The Amount of Vapor Caused by an Impact and the Dependence on Equation of State for Impact Vaporization

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Collisions are general phenomena in planet formation, and it is widely believed that the growth of planets were caused by collisions. The temperature elavation due to a high velocity collision causes vaporization of the material. The criterion for vaporization depends on material. Impact vaporization causes the compositions of planetary bodies. In this study, we carry out impact simulations to obtain the amount of vapor and understand the amount theoretically.

Impact vaporization is understood as follows. The shock wave induced by an impact results in an increase in entropy due to irreversible heating and compressing. The material, heated and compressed by the shock wave, rapidly cools down by isentropic expansion, according to the first law of thermodynamics. In other words, if the increase in entropy exceeds the boiling point of the material, vaporization occurs. Therefore, the amount of vaporized material is determined by the increase in entropy caused by the shock wave induced by the impact.

We investigate the amount of vaporized material using the iSALE code by considering two different equations of state, TillotsonEOS and ANEOS, which are widely used in the field of planetary collisions. We confirm the amount of vapor is consistent for TillotsonEOS and ANEOS, if we choose the parameters for EOSs. Furthermore, we constructed an analytical model for the amount of vapor as a function of impact velocity, which can explain the vaporization threshold velocity.

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