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小惑星内部の固有不均質
Innate Inhomogeneity Inside of Asteroids

中本 泰史 [1*]
NAKAMOTO, Taishi[1*]

[1] 東京工業大学
[1]Tokyo Institute of Technology

One of the main goals of probe and sample return missions for small solar system bodies is to reveal the nature of asteroids, and eventually, to understand the formation processes of asteroids as well as planets. A great advantage of this approach is that evidences of asteroids/planets formation processes are provided directly based on materials.

Both asteroids and planets are thought to be formed from smaller objects called planetesimals. Thus, if planetesimals have some degrees of inhomogeneity with respect to, for example chemical compositions and isotopic abundance, objects made of planetesimals may have a similar inhomogeneity. When we can observe such an inhomogeneity in the present day asteroids, it may be a clue to reveal the formation processes of those objects.

Here, we evaluate a possible degree of inhomogeneity inside of asteroids using a formation theory. First, we consider the planetesimal formation. Formation process of planetesimals is still under debate, so we employ three different models: gravitational instability model, turbulence driven model, and streaming instability model. These models provide different sizes of first generation planetesimals. Second, we model the formation and growth processes of asteroids. We assume that small asteroids we can see today such as Itokawa and 1999JU3 come from a larger body, 20 km or 100 km in size for instance, and they are fragments of those larger bodies. This implies that the small objects may inherit the inhomogeneity in the large body. Thus, what we need to evaluate is the degree of inhomogeneity in the large body. Based on a standard formation theory of asteroids/planets, 100 km sized body would be formed by collecting material within about 0.01 AU in distance. Since this length is about a hundredth of the semi-major axis of the object, the degree of the inhomogeneity in the body can be as large as one hundredth of the inhomogeneity in the solar nebula itself.

The estimated degree of inhomogeneity should be compared with observational data, which will be obtained by space missions such as Hayabusa-2. If we can find the inhomogeneity with a high precision measurement, it would tell us the formation processes of objects in the solar system.

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