Particle Sizes and Sorting in Saturn's C Ring and Cassini Division from Cassini UVIS, VIMS, and RSS Observations R. G. Jerousek[1], J. E. Colwell[1], M. M. Hedman[2], R. G. French[3], E. A. Marouf[4], L. W. Esposito[5], P. D. Nicholson[6]
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Introduction: Saturn's C ring and Cassini Division share many characteristics. Both are dominated by four optical depth morphologies: (1) a low optical depth region, which is referred to as the "background" in the C ring, (2) regions where the optical depth abruptly increases by a factor of several which span one to several hundred km called the plateaux in the C ring and the triple-band feature in the Cassini division, (3) many narrow and opaque rings and gaps, and (4) the C ring and Cassini Division ramps where optical depths gradually climb toward abrupt edges which mark the inner edges of the B ring and A ring. We constrain the parameters of a differential power-law size distribution where the number of particles in radius interval [a, a+da] is given by $n(a) = n_0(a/a_0)^{-q}$ for radii between a_{min} and a_{max} by comparing a multitude of optical depth profiles measured by Cassini UVIS, VIMS, and RSS (X-band, Ka-band, and S-band) to those determined by the thin-layers ring model [1]. The thin-layers model [1] is a simple multiple scattering model where the ring is divided into N monolayers of particles between which multiple scattering can occur.

Results: In the C ring we fit data from 68 UVIS, 13 VIMS, and 16 RSS occultation profiles to the model. Throughout the C ring we find a mean best-fit lower particle cutoff, a_{min} ~ 4 mm, consistent with recent studies of the C ring using VIMS solar occultations [2] and other ring regions such as the outer A ring [3, 4]. We find a mean power-law index q ~ 3.15 in the background C ring and C ring ramp and a power-law index of q ~ 2.9 in each of the C ring pleateaux. Throughout most of the C ring the optical depths fit a single particle monolayer, consistent with constraints on ring scale height from spiral density wave dispersion from [8, 9]. Best-fit model parameters and reduced χ^2 for the C ring are shown in Figure 1.

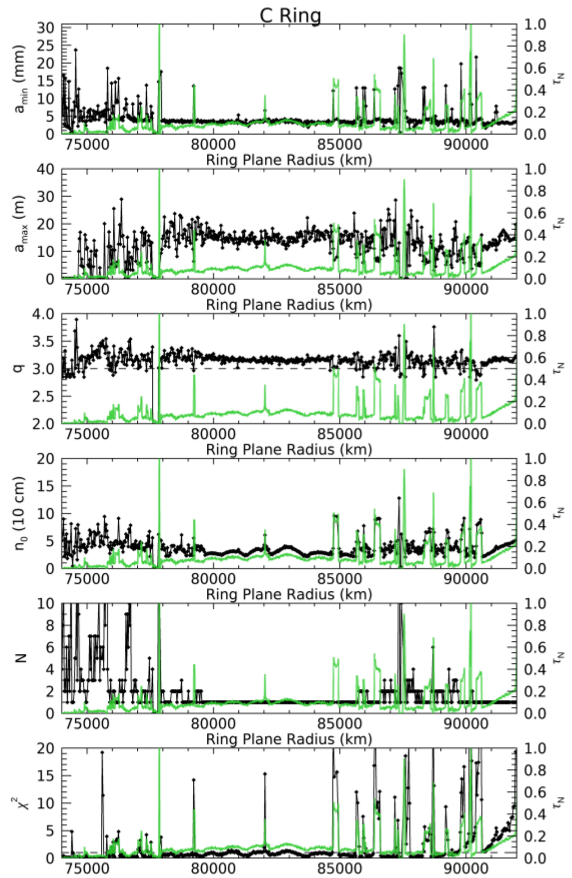

***Fig 1.** Best-fit size distribution parameters from the thin-layers model throughout the C Ring.*

In the Cassini Division we fit data from 126 UVIS, 21 VIMS, and 16 RSS occultation profiles to the model. We find q ~ 2.9 with the exception of the triple-band where q ~ 2.8. Like the C ring, we find a_{min} ~ 4 mm which gradually decreases to a_{min} ~ 1 mm in the outermost portion of the Cassini Division ramp. Throughout most of the C ring the optical depths fit one to several particle layers, consistent with constraints on ring scale height from spiral density wave dispersion from [10]. Best-fit model parameters and reduced χ^2 for the C ring are shown in Figure 2.

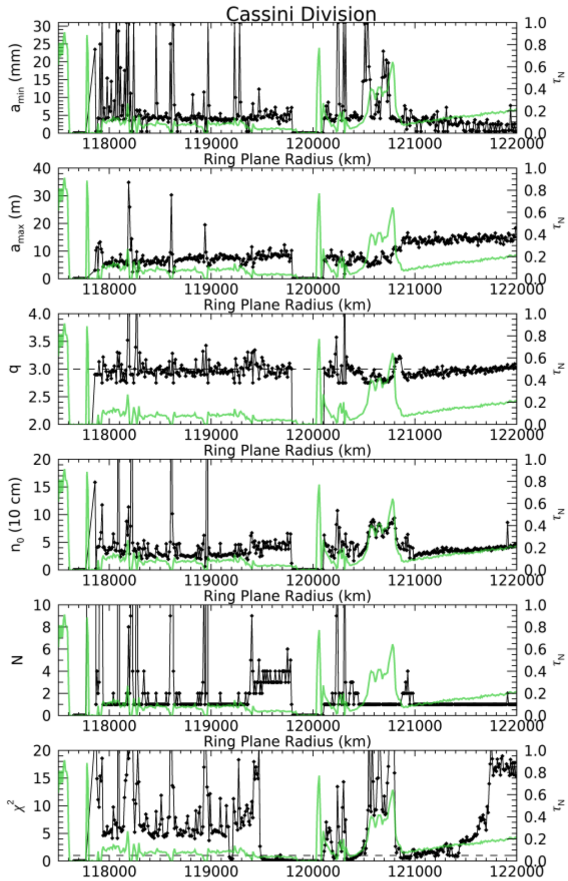

Fig 2. *Best-fit size distribution parameters from the thin-layers model throughout the Cassini Division.*

Optical depths measured at wavelengths between 0.15 μm (UVIS) and 13 cm (RSS S-band) are not sensitive probes of the largest particles in the size distribution so we constrain a_{max} using the excess variance of star signal beyond Poisson counting statistics from the high-resolution UVIS occultation of β-Centauri (77) ingress [5]. We find that the largest particles contributing to the optical depth of the background C ring are ~ 10–20 m but are < 5 m in the C ring plateaux. High-resolution UVIS occultations show that multitude of small, azimuthally-limited gaps called "ghosts" populate both the C ring plateaux and Cassini Division's triple-band feature [6]. These "ghosts" are essentially propeller features, like those found in the A ring by [7], but are opened by 10–20 m boulders. We find that these boulders which sparsely populate the C ring plateaux and do not contribute significantly to the optical depth are ubiquitous in the C ring background and ramp, possibly indicating aggregation well within the Roche zone. Using our best-fit size distribution parameters, we can also attempt to constrain particle mass densities by comparing ring surface mass densities determined from spiral density wave dispersion by [8-10] to those calculated by integrating over the total particle volume per square meter of the ring plane. We find that in order to match the surface mass densities from these previous studies, the water-ice ring particles must be highly porous with densities less than 0.35 g/cm^3 except in the center of C ring where particles' densities are larger than what would be predicted from a water-ice composition, consistent with [11].

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