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Cassini Radio Occultation Observations of the Structure and Properties of Saturn's Ring B

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A series of eight Cassini radio occultation observations were completed from May 3 to September 5, 2005. Four were ingress-egress occultations and four were either ingress or egress occultation, for a total of 12 full cuts of the ring system. Diffraction reconstructed optical depth profiles reveal significant wealth of information about ring structure and its variability (or lack of) with observation longitude. The observations also provide independent measurements of the forward diffraction pattern (forward scattered signal) caused by random blockage of the incident radio wavefront by ring particles and particle aggregates. The measurements may be used to determine/constrain the ring "microstructure," including preferentially oriented and elongated spatial particle correlations due to gravitational wakes. Among the plethora of dynamical and other phenomena observed, the detailed structure of the dense Ring B and its physical properties stand out as fundamental new knowledge. We present here an overview of the Ring B results, and related results for other dense features of Saturn's rings. The optimized occultation geometry and the relatively large ring opening angle (19 to 23.6 degrees) at the time of these occultations allowed detailed profiling of relatively optically thick ring features. Four regions of distinct structural morphology characterize Ring B, identified for convenience as B1, B2, B3, and B4. They are bounded by the radius of $\sim$ 92, 99, 104.5, 110, 117.5 thousand km. Region B1 has the smallest normal optical depth τ (1 to 2) and is characterized by the presence of two well-known flat features. Region B2 hosts remarkable structure unlike any previously observed, characterized by a series of abrupt and deep transitions in τ from about 1 and to > 5

over tens to hundreds of kilometers scales. Region B3 hosts the most optically thick features of Ring B ($\tau > 5.5$). The features are separated by narrow "lanes" of substantially less opacity ($\tau < 3$). Region B4 is moderately optically thick (1.5 to 3.5) and has structure morphology different from all other three regions. Comparison of ring profiles at twelve different inertial longitudes reveal remarkable morphological consistency. The clear exceptions are over the coorbitals 2:1 density wave region in B1 and the outer region of B4, where substantial structural variability characterize this resonantly forced outer edge of Ring B. The structure variation does not appear to be a simple "accordion" effect as the edge boundary moves in and out. Azimuthal asymmetry in the observed optical depth profiles is clearly evident in region B1, indicating likely presence of Ring-A like gravitational wakes. From the scattered signal observations, evidence for the presence of such wakes also extends to region B2 and B4, although their properties appear somewhat different from wakes detected in Ring A. Most remarkable is the detection of a quasi-periodic ring microstructure of period roughly 100-150 meters clearly present in B2 (and perhaps B4), as well as in the dense inner region of Ring A. In contrast with gravitational wakes, the periodic structure is not azimuthally inclined and appears to be an independent structure superposed on the background wake structure.