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The Pulsating Magnetosphere at Jupiter

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The magnetosphere of Jupiter is the largest planetary magnetosphere in the solar system, and plays host to internal dynamics that remain, in many ways, mysterious. Prominent among these mysteries are the ultra-low-frequency (**ULF**) pulses ubiquitous in this system. Pulsations in the electromagnetic emissions, magnetic field and flux of energetic particles have been observed for decades, with little to indicate the source mechanism. While ULF waves have been observed in the magnetospheres of all the magnetized planets, the magnetospheric environment at Jupiter seems particularly conducive to the emergence of ULF waves over a wide range of periods (1-100+ minutes). This is mainly due to the high variability of the system on a global scale: internal plasma sources and a powerful intrinsic magnetic field produce a highly-compressible magnetospheric cavity, which can be reduced to a size significantly smaller than its nominal expanded state by variations in the dynamic pressure of the solar wind. Compressive fronts in the solar wind, turbulent surface interactions on the magnetopause and internal plasma processes can also all lead to ULF wave activity inside the magnetosphere.

To gain the first comprehensive view of ULF waves in the Jovian system, we have performed a heritage survey of magnetic field data measured by six spacecraft that visited the magnetosphere (Galileo, Ulysses, Voyager 1 & 2 and Pioneer 10 & 11). We found several-hundred wave events consisting of wave packets parallel or transverse to the mean magnetic field, interpreted as fast-mode or Alfvénic MHD wave activity, respectively. Parallel and transverse events were often coincident in space and time, which may be evidence of global Alfvénic resonances of the magnetic field known as field-line-resonances. We found that 15-, 30- and 40-minute periods dominate the Jovian ULF wave spectrum, in agreement with the dominant “magic frequencies” often reported in existing literature.

We will discuss potential driving mechanisms as informed by the results of the heritage survey, how this in turn affects our understanding of energy transfer in the magnetosphere, and potential investigations to be made using data from the JUNO spacecraft. We will also discuss the potential for multiple resonant cavities, and how the resonance modes of the Jovian magnetosphere may differ from those of the other magnetized planets.