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# Analysis of Saturn's Huygens Ringlet using Cassini ISS images

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Saturn's Huygens ringlet, located ~250 km exterior to the outer edge of Saturn's B ring, has for some time been known to be eccentric. Porco (1983) measured an m=1 Keplerian mode with a radial amplitude of ~30 km using Voyager data sets, and based on the relatively large residuals in the simple Keplerian ellipse model, hypothesized that an additional wavenumber-2 pattern may be present as a response to the nearby Mimas 2:1 inner Lindblad resonance and/or the large-amplitude distortion in the massive B-ring edge, which at that time was assumed to be produced by the resonance. An attempt to fit such a pattern using 13 Voyager measurements (11 ISS images, one RSS occultation, and one UVS occultation) did not produce a statistically significant result. Using Cassini ISS imaging data, we show that the ringlet is indeed influenced by the Mimas resonance, but primarily on the inner edge. The outer edge shows a wavenumber-2 pattern as well, but its pattern speed indicates that it is a free oscillation of the ringlet. The amplitudes of the inner and outer m=2 modes, ~1.6 and 3.0 km respectively, are far too small to have been detected by Voyager.

The relation between Keplerian modes of the inner and outer edges of the ringlet is complicated, with two distinct behaviors apparent: the earliest data set, taken in 2005, shows a steep eccentricity gradient, a mean width of ~50 km, and an apsidal offset (outer minus inner) of ~45 deg; later data sets show a nearly flat eccentricity gradient, mean widths decreasing with time to ~20 km, and near apsidal alignment.

Differential precession would produce a negative apsidal offset (at least initially), not the positive offset seen in the earliest observation. In order to reach the observed configuration, the ring would have to be either oscillating about an apse-aligned state with an amplitude of at least 45 deg, or the inner edge would need to have overtaken the outer edge shortly before the 2005 observations. In order for the inner apoapse to shear past the outer periapse, the ring elements would need to adjust to avoid streamline crossing. The large mean width and eccentricity gradient seen in the earliest data set may be consistent with such an adjustment. The decreasing width seen in the subsequent observations suggests an active confinement mechanism that has yet to be explained.