Numerical simulation of the metal droplet in the magma ocean

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Earth's core was formed by separation of iron from the silicate magma ocean. The mechanism by which this occurs is important because it controls the initial states of the core and mantle, in particular concerning the distribution of heat and chemical species between them. In the process we study, metal droplets with a size of order 1 cm are formed by the equilibrium between surface tension and shear stresses and they fall down to the bottom of the magma ocean (Rubie et al., 2003). The gravitational energy that is gained, is transformed in heat by viscous heating and we want to quantify the resulting thermal structure.

To compute this process, tracking of the metal-silicate surface is needed. Using finite difference or finite element method, the phase boundary is affected by numerical diffusion and the accurate implementation of the surface tension is difficult.

In this study, we treat this problem using Lagrangian particle method based on moving particle semi-implicit (MPS) method. This method avoids numerical diffusion and surface tracking is straightforward. We discuss the size and shape of droplets, their falling speed, the interaction between droplets, and the resulting temperature distribution.