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Radio Observations of HD 80606 Near Planetary Periastron

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Giant planets in the Solar System generate radio emission as a result, at least partially, of the interaction between the solar wind and their magnetospheres that then generates an electron cyclotron maser in their magnetic polar regions. Further, changes in the solar wind pressure incident on their magnetospheres have been observed to modulate the radio powers (or luminosities) emitted by the Solar System giant planets.

Detecting electron cyclotron maser emissions from extrasolar planets would provide an estimate of the strengths of the planetary magnetic fields, from which constraints on their interior structures could be inferred as well as possibly serving to characterize the "space weather" environments of their host stars. While there have been numerous searches for analogous emission from extrasolar giant planets, with observations conducted at multiple telescopes, all have been unsuccessful to-date. The lack of detection is likely due to a combination of observing at frequencies that are (much) higher than would be expected, given potential planetary magnetic field strengths, and limited telescope sensitivities, as well as possibly effects due to beaming of the electron cyclotron radio emissions.

The planet HD 80606b is a giant planet, notable for having the second largest orbital eccentricity known ($e = 0.93$). During most of its orbit, the planet is at distances of order 0.9 au, plunging for approximately two weeks to distances of approximately 0.03 au. By analogy to stellar wind modulation of the electron cyclotron maser emissions in the Solar System, radio emission from HD 80606b should undergo substantial variation in the course of its orbit. Lazio et al. [1] predicted that variations in its radio power could exceed a factor of 1000.

We report new Low Frequency Array (LOFAR) and Owens Valley Radio Observatory Long Wavelength Array (OVRO-LWA) observations of HD 80606b near planetary periastron. These observations are distinguished from previous observations by three factors: (i) The observations are at frequencies spanning 28 MHz to 84 MHz, which, critically, covers the frequency range at which Jupiter emits ($\nu < 40$ MHz), and lower than most previously reported observations of extrasolar planets; (ii) Sensitivities of a few millijanskys at 50 MHz with LOFAR and of approximately a hundred millijanskys across the full frequency range with the OVRO-LWA have been obtained, nearly an order of magnitude deeper than previous extrasolar planet observations below 100 MHz; and (iii) OVRO-LWA observations at frequencies below 50 MHz before and after periastron cover nearly the full rotational period estimated by Lazio et al. [1] to account for beaming of the electron cyclotron maser emission.

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References

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