Landau Resonance Acceleration of MeV Electrons by Obliquely Propagating Whistler-mode Chorus Emissions

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A recent analysis of wave and particle data obtained by the Van Allen Probes [Foster et al., 2017] demonstrates highly efficient acceleration of relativistic electrons by whistler-mode chorus emissions. The analysis identified that the acceleration is mostly due to the cyclotron resonance of relativistic electrons with chorus emissions propagating quasi-parallel to the ambient magnetic field. As the energy of an electron becomes relativistic (1 - 2 MeV), the parallel resonance velocity approaches zero near the equator, where nonlinear trapping of resonant electrons becomes possible, resulting in relativistic turning acceleration [Omura et al., 2007]. The detailed subpacket analysis shows that there arises a parallel wave electric field that can trap energetic electrons through Landau resonance. A recent test particle simulation [Hsieh and Omura, 2017], however, shows that the perpendicular wave electric field can also play a significant role in trapping and accelerating relativistic electrons through Landau resonance. We present a theoretical analysis of the Landau resonance acceleration, and verify it by the subpacket analysis of chorus emissions observed by Van Allen Probes. We compare the efficiencies of accelerations by the cyclotron resonance and the Landau resonance.

References:

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