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Chorus waves: a high-gain free-electron laser in the Earth's magnetosphere[1] A. BHATTACHARJEE, R. SOTO-CHAVEZ, Space Science Center, University of New Hampshire — Chorus waves in the magnetosphere are very-low-frequency (VLF) phenomena that arise due to the interaction of gyro-resonant electrons with whistler waves. These waves typically have frequencies equal to half the electron gyro-frequency at the geomagnetic equator, are amplified to amplitudes of more than 30dB, and exhibit a continuous frequency chirp. The study of these waves, and their role in energizing particles, is one of the principal objectives of the upcoming Radiation Belt Storm Probes (RBSP) mission. Here we present a new model of chorus waves based on the high-gain free-electron laser mechanism. We derive a new closed set of self-consistent relativistic equations that couple the Hamiltonian single-particle equations with Maxwell's equations for the radiation field, assuming that the latter is slowly varying. We demonstrate, neglecting slippage between the electrons and the radiation field, that in the exponential high-gain regime, these differential equations yield an exact cubic algebraic equation that predicts whistler wave amplification levels in good agreement with observations. When slippage is included in the theory, the radiation field phase evolves in time, predicting a frequency chirp.

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