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Variable opening angle of emission cone of Jovian decameter radiation generated by cyclotron maser instability

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Abstract

A recent study of the Io-controlled Jovian decameter radiation revealed that the radio emission is beamed in a hollow cone which presents a flattening in a specific direction linked to the local magnetic field in the source. We investigate some reasons for the existence of such a flattening. The Jovian decameter radiation, like the other auroral radio emissions emanating from the magnetized planets in the solar system, is known to be produced by the cyclotron maser instability (CMI). This mechanism allows the direct amplification of the waves through a resonant coupling between the electron population of the plasma and the electromagnetic waves with right circular polarization of the X mode. In a medium with axial symmetry, i.e., where $\mathbf{B}$ and ∇B are parallel, this amplification is maximum for a particular value of the emergence angle relatively to the local magnetic field $\mathbf{B}$. We suppose that the plasma is constituted of a cold component which supports the wave propagation and an energetic component which takes part in the growth of the waves by supplying the CMI with free energy. When $\mathbf{B}$ and ∇B are not parallel, the angle corresponding to the maximum amplification is not constant anymore, so that the emission cone does not have any axial symmetry and then presents a flattening; it is the case of the Io-controlled Jovian decameter radiation.