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Are planetary ECMI emissions driven by loss-cone or shell distributions?

Robert Mutel, Donald Gurnett, and John Menietti
University of Iowa, Physics & Astronomy, Iowa City, United States (robert-mutel@uiowa.edu, 319 335 1753)

In all solar system planets with global magnetospheres, the electron cyclotron maser instability (ECMI) generates intense, highly polarized coherent radio emission. It is generated as downward-beamed electrons modify their phase distributions in converging magnetic fields, resulting in $\partial f/\partial v_\perp > 0$ and the creation of X and O-mode radiation near the electron cyclotron frequency. This occurs in exclusively in density-depleted auroral regions, where the condition $\Omega_p/\Omega_c \ll 1$ is satisfied. Many characteristics of the emitted radiation, such as polarization ellipticity, angular beaming pattern, and energy conversion efficiency, depend on the nature of the unstable phase distribution.

Two types of phase distribution that have been invoked to explain ECMI radiation: loss-cone and shell ('horseshoe') distributions. Since these distributions can result in very different emission properties, and hence plasma-physical parameters derived from the observed radiation, it is important to ascertain which distribution is more effective in driving the instability and whether the dominant distribution varies with individual planet. Direct measurements of unstable phase space distributions are difficult because they must be made *in situ* in the source region with very high time-resolution. This has proved difficult: Only at Earth and Saturn are there any direct phase space measurements, and they are often compromised by inadequate time or pitch angle sampling.

We summarize the empirical evidence for and against loss-cone and shell distributions at Earth, Jupiter, and Saturn, based on observed emission properties (polarization, mode, angular beaming). We also examine the ECMI growth rates for a parameterized phase distribution function that varies continually from shell (zero velocity offset) to loss-cone. We find that the shell distribution provides a more robust growth rate, is more consistent with in situ measurements and with emission properties, but that some aspects of the observed radiation e.g., the angular beaming pattern of Jovian decametric emission, may favor a loss-cone distribution.