Modeling the radio emissions of Jupiter and Saturn

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Jupiter and Saturn share with Earth and the other giant planets the particularity to be intense radio emitters. These radio emissions are linked to the magnetic fields of these planets, which form magnetospheres, and more particularly to the dynamics of the magnetospheres. Any perturbation of the magnetosphere takes the form of a current circulating along the magnetic field lines and closing in the planet ionosphere, generating auroras. Low frequency radio emissions can be considered one of the auroral emissions, although being emitted at much higher altitudes.

Radio emissions are generated through a plasma instability known as the cyclotron maser instability, which consists in the resonance between the electron gyration motion around the magnetic field lines and a polarized wave close to the electron cyclotron frequency. Hence, their frequency can be related to the intensity of the magnetic field in the source and are indirectly related to their altitudes.

The characteristics of the radio emissions, in particular their emission pattern are directly related to the characteristics of the magnetospheric perturbation the power them. Thus, the morphology of the radio emissions in the time-frequency plane carries information about the interaction it originates from, but is also dependent on the local plasma parameters in the source.

The modeling of the radio emissions characteristics depends on many parameters, but is simplified in the case of the Jupiter and Saturn radio emissions since the electron cyclotron frequency is much larger than the plasma frequency in the auroral region, allowing the radio waves to be weakly dependent on the local plasma parameters. In this case, the morphology of the radio emissions is directly related to the characteristics of their parent magnetosphere interaction.

I will present the models that explain the observed characteristics of the auroral radio waves, their application to the Jupiter and Saturn cases, and present the conclusion we can draw from the radio observation about the magnetosphere interactions of these planets.