磁気圏尾部における磁気再結合のＭＨＤ的特徴

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MHD Features of Magnetic Reconnection in the Tail

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Magnetic reconnection is an important mechanism to energize and carry the plasma toward the earth as well as toward the distant tail in the magnetosphere. When the IMF turns from northward to southward, drastic expansion phase happens in the magnetosphere 40-60 minutes later through pre-growth and growth phases. The expansion phase corresponding to sudden increases of the plasma pressure and plasma flow in the plasma sheet is initiated by onset of near-earth tail reconnection in the global MHD simulation of interaction between the solar wind and the magnetosphere.

The tail reconnection must be important as an energization mechanism for the plasma sheet plasma through formation of the slow shock structure, however the precess is not clear on the earth side of the near-earth neutral line (NENL). In particular, the onset of expansion phase starts 6-8 minutes later after the Bz component becomes negative in a small region for the first time. What happens in the interval?. We have studied behaviors of tail reconnection in detail by using a high resolution 3-dimensional global MHD simulation of interaction between the solar wind and the magnetosphere.

In the interval between the onset of tail reconnection and that of expansion phase, the tail reconnection proceeds for the closed field lines in the tail. When the last closed field lines are suffered the tail reconnection, the expansion onset suddenly starts to generate strong plasma flows and to increase temperature on both sides of NENL in the plasma sheet. When we look at time variations of the earthward and tailward flows and plasma temperature, we can clearly identify the interval of growth phase and the interval of expansion phase for about 2 minutes.

The plasma temperature enhances about 5 times even on the earth side of NENL, which imply formation of the slow shock structure there. The maximum earthward flow is about 600 km/s and that of the plasma temperature is 1 KeV in the present simulation and this occurs because of the small grid size of 0.15 Re and allowance of low plasma density. This results suggest much faster plasma flow and higher temperature if we could allow lower plasma density. After the expansion phase, Bz component increases at the geosynchronous distance in the tail by earthward transport of magnetic flux. When we look at spatial distributions of the plasma density, pressure, temperature and kinetic energy, and also the kinetic, internal and Poynting vector energy fluxes, it is noted that the kinetic energy quickly converts quickly to internal plasma energy then Poynting flux. Therefore, it need not to find always the strong kinetic energy and flux on the earth side of NENL.