ExPRES: a Tool to Simulate Exoplanetary and Planetary Radio Emissions

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All magnetized planets are known to produce intense non–thermal radio emissions through a mechanism known as Cyclotron Maser Instability (CMI), requiring the presence of accelerated electrons generally arising from magnetospheric current systems. In return, radio emissions are a good probe of these current systems and acceleration processes. The CMI generates highly anisotropic emissions and leads to important visibility effects, which have to be taken into account when interpreting the data. Several studies showed that modeling the radio source anisotropic beaming pattern can reveal a wealth of physical information about the planetary or exoplanetary magnetospheres that produce these emissions. We present a numerical tool, called ExPRES (Exoplanetary and Planetary Radio Emission Simulator), which is able to reproduce the occurrence in time–frequency plane of CMI–generated radio emissions from planetary magnetospheres, exoplanets or star–planet interacting systems. Special attention is given to the computation of the radio emission beaming at and near its source. We explain what physical information about the system can be drawn from such radio observations, and how it is obtained. These information may include the location and dynamics of the radio sources, the type of current system leading to electron acceleration and their energy and, for exoplanetary systems, the magnetic field strength, the orbital period of the emitting body and the rotation period, tilt and offset of the planetary magnetic field. Most of these parameters can be remotely measured only via radio observations. The ExPRES code provides the proper framework of analysis and interpretation for past (Cassini, Voyager, Galileo. . .), current (*Juno*, ground-based radiotelescopes) and future (BepiColombo, Juice) observations of planetary radio emissions, as well as for future detection of radio emissions from exoplanetary systems (or magnetic white dwarf–planet or white dwarf–brown dwarf systems). Our methodology can be easily adapted to simulate specific observations, once effective detection is achieved.

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