Observational Studies of Saturn's Rings

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The objective of this work is to investigate several noteworthy pheonomena in Saturn's rings which have until now received an inadequate amount of attention. Among these are the periodic variation of the 'spokes' in the B ring and eccentric features throughout the rings.

One of the major discoveries by Voyager has been the existence of eccentric features within the predominantly circular rings of Saturn (Smith *et al.* 1981,1982). Several of these nonaxisymmetric features are narrow elliptical rings which share many characteristics with the rings of Uranus (Porco 1983; Porco *et al.* 1984a). In recent work, two new narrow ringlets have been added to the list of eccentric features in the rings of Saturn (Porco and Nicholson 1986). The ringlet at $1.95R_s$ sits in the Huygens gap outside the outer B ring edge and together they comprise an interesting dynamical system. The B ring edge, also a major eccentric feature which clearly owes part of its shape and kinematics to the nearby 2:1 inner Lindblad resonance with the satellite Mimas (Porco *et al.* 1984b), is not completely described by a simple $m = 2$ radial distortion expected from this resonance. The 'Huygens' ringlet behaves, to first order but not entirely, as do the majority of $m = 1$ narrow ringlets in the solar system precessing around an oblate planet (Fig. 1a). In addition, it does not exhibit the positive linear width-radius relation found for many narrow ringlets like the $\epsilon$, $\alpha$, and $\beta$ rings of Uranus (Fig. 1b). Voyager Imaging and occulation (RSS, PPS, UVS) data are now in hand, as well as image-processing software which allows accurate absolute positional measurements to be made in Voyager imaging data. Work is in progress to re-examine this region of Saturn's rings and to study the possibility of a dynamical interaction between the outer B ring edge, the Huygens ringlet, and the nearby Mimas 2:1 resonance. An understanding of the kinematics and dynamics of this region promises to yield important clues to a matter of great interest in both theoretical and observational ring studies: the behavior of ring particles in regions of high optical depth like the outer B ring.

Ever since the Voyager discovery of the broad-band, impulsive Saturn Electrostatic Discharges (SED) whose spectrum is akin to that of lightning, it was speculated that the spokes observed in Saturn's B ring might be the visible manifestation of the SED. It has been known for some time that the variation of spoke activity in Saturn's B ring is modulated at a period equal to $641 \pm 5$ minutes, within observational uncertainty equal to that of Saturn's magnetic field, $639.4 \pm .05$ minutes (Porco and Danielson 1984). However, the SED's have modulation period of $610 \pm 5$ minutes (Evans *et al.* 1981), significantly different that the magnetic field period. There is a strong suggestion of a peak at a period of 610 minutes in the spectrum of spoke activity (Fig. 2) and current work is focussed on the investigation of this feature (Porco and Haemmerle 1987) and the problem of the physical connection, if any, between spokes and the SED.

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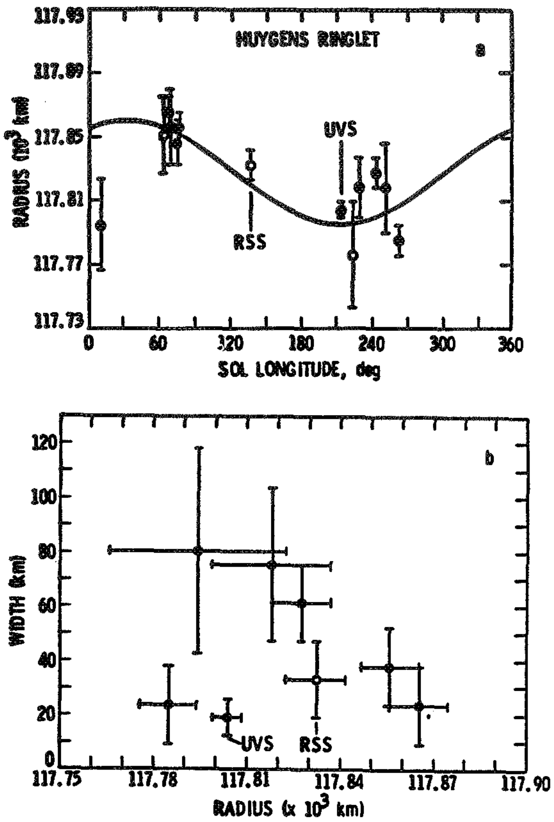


Fig 1. a. The radius-longitude data obtained from Voyager imaging and occultation experiments and the best fitting co-planar elliptical model for the Huygens ringlet at 1.95 Rs. The data points (open circles - Voyager 1; filled circles - Voyager 2) have been precessed to a common epoch. b. The radius-width data for the Huygens ringlet. Both figures from Porco (1983).

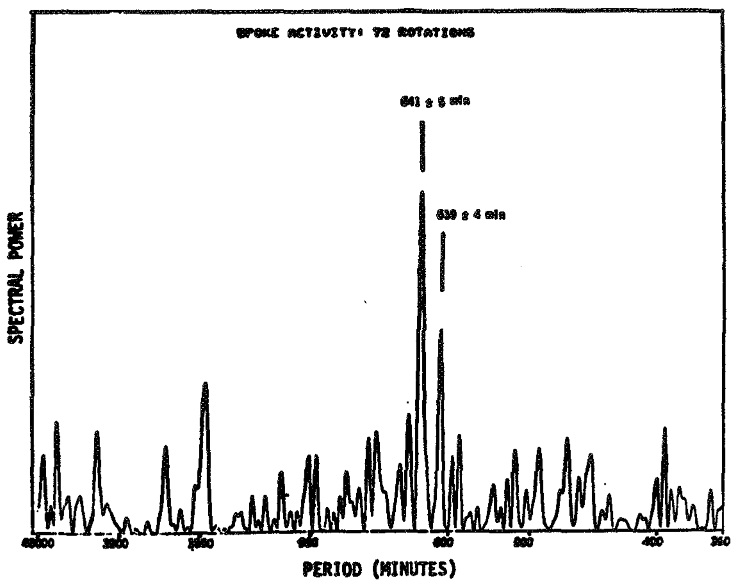


**Figure 2.** Fourier power spectrum of spoke activity observed on the morning ansa in Voyager 2 imaging data spanning 72 Saturn rotations. The highest peak at 641 ± 5 min occurs very close to the magnetic field period (639.4 min). The next highest peak at 610 ± 4 min may indicate a relationship between spokes and SED's which have a period of 610 min. Figure from Porco and Danielson (1984).