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Simulation of Electromagnetic Ion Cyclotron Triggered Emissions in the Earth's Inner Magnetosphere

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In a recent observation by the Cluster spacecraft, electromagnetic ion cyclotron (EMIC) triggered emissions were discovered in the inner magnetosphere. We perform hybrid simulations to reproduce the EMIC triggered emissions. We develop a self-consistent one-dimensional (1D) hybrid code with a cylindrical geometry of the background magnetic field. We assume a parabolic magnetic field to model the dipole magnetic field in the equatorial region of the inner magnetosphere. Triggering EMIC waves are driven by a left-handed polarized external current assumed at the magnetic equator in the simulation model. Cold proton, helium, and oxygen ions, which form branches of the dispersion relation of the EMIC waves, are uniformly distributed in the simulation space. Energetic protons with a loss cone distribution function are also assumed as resonant particles. We reproduce rising tone emissions in the simulation space, finding a good agreement with the nonlinear wave growth theory. In the energetic proton velocity distribution we find formation of a proton hole, which is assumed in the nonlinear wave growth theory. A substantial amount of the energetic protons are scattered into the loss cone, while some of the resonant protons are accelerated to higher pitch angles, forming a pancake velocity distribution.

Keywords: EMIC wave, Triggered emission, Hybrid simulation, Inner magnetosphere, nonlinear wave growth