Three-dimensional Structures of Micrometeorites: Comparison with Simulated Dust Aggregates

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Three-dimensional (3-D) structures of micrometeorites (MMs), which were recovered from Antarctic snow or ice and affected little alteration by heating during atmospheric entry, were studied using synchrotron radiation based x-ray microtomography. Most of the MMs are porous, and almost all of the pores are connected to the exterior three-dimensionally ("open pores"). Parameters for 3-D pore structures, such as porosity for "open pores", mass-dispersion radius (so called gyration radius) and fractal dimensions, were obtained quantitatively using image analysis. With increasing porosity to about 40%, fractal dimension decreases to about 2.5. The porosity – fractal dimension trend for MMs is clearly distinct from other porous grains with different origins (medicinal granules and melted aerogel grains mixed with a small amount of cosmic dust) and the Menger sponge as an example of 3-D fractal objects.

The 3-D structures of MMs were compared with those of dust aggregates simulated by collisions of ballistic cluster-cluster aggregates (BCCAs) composed of 512 or 8192 ice particles of 0.1 μm in radius [1,2]. Mass-dispersion radius was used instead of porosity because porosities of dust aggregates cannot be obtained accurately. With increasing the collision velocity to 26.1 m/s, mass-dispersion radius of dust aggregates decreases and its fractal dimension increases to about 2.5. The most porous MMs are located in an extension of the dust aggregate trend. However, fractal dimension of the dust aggregates cannot exceed 2.5 by collision, and thus the pore structures of the porous MMs cannot be made simply by collision of dust alone. Compression of dust aggregates by accumulation into and consolidation in parent bodies of MMs might be essential to form the pore structures observed in MMs

Reference

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[2] K. Wada *et al*., Abstract in JSPS scientific research on priority area "Extrasolar planets" Dust Group meeting (2008).