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Three-dimensional shapes and spatial distribution of flattend chondrules in carbonaceous chondrite (Sahara98044)

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Chondrules are silicate spherules which are about 1mm diameter and characteristically included in primitive meteorites, chondrites. It has been accepted from their spherical shapes that chondrules were once molten and cooled rapidly. So they would have important information about the evolution of solid material in the solar system.
Chondrules in Sahara98044 (CV3) are largely flattened and seem to be aligned in a direction on cross sectional surfaces of the meteorite sample (about 1.0 x 1.0 x 3.8 cm3). There would be two major possibilities for the origin of the flattening, such as flattening during the chondrule formation or the deformation on the parent body of the meteorite. In order to constrain the flattening process of chondrules, three-dimensional structures of Sahara98044 (CV3) was obtained using X-ray tomography. The same method was also applied to Allende (CV3), which does not have largely flattened chondrules, for comparison. The shapes and spatial distribution of chondrules in Sahara98044 show that the directions of the short axes of oblate chondrules are closely concentrated to a direction and those of the long axes of prolate chondrules are approximately perpendicular to the short axis direction. In contrast, chondrules in Allende are distributed randomly. The mean aspect ratio (shortest axis length/longest axis length) of chondrules in Sahara98044 is 0.65. When the chondrules were stretched to the short axis direction of oblate chondrules, the mean aspect ratio increases first and then decreases. The maximum value is 0.78, which is almost the same as the mean aspect ratio of chondrules in Allende.
The above results strongly indicate that the chondrules in Sahara98044 would have deformed after accretion to the parent body. The most probable origin for the deformation would be impact shock because of its low petrologic type of Sahara98044. Creep at a high temperature would not be the origin for the deformation because thermal metamorphism of the meteorite should be accompanied. The peak pressure of the impact shock is estimated to be about 20 GPa by comparing the aspect ratios of chondrules based on impact-shock experiments of Nakamura et al. (2000) [1].
[1] Nakamura et al. (2000) Icarus, 146, 289-300.

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