木星磁気圏での相対論的プロトンとEMIC波の相互作用に関するテスト粒子シミュレーション

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Test particle simulation of relativistic protons interacting with EMIC waves in Jovian magnetosphere

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We perform a test particle simulation of interaction between relativistic protons and a coherent EMIC wave. The Earth's magnetic field cannot trap highly energetic protons above few GeV. On the other hand, in the Jovian magnetic field relativistic protons can be trapped. Assuming parameters of the Jovian magnetosphere, we find very efficient proton acceleration process by the EMIC wave. In the process of acceleration, the Lorenz factor is increased and changes the resonance condition. Hence, parallel motion of resonant protons changes from opposite direction to the same direction of wave propagation. This process results in longer resonance time than that in nonrelativistic case. We construct the nonlinear interaction theory between relativistic protons and coherent EMIC waves, and confirm that this process is the same as the Relativistic Turning Acceleration process of electrons interacting with whistler mode waves [1]. We also find that almost all protons can be trapped by EMIC waves regardless of their initial gyrophases. We analyze this phenomenon, and confirm it is due to the same scattering at low pitch angles as observed in electron-chorus interaction [2]. From these results, we find that a large portion of protons with low pitch angles can experience RTA and some of them can attain the maximum energy as large as 9 GeV.