to consider that such a large deformation is caused by the crystallization, because we do not see a prominent crystalline structure in largely deformed spherules.

The measured large deformation should be explained by reasons other than the variations of the surface tension or viscosity, and the crystallization. For example, fragments of a meteorite entering the Earth atmosphere may collide with each other to form largely deformed cosmic spherules. Or a bubbling in a liquid may deform the molten particle. Details should be investigated further in the future.

References

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