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An Occam's razor approach to interpreting observed wave modes and polarization in planetary magnetospheres

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Radio emission from planetary magnetospheres manifests a rich variety of temporal, spectral, and polarization structure. In principle, analysis of these wave characteristics can be used to infer physical properties of the plasma, both at the site of generation and along the ray path to the observer. For radiation generated near the electron cyclotron frequency, the cyclotron maser instability (CMI), driven by parallel electron beams in converging magnetic fields, is well-accepted as the dominant generation mechanism. However, there are significant unresolved questions concerning the generation and propagation of individual wave modes and their polarization. In particular, both linear and nonlinear mode coupling and conversion at density boundaries has been invoked to explain the observed modes and polarizations. Recent spacecraft observations of terrestrial AKR (Cluster) and Saturnian SKR (Cassini) within their respective auroral acceleration regions have allowed new insights which may simplify this picture. Based on these observations, a simpler paradigm is emerging, in which L, Z, and X modes are generated at the CMI source region, and that observed intensity and polarization characteristics depend almost entirely on propagation effects between the source region and the spacecraft. We illustrate this scheme with ray-tracing results applied to several sample observations taken from Cluster (WBD) and Cassini (RPWS).