Announcing the Final Examination of Tracy Becker for the Degree of Doctor of Philosophy in Physics

Date: Thursday, December 3, 2015
Time: 2:00 p.m.
Room: PSB 161
Dissertation title:
Saturn's Rings: Measuring Particle Size Distributions Using Cassini UVIS Occultation Data

Abstract:

Since its arrival at Saturn in 2004, the Cassini spacecraft has utilized its suite of sophisticated instruments to further our understanding of the Saturnian ring system. We analyze occultation data from Cassini's Ultraviolet Imaging Spectrograph (UVIS) in order to measure the particle size distribution in Saturn's rings.

Throughout the ring system, particle accretion is countered by collisional and tidal disruption. The presence of sub-centimeter particles is a tracer of ongoing dynamics in the rings. Sub-centimer-sized particles efficiently diffract light at ultraviolet wavelengths, and thus produce signatures of diffraction in the UVIS occultation data.
We have developed a numerical model that reconstructs the geometry of a UVIS observation and produces a synthetic diffraction signal for a power-law particle size distribution that we compare to the observed signal. We implement this model for two sets of observations: (1) diffraction spikes at sharp ring edges during stellar occultations and (2) the light curve due to attenuated and diffracted sunlight by particles in Saturn's F ring during solar occultations.

In Saturn's A ring, diffracted light can augment the stellar signal by up to 6% and can be detected tens of kilometers radially from the edge. The radial profile of the diffraction signal is dependent on the size distribution of the particle population near the ring edge.We find an overall steepening of the power-law size distribution and a decrease in the minimum particle size at the outer edge of the A ring when compared with the Encke Gap edges some 3000 km interior to the outer edge. This suggests that interparticle collisions caused by satellite perturbations in the region result in more shedding of regolith or fragmentation of particles in the outermost parts of the A ring. We rule out any significant population of sub-millimeter-sized particles in Saturn's A ring, placing a lower limitation of 1-mm on the minimum particle size in the ring.

We also model the light curves produced as Saturn's F ring occults the Sun. Five of the eleven solar occultations analyzed show a clear signature of diffracted light. We measure a large variation in the the size distribution of the particles that fill the ~500 km region surrounding the F ring core. We find that smaller particles (≤ 50μm) are present during solar occultations for which diffraction was detected, and place a lower limit on the minimum particle size of 100μm for occultations during which diffraction was not detected. A comparison with images of the F ring observed by the Cassini Imaging Science Subsystem reveals that the detections of small particles in the UVIS data correspond with locations of collisional events in the F ring. This implies that collisions within the F ring core replenish the micron-sized dust in the 500-km region that encompasses the F ring core.

Outline of Studies:
Major: Physics, Planetary Sciences Track

Educational Career:
B. S. Lehigh University, 2010

Committee in Charge:
Dr. Joshua E. Colwell (Chair)
Dr. Yanga R. Fernández
Dr. Humberto Campins
Dr. Mark R. Showalter (External Committee Member)
Dr. Richard A. Klemm (External Committee Member)

Approved for distribution by Dr. Joshua E. Colwell, Committee Chair, on November 25, 2015.

The public is welcome to attend.