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The E ring as seen by the Cassini dust detector

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Saturn's dilute E ring is the largest ring of the solar system and extends from about 3.1 R_S (Saturn radius $R_S = 60\,330$ km) to at least 8 R_s encompassing the icy moons Mimas, Enceladus, Tethys, Dione, and Rhea. After Cassini's insertion into its Saturnian orbit in July 2004, the spacecraft performed a number of equatorial as well as steep traversals through the E ring inside the orbit of the ice moon Dione.

Here, we report about dust impact data we obtained during 2 shallow and 6 steep crossings of the orbit of the dominant ring source – the ice moon Enceladus. The vertical ring structure at $3.95R_s$ agrees well with a Gaussian with a full–width–half–maximum (FWHM) of $\sim 4\,200$ km. We show that the FWHM at $3.95R_S$ is due to three-body interactions of dust grains ejected by Enceladus' recently discovered ice volcanoes with the moon during their first orbit. We find that particles with initial speeds between 225 m/s and 235 m/s relative to the moon's surface dominate the vertical distribution of dust. Particles with initial velocities exceeding the moon's escape speed of 207 m/s but slower than 225 m/s re-collide with Enceladus and do not contribute to the ring particle population. Our data imply that the densest point is displaced outwards by about $0.25R_S$ with respect of the Enceladus orbit. The differential size distribution $n(s)\,ds \sim s^{-q}ds$ for grains $> 0.9\mu$m is described best by a power law with slopes between 4 and 5.

We also obtained dust data during ring plane crossings in vicinity of the orbits of Mimas and Tethys. The vertical distribution of grains $> 0.8\mu$m at Mimas orbit is also well described by Gaussian with a FWHM of $\sim 5\,400$ km and displaced by $\sim 1\,000$km with respect to the geometrical equator. The vertical distribution of ring particles in vicinity of Tethys, however, does not match a Gaussian.

We use the FWHM values obtained from the vertical crossings to establish a 2-dimensional model for the ring particle distribution which matches our observations during vertical and equatorial traversals through the E ring.