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Radio Observations of HD 80606 Near Planetary Periastron

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This paper reports Very Large Array observations at 325 and 1425 MHz (90cm and 20cm) during and near the periastron passage of HD 80606b on 2007 November 20. We obtain flux density limits (3-sigma) of 1.7 mJy and 48 microJy at 325 and 1425 MHz, respectively, equivalent to planetary luminosity limits of 2.3 x 10^{24} erg/s and 2.7 x 10^{23} erg/s. These are well above the Jovian value (at 40 MHz) of 2 x 10^{18} erg/s. The motivation for these observations was that the planetary magnetospheric emission is driven by a stellar wind-planetary magnetosphere interaction so that the planetary luminosity would be elevated. Near periastron, HD 80606b might be as much as 3000 times more luminous than Jupiter. Recent transit observations of HD 80606b provide stringent constraints on the planetary mass and radius, and, because of the planet's highly eccentric orbit, its rotation period is likely to be "pseudo-synchronized" to its orbital period, allowing a robust estimate of the former. We are able to make robust estimates of the emission frequency of the planetary magnetospheric emission and find it to be around 60--90 MHz. We compare HD 80606b to other high-eccentricity systems and assess the detection possibilities for both near-term and more distant future systems. Of the known high eccentricity planets, only HD 80606b is likely to be detectable, as HD 20782B b and HD 4113b are both likely to have weaker magnetic field strengths. Both the forthcoming "EVLA low band" system and the Low Frequency Array may be able to improve upon our limits for HD 80606b, and do so at a more optimum frequency. If the low-frequency component of the Square Kilometre Array (SKA-lo) and a future lunar radio array are able to approach their thermal noise limits, they should be able to detect an HD 80606b-like planet, unless the planet's luminosity increases by substantially less than a factor of 3000.

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