RECENT RESEARCH ACTIVITIES

Simulations and modeling of geospace environment

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Efficient acceleration of relativistic electrons at Landau resonance with obliquely propagating whistler-mode chorus emissions is confirmed by theory, simulation, and observation. The acceleration is due to the perpendicular component of the wave electric field. We have derived formulae of inhomogeneity factors for Landau and cyclotron resonances to analyze nonlinear wave trapping of energetic electrons by an obliquely propagating chorus element [1]. We conduct test particle simulations to examine the acceleration mechanism of relativistic electrons through interaction with multi-subpacket chorus waves. We develop the wave model with rapidly fluctuating amplitude and phase discontinuities across each subpacket in order to examine how these features of multi-subpacket chorus wave influence the nonlinear trapping processes in efficient acceleration of relativistic electrons such as relativistic turning acceleration (RTA) and ultra-relativistic acceleration (URA) [2]. Applying test particle simulations with a pair of whistler mode chorus emissions, we traced a large number of electrons in various initial conditions along an L = 4.5 magnetic field line to build a set of Green's functions for analyzing evolution of the electron distribution under the chorus emissions propagating obliquely to the magnetic field. Employing convolution integral for the Green's functions, we tracked the formation of relativistic electron fluxes from an injected energetic electron through interaction with consecutive chorus emissions [3].

The pathway of energy from the solar wind to the ionosphere is not fully understood. We performed the global magnetohydrodynamics (MHD) simulation, and showed two pathways. One comes from the solar wind directly, and the other one comes from the solar wind by way of the ionosphere. The field-aligned current (FAC) flowing in the inner magnetosphere is called a Region 2 FAC. The distribution of the Region 2 is shown to depend on altitude [4]. By combing the MHD simulation with the advection simulation, we showed the region where the whistler mode chorus waves can grow nonlinearly. The whistler waves can first grow due to the linear mechanism, followed by rapid, nonlinear mechanism accompanied with rising-tone chorus elements. When the solar wind speed is high, the whistler waves grow more efficiently due to linear and nonlinear mechanisms over a wider area. For slow solar wind, the linear growth is mostly suppressed, but the nonlinear growth can still take place when external seed waves are present [5].

References

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