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Experimental studies of the collisional properties of Saturnian ice particles

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Abstract

The processes leading to the creation of the numerous structures in the Saturn's rings are dominated by two effects. On the one hand there is a gravitational interaction of the ring particles with Saturn or its moons and moonlets increasing the eccentricity of the ring constituents. On the other hand frequent inelastic collisions between ring particles occur and result in damping of their motion and therefore circularizing the orbits and locally confining the rings [1].

Spectroscopic measurements of the Saturnian rings have shown, that the ring particles consist of almost pure water ice [2]. The determination of the size distribution of the ring constituents from *Cassini* and *Voyager* data revealed typical particles sizes between $1\,\mathrm{cm}$ and $10\,\mathrm{m}$ [3].

In contrast to the numerous observational data obtained by spaceborne and ground-based methods only a little set of experimental data exist on the collisional behavior of icy particles. Up to now laboratory measurements were only performed for quasi-two-dimensional, central collisions of large icy spheres [4, 5, 6].

We will present results from parabolic flight experiments in which pairs of spherical ice particles were collided in a microgravity environment. The projectiles with sizes of $15\,\mathrm{mm}$ were accelerated to relative velocities between $\sim 6\,\mathrm{cm\,s^{-1}}$ and $\sim 22\,\mathrm{cm\,s^{-1}}$ and gently collided inside a cryogenic high-vacuum chamber. We were able to determine the coefficient of restitution from the three-dimensional trajectories of the samples.

We will compare the results to those obtained in a prototype experiment investigating collisions of an ensemble of one hundred cm-sized glass spheres. These experiments were conducted in microgravity conditions at the Bremen drop tower facility allowing for collisions at relative velocities of $\sim 0.5\,\mathrm{cm\,s^{-1}}$ to $\sim 8\,\mathrm{cm\,s^{-1}}$. Additionally, we will report on experimental studies of high-velocity impacts ($\sim 45\,\mathrm{m\,s^{-1}}$) of dm-sized solid ice bodies into a massive ice target, providing insight into the processes considered for the formation of spirals and jets in Saturn's F ring as recently proposed [7].

References

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