GROWTH AND SEDIMENTATION OF DUST GRAINS IN THE PRIMORDIAL SOLAR NEBULA

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Of the formation processes of the solar system, the process of growth and sedimentation of dust particles in the primordial solar nebula is investigated for a region near the Earth's orbit. The growth equation for dust particles, which are sinking as well as in thermal motion, is solved numerically in the wide mass range between 10^{-12} g and 10^{6} g.

The numerical simulation shows that the growth and sedimentation proceed faster than found in the earlier work owing to the co-operated interaction of the growth and the sedimentation; that is, in about 3×10^{3} yrs after the beginning of the growth and sedimentation a dust layer, composed of particles of centimeter sizes is formed at the equator of the solar nebula. Furthermore, the mass density of dust particles floating in the outer layers of the nebula is found to be of the order of 10^{-4} compared with that before the sedimentation. From these results, it can be estimated that in about 5×10^{3} yrs after the beginning of sedimentation the dust layer breaks up owing to the onset of gravitational instability.

DISCUSSION

Unno: What effect would the shape of the dust grain have, if it is chain-like as inferred from laboratory experiments?

Nakagawa: Here we assumed spherical dust grains. As you pointed out, dust grains can have a chain-like or plate-like shape. But this is the case when their sizes are much much smaller than a micrometer, according to laboratory experiments. Of course, we cannot expect the shapes of grains with sizes of micrometers to be strictly spherical. The sedimentation velocities of these non-spherical grains may be different from those we used. But I think the difference is rather small, and our conclusions cannot be altered in order of magnitude.

Tscharnuter: What are the effects of turbulence on the growth of the

D. Sugimoto, D. Q. Lamb, and D. N. Schramm (eds.), Fundamental Problems in the Theory of Stellar Evolution, 131–132.

particles and the time scale of sedimentation?

Nakagawa: We assumed that in the initial state any turbulent motion had already decayed. I think that turbulence, if it exists, will soon decay after the solar nebula reaches hydrostatic equilibrium, because there is no energy source exciting the turbulence.

https://doi.org/10.1017/S0074180900073800 Published online by Cambridge University Press