

# Possibility of Lightning and Chondrule Generation during Planetesimal Formation

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Formation of planetesimals is thought to be the result of the accumulation of dust particles in the early solar nebula. But there are many unanswered questions about this process, so it is currently an active area of research. On the other hand, the formation of chondrules, which are abundant in chondritic meteorites, is also being actively studied. In this study, we examine a model in which chondrules are formed by lightning generated by dust particles that accumulate to form planetesimals.

Our model consists of two major parts: the first is a clump (a mixture of gas and dust particles) that is born due to gravitational instability in the early solar nebula, from which a planetesimal is born. In the clump, dust particles become electrically charged due to collisions between them, and their spatial separation creates an electric field, which generates lightning. We will clarify whether and under what conditions lightning occurs in such a process. And in the second part, we will investigate how dust particles (chondrule precursors) are heated by the generated lightning to clarify whether chondrules can be formed.

For the first part, the conditions necessary for lightning to occur inside a clump (the generation of an electric field strong enough to cause dielectric breakdown) were clarified. We also investigated the case of gravitational instability of the dust layer in the minimum-mass solar nebula model, and found that the above conditions are satisfied. In other words, it is possible for lightning to occur in the clumps that form planetesimals in the solar nebula.

Next, we investigated the temperature of the chondrule precursor dust particles inside and in the vicinity of a lightning event using radiation hydrodynamics calculations. As a result of simulations with various physical states of lightning, the conditions of lightning (initial temperature, radius, etc.) that can heat the dust particles to a sufficiently high temperature were clarified.

These results indicate that the model of planetesimal formation due to gravitational instability, the associated lightning, and the resulting chondrule formation may be a viable model for chondrule formation.

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