Solar System Ice Giants versus Exoplanet Ice Giants. A. M. Rymer¹, M. Hofstadter², A. Simon³, K. Mandt¹, K. M. Sayanagi⁴, I. de Pater⁵
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Introduction: Major revelations of the structure and mechanics of the interiors of Jupiter and Saturn from Juno and the Cassini Grand Finale, respectively, are a stark contrast to our ignorance of ice giant interiors (e.g., Masters et al., 2014; Turrini et al., 2014; Hofstadter et al., 2017; Dougherty et al., 2018; Galanti et al., 2019; Moore et al., 2018; Guillot et al., 2018). The composition and interior of Neptune is poorly constrained. It is of particular importance to determine the global ice-to-rock-ratio, the noble gas abundances, and the isotopic ratios of H, C, N, and O which are key to understanding how the giant planets formed and evolved (e.g., Mousis et al., 2018).

Figure 1. Left: Phase diagram of water showing hypothesized interior conditions for the ice giants (Millot et al. 2019); magnetic fields are likely generated in the shallow ionic fluid region. Right: Radial magnetic field at the 1 bar pressure level as measured by Voyager 2, including the dipole, quadrupole, and octupole components (Holme & Bloxham, 1996). Color represents field intensity with purple (green) denoting outward (inward) directed fields.

The Kepler Mission discovery of vast numbers of 2-4 Earth radii exoplanets, often called “mini-Neptunes”, give additional impetus to understanding the structure and composition of Neptune. The last several years of exoplanets detection and characterization have taught us that planets with the sizes of Neptune are very common in our galaxy and therefore a better understanding of this planetary class is desirable. The formation of the ice giants is still an open question in the fields of planetary science and astrophysics (e.g., Pollack et al., 1996, Dodson-Robinson & Bodenheimer, 2010, Helled & Bodenheimer, 2014). Neptune emits the largest amount of internal heat relative to insolation of all giant planets, and especially compared to Uranus’ which emits the lowest amount. What is responsible for this inter-ice giant dichotomy and how is it rectified against their similar magnetic fields and zonal flows?

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