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Magnetosphere-ionosphere coupling at Jupiter-like exoplanets with internal plasma sources: implications for detectability of auroral radio emissions

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In this paper we provide the first consideration of magnetosphere-ionosphere coupling at Jupiter-like exoplanets with internal plasma sources such as volcanic moons. We estimate the radio power emitted by such systems under the condition of near-rigid corotation throughout the closed magnetosphere, in order to examine the behaviour of the best candidates for detection with next generation radio telescopes. We thus estimate for different stellar X-ray-UV (XUV) luminosity cases the orbital distances within which the ionospheric Pedersen conductance would be high enough to maintain near-rigid corotation, and we then consider the magnitudes of the large-scale magnetosphere-ionosphere currents flowing within the systems, and the resulting radio powers, at such distances. We also examine the effects of two key system parameters, i.e. the planetary angular velocity and the plasma mass outflow rate from internal sources. In all XUV luminosity cases studied, a significant number of parameter combinations within an order of magnitude of the jovian values are capable of producing emissions observable beyond 1 pc, in most cases requiring exoplanets orbiting at distances between $\sim$1 and 50 AU, and for the higher XUV luminosity cases these observable distances can reach beyond $\sim$50 pc. The implication of these results is that the best candidates for detection of such internally-generated radio emissions are rapidly rotating Jupiter-like exoplanets orbiting stars with high XUV luminosity at orbital distances beyond $\sim$1 AU, and searching for such emissions such may offer a new method of detection of more distant-orbiting exoplanets.