Nonlinear generation mechanism of EMIC falling tone emissions

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We have conducted a self-consistent hybrid simulation, successfully reproducing EMIC emissions with falling-tone frequencies. The hybrid simulation is implemented with a parabolic ambient magnetic field. In the simulation, strong oxygen band EMIC emissions are generated through nonlinear wave growth. The cold ion density is modulated by electrostatic structures which are induced by the forward and backward propagating oxygen band EMIC waves. Along with the growth of the oxygen band, the helium band waves also grow because of the linear growth and the nonlinear growth. The nonlinear growth of the helium band waves is affected by the cold plasma density modulation, and there appear short wave packets of helium band emissions. The short wave packets entrap energetic protons efficiently, resulting in electromagnetic proton hills in the velocity phase space. The proton hill forms a nonlinear resonant current causing the falling frequency of the EMIC waves. We find strong deformation of the velocity distribution function of the energetic protons due to the proton hill being guided by the increasing resonance velocity.

