SHAPES OF COSMIC SPHERULES: WHAT DO THEY TELL US?

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Introduction: Cosmic spherules are products of dust-particle heating in the Earth's atmosphere: dust particles are heated by the gas friction and melted, and re-solidified to form spherules. Tsuchiyama *et al*. [1] have examined 3-D shapes of cosmic spherules and found that they have spherical, prolate and oblate shapes. Since the spherules melt in the Earth's atmosphere, the mechanism that forms such shapes should be related to the atmosphere. In this work, we examined some mechanisms that may form observed shapes of cosmic spherules, and found that some mechanisms may work well but they cannot explain the degree of deformation.

3-D Shapes of Cosmic Spherules: We examined more than 500 cosmic spherules collected from Antarctica. We measured three axial radii of once molten stony cosmic spherules in a radius range from 40 μm to 120 μm. We have found that there are spherical, oblate and prolate shapes in the cosmic spherule. When those shapes are approximated by triaxial ellipsoids, we can define the degree of deformation. Some of the spherules have the degree of deformation as large as 0.4 (0 means a perfect sphere and 1 means a thick less needle or a disk), though many of them have 0.1 or less.

After the measurement of sizes, each spherule was polished to have flat surface and analyzed for major element concentrations using an electron microprobe analyzer.

A Model: We have developed a model to describe the motion of dust particles in the atmosphere (this part is similar to the one by Love & Brownlee [2]) and evaluate the gas ram pressure on the molten particle. Using the obtained ram pressure, we calculate the hydrodynamic motion of molten material in the particle and estimate the shape of the particle at the moment of the re-solidification [3, 4]. If the particle has a spin (rotation), the particle is expected to become prolate or oblate shape, depending on the direction of the rotation axis and the rotation rate.

Results and Discussions: The current model can successfully explain the formation of both prolate and oblate shapes. However, the model cannot reproduce the observed degree of deformation: the predicted degree of deformation is 0.1 or less. We examined the effects of different surface tension and viscosity, but we concluded that they were not able to explain the observed deformation. Thus, the discrepancy between the measured deformation and the model prediction is left unsolved. Some unknown mechanisms may play a role.

References:

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