惑星間空間衝撃波到来時における内部磁気圏イオンダイナミクスのエネルギー、ピッチ角依存性

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Energy and pitch angle dependence of impact of interplanetary shock on ions in the inner magnetosphere

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Cluster satellite observations have shown that, soon after arrival of the interplanetary (IP) shock, overall intensity of trapped ions rapidly increases and multiple energy dispersion appears in an energy-time spectrogram of ions with small equatorial pitch angles [Zong et al., 2012]. This is because IP shock redistributes the charged particles trapped in the inner magnetosphere and has a large impact on magnetosphereic ions. However, the acceleration and transport of ions with all pitch angles is not well understood. In order to investigate the impact on the trapped ions and its dependence on the pitch angle, we have performed test particle simulation under the electric and magnetic fields provided by the magnetohydrodynamics (MHD) simulation. In MHD simulation, we changed the solar wind speed (372 to 500 km/s) in order to reproduce the IP shock. The number density in the solar wind was set to a constant to be 5 cm-3, and the Z component of the interplanetary magnetic field (IMF) was turned from +5 to -5 nT. A fast mode wave propagates tailward in the magnetosphere just after arrival shock. The amplitude of the electric field exceeds 20 mV/m. To reconstruct an energy-time spectrogram of the oxygen ions at (7,0,0) Re in the GSM coordinates, we started to trace trajectories of ions the backward in time starting at (7,0,0) Re just after arrival of the fast mode wave.

Knowing initial and final positions in 6D space, we mapped phase space density f by using Liouvilles theorem.

The phase space density f before the arrival shock is assumed to be isotropic Maxwellian. The result shows that a multiple energy-time dispersion appears in the simulated spectrogram of the ions with small equatorial pitch angles. However, the multiple energy-time dispersion is not present in the spectrogram of the ions with equatorial pitch angle of 90 deg. The result of our simulation is consistent with the Cluster satellite observations. There are two types of the acceleration process. One is drift betatron acceleration, and the other is gyro betatron acceleration. We will discuss the acceleration process that generates the multiple dispersion effectively.