Cassini Imaging Observations of Jupiter's Rings

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Several hundred images of the Jovian main ring over a broad range of wavelengths and viewing gometries were obtained during Cassini's Jupiter flyby in late 2000. This data set represents the most comprehensive coverage in spectrum and phase ever collected by one instrument on the Jupiter ring. The observations focused on a) determining the nature and size distribution of the particles in the main ring; b) searching for temporal variations in the ring; c) searching for material beyond the known rings; and d) determining the three dimensional ring structure.

Observations of the ring from Cassini were expected to be challenging due both to the distance from Jupiter ($137 - 285$ R_J, nearly ten times farther than the Voyager encounters) and the inherent faintness of the ring ($\tau \sim 3 \times 10^{-6}$). As a result, many of the images are dominated by scattered light from the bright limb of Jupiter. However, with appropriate processing, the ring can be detected in the vast majority of the several hundred ring-targeted exposures.

Cassini images of the rings cover a large range of phase angles ($\alpha = 0 - 121.5°$). At each phase angle we imaged the ring in nine colors (0.3μm to 0.95μm) and at three polarizations. Existing phase curves of the Jupiter ring are sparsely populated, with observations taken primarily in forward-scatter ($\alpha \sim 180°$) and at very low phase from the ground. We are in the process of calibrating the Cassini images, which will dramatically fill in the phase curve. Analysis of the wavelength-dependent phase curve will allow us to strongly constrain the particle sizes in the main ring, and in turn their lifetimes and histories. The polarization observations will yield insight into nature of the small particles and the surface structure of the larger particles and the processes acting upon them – for instance, grain sputtering and collisions.

Detection of the fainter halo ring ($\tau \sim 10^{-6}$) in the Cassini images is probably not possible due to scattered light from Jupiter. We also searched for material in the vicinity of the faint gossamer rings ($\tau \sim 10^{-7}$) out to 6 R_J, well beyond the locations of the known Thebe and Amalthea gossamer rings. We have not detected these rings in preliminary analysis of the images.

Observations by Cassini just after it passed through the planet's equator, at a distance of 137 R_J, yielded the best spatial resolution of 58 km/pixel. A sequence of observations followed both ring ansae at a spacecraft latitude of $\sim 1'$. Although the spatial resolution is inadequate to directly measure the ring's vertical thickness better than the $z < 30$ km constraint from Voyager, modeling of the ring's brightness profile as it opens up may allow us to measure its height. The ring's vertical structure is believed to be intimately associated with the dynamics of its small ring satellites, Metis and Adrastea. The orbits of these satellites have been refined using Cassini imaging data. (See presentation by Evans et al. this meeting.)

Finally, Cassini obtained 40-hour, 150-exposure movies of the main ring on both the inbound ($\alpha \sim 3°$) and outbound ($\alpha \sim 120°$) segments. We have not yet found evidence for any temporal variation in the ring, or any 'clumps' of material larger than our spatial resolution of 120 km.

Results from our analyses of these observations will be presented.