Adhesion of silicate dust grains covered with organic matter : development of an adhesion model and application to planetasimal formation

*Kazuaki Homma[1], Satoshi Okuzumi[1]

1. Tokyo Institute of Technology

An essential process in forming planetesimals in protoplanetary disks is collisional growth . However dust aggregates consisting of silicate grains is difficult to grow to be planetesimals through collision by silicate low adhesion force.
Therefore, our study focuses on organic matter which is on surface of individual silicate dust grains in protoplanetary disks. This was suggested by the chondritic porous interplanetary dust particles (CD IDPs) which are assumed that they come from comets . CD IDPs are consisting of grains which have a layered structure that is composed of a silicate core, an organic matter mantle . Moreover, organic matter is easier to stick than silicate because organic matter is softer than silicate. Therefore an organic mattle's high adhesion efficiency may encourage this grains to grow to be planetesimals . However previous studies had not taken into account for the effect of an organic mantle to planetesimal formation.
In this study we aim to reveal dust aggregates consisting of silicate grains covered with organic matter can grow to be planetesimals through collision.Here we do three things. First, we develop an approximate adhesion model about contact between two spherical elastic solids which are composed of a silicate core ,an organic matter mantle . Second ,we calculate the critical collision velocity of dust aggregates consisting of silicate grains covered with organic matter with this model. Third, we calculate collisional growth of dust aggregates consisting of silicate grains covered with organic matter.
We find that critical collision velocity of aggregates is 20 m/s to 110 m/s depending on temperature, supposing dust aggregates consisting of silicate grains covered with organic matter which is 10% to dust grains radius . In protoplanetary disks, maximum collision velocity of aggregates is 50m/s . Therefore these aggregates can grow to be planetesimals through collision in protoplanetary disks depending on disk temperature. Our result also suggests that these aggregates which was more than 1AU away grow at there, fall to the central star , and regrow to planetesimals around 1AU after these aggregates.
We showed dust aggregates consisting of silicate grains covered with organic matter grow to be planetasimals for organic matter’ s high adhesion efficiency . However, there is a problem that these planetesimals in our study has bigger mass fractions of carbon than the Earth or chondrites. Hence, we will need to reveal how carbon and organic matter content in these planetesimals change through planet formation or chondrite formation.

Keywords: Planetesimal formation, Organic matter

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