Generation Mechanism of Electromagnetic Rising-tone Emissions in the Magnetosphere

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Keywords: nonlinear wave particle interaction, space plasma, radiation belts, particle simulation.

Abstract: The We describe the generation mechanism of electromagnetic waves known as whistler-mode chorus emissions with right-handed polarization and electromagnetic ion cyclotron (EMIC) triggered emissions with left-handed polarization interacting with energetic electrons and protons, respectively, through cyclotron resonance. These waves are frequency observed in the magnetospheres of the magnetized planets such as Earth, Jupiter, and Saturn. They are coherent waves with increasing frequencies generated at the magnetic equator and propagating along the magnetic field. The resonant particles undergo nonlinear trapping motion around the resonance velocity, and they form electromagnetic electron/ion holes in the velocity phase space. In the presence of the inhomogeneity due to the frequency variation and the gradient of the magnetic field, the electron holes or hills result in resonant currents generating rising-tone emissions [1,2,3]. After formation of a coherent wave at a frequency of the maximum linear growth rate, triggering of nonlinear wave growth with the increasing frequency takes place when the wave amplitude is close to the optimum wave amplitude [4,5]. The wave amplitude also has to be greater than the threshold amplitude [2,3] so that the nonlinear wave growth can occur as an absolute instability at the magnetic equator. The triggering process is repeated at progressively higher frequencies, generating subpackets of a rising-tone element. These electromagnetic emissions control the dynamics of radiation belts. Whistler-mode chorus emissions are responsible for acceleration of relativistic electrons [6,7,8], while EMIC triggered emissions induces precipitation of relativistic electrons into the atmosphere through anomalous cyclotron resonance [9,10].

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Omura Y.
Generation Mechanism of Electromagnetic Rising-tone Emissions in the Magnetosphere.
DOI: 10.5220/0005422201210122
In *Proceedings of the Third International Conference on Telecommunications and Remote Sensing (ICTRS 2014)*, pages 121-122
ISBN: 978-989-758-033-8

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