地球磁気圏サブパケットコーラス波によるサイクロトロン共鳴電子加速過程

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Dynamics of energetic electrons interacting with sub-packet chorus emissionsin the magnetosphere

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The recent study has revealed RTA and URA processes, the acceleration of relativistic electrons by interaction with chorus emissions. The wave model, however, is found to require some updates based on the recent observations. We develop a new wave model compatible with the observations and study the particle motion under the influence of this new wave model. The most distinctive feature of the new model is its amplitude growth manner. The wave is excited near the equator and grows in amplitude as an absolute instability as a function of time. This amplitude growth is bounded by the optimum and threshold amplitudes. When the amplitude grows to reach the optimum amplitude, it drops down to the threshold value and repeats the growth with a saw-like shape defined as sub-packet wave. The sub-packet wave generated near the equator experiences the convective amplitude growth propagating to the higher latitude region. Since the group velocity of the wave propagation is a function of its frequency, a wave source generated and released from the equator at a certain time and a group velocity could be overtaken by another wave released at a later timing and hence a faster group velocity. Furthermore, the chorus wave propagation is also strongly influenced by the initial frequency of its generation process near the equator. Since the group velocity grows to the maximum when the wave frequency is a quarter of the local gyrofrequency, fce, a chorus wave generated at a lower initial frequency than one fourth of fce is compressed during the propagation process. This is because frequency of chorus wave is increased at the equator and consequently a wave generated at a later timing has a closer frequency to one fourth of fce to propagate faster than those waves released at earlier timings. By the same logic, chorus wave with a higher initial frequency than one fourth of fce is elongated during the propagation by getting the frequency away from one fourth of fce and hence slowing down the propagation speed as time passes. In sub-packet case, this frequency value is further affected by the sub-packet amplitude wave form to make the process more complex. Into this new wave form, energetic electrons are inserted and their motions are examined. For example, a resonant electron can be entrapped by the wave, being accelerated and normally detrapped after a certain period of time, but there can be a possibility that the following sub-packet wave in a complex propagation manner coincidently entraps the electron to provide multiple accelerations. We injected a large number of electrons over a wide energy range from 10keV to 10MeV into the sub-packet wave to simulate the nonlinear dynamics of RTA and URA. The electrons motion or more precisely entrapping and detrapping processes are examined under various conditions.