EPSC Abstracts
Vol. 5, EPSC2010-913, 2010
European Planetary Science Congress 2010

Vertical Ripples in the Jovian Ring

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Abstract

Galileo spacecraft images from 1996 revealed a pattern of vertical corrugations in the Jovian ring (Fig. 1). We find that Jupiter's "ripples" have similar kinematics to a pattern of vertical corrugations seen in Saturn's D and C rings, as reported by Hedman et al. [1,2]. We explore the possible events that could have triggered this pattern in the Jovian ring.

1. Investigation

Hedman et al. [1] reported the detection of vertical corrugations in Saturn's D ring, based on an analysis of the Cassini images. During Saturn's recent equinox, this same pattern was seen to cross the entire C ring as well [2]. The pattern is a spiral, which continues to wind up due to the differential regression of nodes. The rate of wind-up is consistent with that predicted from the higher-order moments of Saturn's gravity field. Playing the process backwards, Hedman et al. show that the pattern began with a global tilt of Saturn's inner rings, triggered by unknown causes in the early 1980s.

These corrugations are reminiscent of vertical ripples in the Jovian ring, first reported by Ockert-Bell et al. [3]; see Fig. 1. The pattern only appeared in three images in 1996, and was never seen again. Later images from Galileo in 2000–2001 and from New Horizons in 2007 had similar viewing geometry, resolution and sensitivity, but did not reveal any patterns with comparable wavelengths and amplitudes. In light of the result that the corrugations in Saturn's rings are a spiral that winds tighter due to differential nodal regression, we revisit these data sets to determine if a similar phenomenon could have been at work at Jupiter. A re-analysis of the 1996 images reveals that the pattern comprises not one but two vertical ripple patterns. The stronger pattern has a wavelength of ~ 1700 km, whereas the second has a wavelength of ~ 600 km. Vertical amplitudes are ~ 3 km and ~ 0.6 km, respectively. Assuming the differential nodal regression rate expected for the Jovian ring, we now find these same corrugations in Galileo images from 2000. The wavelengths should be 19 and 14 km in New Horizons data, too short to be detected in that data set. The confirmation of similar patterns, with similar kinematics, in the rings of Jupiter and Saturn, and the double-pattern seen in the Jupiter data, provide new constraints on the frequency and nature of the events that initiate them. Possible formation mechanisms for the Jovian patterns will be discussed.

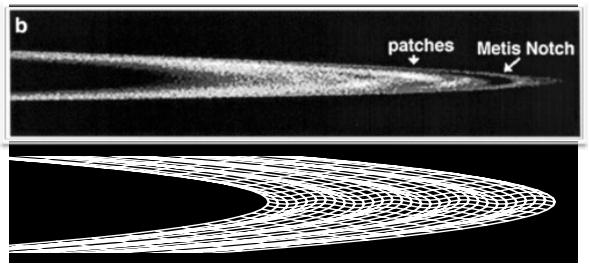

Fig. 1. After strong contrast enhancement, this nearly edge-on view of the Jovian ring ansa shows alternating patterns of bright and dark "patches", a characteristic property of corrugated rings. From Ockert-Bell et al. [3], their Fig. 3b. The lower panel illustrates this effect via a wire-frame diagram.

2. References

[1] Hedman, M., et al.: Saturn's dynamic D ring, Icarus, Vol. 188, pp. 89–107, 2007.

[2] Hedman, M. M., Burns, J. A., Tiscareno, M. M., and Porco, C. C.: Curious corrugations in the C ring, Bull. Amer. Astron. Soc., Vol. 25, #25.06, 2009.

[3] Ockert-Bell, M., et al.: The structure of Jupiter's ring system as revealed by the Galileo imaging experiment, Icarus, Vol. 138, pp. 188–213, 1999.