Parametric Interaction of VLF and ELF Waves and Impact on Energetic Electrons in a Radiation Belt

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Different sources for Very Low Frequency (VLF) whistler wave generation including parametric mechanisms of excitation with involvement of Extremely Low Frequency (ELF) waves, Ion Acoustic (IA) waves as well as conventional loop antennas will be analyzed. Whistler waves interact with Radiation Belt (RB) electrons via cyclotron resonance. This interaction leads to enhanced pitch angle diffusion and shifting energetic electrons towards the loss cone. In order for this interaction to be efficient it is necessary to create certain level of finite amplitude VLF electromagnetic whistler waves in the interaction region. In the case of conventional sources a great deal of the source power is radiated not as a whistler wave but as a quasi-electrostatic Low Oblique Resonance (LOR) mode which does not propagate on great distances from the source region. Only a small percentage of the power ~ (3 – 5)% is radiated as the electromagnetic whistler wave. We present new results on parametric interaction of LOR waves with IA waves and ELF waves to demonstrate the possibility to overcome this difficulty. It will be shown that interaction of LOR waves with low frequency waves gives rise to electromagnetic whistler waves on combination frequencies. It is shown in this work that the amplitude of these waves can considerably exceed the amplitude of whistler waves directly excited by a loop source. Additionally, particle-in-cell (PIC) simulations, which demonstrate the excitation and spatial structure of VLF waves excited by conventional and parametric sources will be presented.

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