**EVIDENCE FOR CHANGES IN SATURN'S INTERIOR FROM STRUCTURES IN ITS RINGS.** M.M. Hedman[1], P. D. Nicholson[2], M. El Moutamid[2] [1]University of Idaho, 875 Perimeter Dr. MS 0903, Moscow ID 83844, [2]CRSR, Cornell University, Ithaca NY 14853. (mhedman@uidaho.edu, nicholso@astro.cornell.edu, maryame@astro.cornell.edu)

While Jupiter and Saturn are both known to be composed primarily of Hydrogen and Helium, many aspects of the internal structures of these giant planets are still unclear [1-2]. For example, we do not yet know the size and mass of any compositionally distinct cores inside these planets [3]. Recently, the Juno Mission to Jupiter and the Cassini Mission to Saturn have been providing abundant new information about these planets, and while these data will certainly help clarify what is going on inside these planets in the near future, some of these findings are still very puzzling.

In particular, detailed studies of Cassini observations of Saturn's rings have revealed numerous structures that are likely generated by oscillations and asymmetries inside the planet [4-7]. While some of these features had been found previously in Voyager observations and had been interpreted as products of structures inside Saturn [8], the much more extensive Cassini data now allows us to determine the rotation rate and/or oscillation frequencies of the planetary structures that are generating specific patterns in the rings. This means that we can use the rings as a sort of seismometer to probe Saturn's interior.

Further study of the ring signatures has shown that there are two very different sorts of planetary structures that are affecting the rings: normal-mode oscillations and azimuthal asymmetries. The normal-mode oscillations were the ones originally predicted by [8] and produce variations in the planet's gravitational field that are much faster than the planet's rotation rate. Most of the ring structures generated by these oscillations have not changed appreciably since Voyager, which imply they correspond to relatively persistent aspects of the planet's interior. Indeed, recent analyses of these oscillation modes have been used to argue that some parts of Saturn's interior are stably stratified [9]

By contrast, there are other structures in the rings that appear to be generated by variations in the planet's gravitational field that have approximately the same rotation rate as Saturn's winds. These are most likely due to mass anomalies or other asymmetries inside the planet. Detailed investigation of the ring structures generated by these asymmetries reveals that their appearance has changed over the course of the Cassini mission, which implies that the asymmetries inside the planets are not rotating at a strictly constant rate. Indeed, for all cases we can identify, the frequency of the perturbation appears to be increasing, and so it appears that something is happening inside Saturn that is causing structures inside the planet to spin up over the course of the last decade. Furthermore, one of these structures was first seen by Voyager, and the planetary phenomenon responsible for that feature appears to have been evolving in this way for at least the last Saturn year. The observed trends therefore are unlikely to be tied to seasonal changes. Instead, they may reflect longer-term evolution in the planet's atmosphere and/or interior.

**References:**

[1], Fortney, J.J. and N. Nettelman, (2010) *SSR* 152:423-447 [2] Guillor, T. and D. Gautier. (2014) arXiv:1405.3752 [3] Wahl, S.M. et al. (2017) *GRL* 44:4649-4659. [4] Hefman, M.M. and P.D. Nicholsom (2013) *AJ* 146:12 [5] Hedman, M.M. and P.D. Nicholson (2014) *MNRAS* 444:1369-1388 [6] French, R.G. et al. (2016) *Icarus* 279:62-67 [7] El Moutamid, M. et al. (2016) *Icarus* 279:125-140 [8] Marley, M.S. and C.C. Porco (1993) *Icarus* 106:508. [9] Fuller, J. *Icarus* 242:283-296