

Size of the Smallest Particles in Saturn's Rings

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Spacecraft and ground-based observations have shown that particles in Saturn's main rings have a power-law distribution roughly between centimeter and ten meters, but sub-centimeter particles appear to be lacking. Recent studies based on Cassini observations suggest that the size of the smallest particles is on the order of millimeters. Cohesive force between particles has been proposed to explain the paucity of sub-centimeter particles, but its strength depends on impact velocity. In order to better understand recent Cassini observations about small ring particles, we examine impact velocity between ring particles using N-body simulation including size distribution. We find that most collisions take place at velocities lower than 0.1 cm per second; even in dense rings where particles' velocity dispersion is enhanced by gravitational wakes, they collide at such low velocities because particles tend to move coherently in the wakes. This velocity is too low to detach sub-centimeter particles that are attached to the surface of large ones due to the cohesive force, explaining their paucity in the main rings. On the other hand, more infrequent high-velocity impacts can release millimeter-sized particles strongly attached to the surface of large ones, explaining the observed free millimeter-sized particles with relatively low abundance. We will discuss implications of our results for the observed size of the smallest particles in Saturn's main rings.

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