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The outcome of protoplanetary dust growth: pebbles, boulders or planetesimals?

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Planet formation starts with the coagulation of micron sized dust grains. These particles move relative to each other in the gas disk surrounding the young star and due to this relative motion they collide. The outcome of a collision depends on the relative velocity of these particles, their masses and porosities, etc.

Many laboratory experiments on dust collisions were carried out to investigate this problem. The experiments showed that several different collision types exist such as hit&stick, penetration, bouncing, mass transfer, erosion, fragmentation, etc. But most of the coagulation models only take into account hit&stick and fragmentation.

We show the results of a Monte Carlo dust evolution code which uses a collision model based on all the available experiments and all possible collision types (see Guettler et al, accepted in A&A) to constrain the maximum particle sizes reachable by coagulation of dust aggregates.

We find that in the Minimum Mass Solar Nebulae model (MMSN) particles grow initially by sticking and reach a maximum size of a centimeter-milimeter. Further growth of these aggregates is halted due to bouncing which turns out to be the most dominant collision type in these simulations (Zsom et al, accepted in A&A).

Possible alternative planetesimal formation mechanisms, such as the gravitational instability of Johansen et al (2007) or the particle concentration mechanism of Cuzzi et al (2008), will be discussed as well.