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Experimental Studies on the Aggregation Properties of Dust in Planet-Forming Regions

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To investigate the initial stage of planet formation, we built a setup for collision experiments with millimeter-sized, highly porous and well characterized dust aggregates. The experiments, which were successfully conducted at ambient temperature during ESA's 45^{th} Parabolic Flight Campaign, are the first in a series of at least three parabolic flight campaigns. The recent experiment probed the sticking and collision behavior of dust aggregates (composed of 1.5 μm-sized monodisperse $\mathrm{SiO_2}$ grains) from which planetesimals and cometary nuclei are considered to have formed. In the parabolic flights, pairs of fragile dust aggregates were collided under microgravity conditions at relative velocities between $\sim 25\,\mathrm{cm\,s^{-1}}$ and $\sim 40\,\mathrm{cm\,s^{-1}}$ using a set of pistons driven at constant acceleration. Additionally, fragile aggregates were impacted on a dusty target screen, simulating protoplanetary collisions with larger bodies. The collision events happened at random impact angle and were recorded by a high–speed, high–resolution digital camera.

The majority of both the particle-target and aggregate-aggregate collisions showed a quasi-elastic rebounding behavior. Whereas $\sim 10\,\%$ of the particle-target collisions resulted in sticking (of sub-millimeter-sized fragments only), the other key effect in $\sim 10\,\%$ of the aggregate-aggregate collisions was fragmentation. The measured coefficient of restitution for the bouncing collisions indicates that the residual translational energy is $\sim 5\,\%$ of the primal energy of the aggregates' motion for central collisions and increases with increasing impact parameter.

The next parabolic flight campaign will be conducted during July 2007. We will repeat

previous experiments at low temperatures ($140 - 220\,\mathrm{K}$) simulating the conditions at $1.5 - 5\,\mathrm{AU}$ in the solar nebula. Should the experiments be successful, first results on the temperature dependence of the collision behavior of dust aggregates will be presented.