The Effects of the IMF Bx Component on Magnetic Reconnection in the Earth""s Magnetosphere

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1. Introduction: The solar wind and the magnetic field lines have a characteristic structure known as Parker spiral and the angle between the spiral and the concentric circle becomes 45 degrees at the position of the earth. Therefore, in such a case the IMF (Interplanetary Magnetic Field) Bx component as well as the other IMF components can usually exist and might play an important role on the earth""s magnetosphere.

There have been found several dawn-dusk asymmetric phenomena from satellite observations, which are difficult to be explained from the effect of IMF By component. They are the magnetosheath flow, characteristics of the magnetopause magnetic field and location of the substorm onset in the magnetotail. The strong earthward plasma flow, which may be associated with the substorm onset, has a tendency to more often appear on the dusk side in the tail.We have studied the effects of the IMF Bx component on magnetospheric structure and dynamics due to the Parker spiral by using a 3-dimensional global MHD simulation of interaction between the solar wind and the earth""s magnetosphere.

2. Simulation Model: We have used a 3-dimensional global MHD simulation of the interaction between the solar wind and the magnetosphere. In the upstream solar wind, we assumed that the IMF field lines are in the plane of the Parker spiral which is inclined by 45 degrees to the y-z plane. The parameters in the simulation are as follows: the number density of the solar wind is 5/cc, velocity 300 km/s, temperature 20,000K and the IMF Bx=By, Bz=0 or+ Bx, -Bx and the magnitude is B=5-50 nT. In such a case the sound Much number, Ms=Vsw/Vth=4.04, the Alfven Much number Ma=Vsw/Val=2.05 and the Much number of fast magnetosonic wave, M=Vsw/Vfms=1.83 for B=15 nT, Bx=By and Bz=0 in the upstream solar wind.

3. Simulation Results: We found that including an IMF Bx component in the simulation creates transient phenomenon with dawn-dusk and north-south asymmetry in the earth""s magnetosphere and that the asymmetric structure is maintained even when the magnetosphere reaches a quasi-steady state. The asymmetries persist when Bx is small. The asymmetric structure in the magnetosheath and magnetosphere is enhanced when the IMF is large and the Alfven Mach number becomes small (less than 2).

4. Discussion and Summary: Since the IMF grows at the expense of the flow across the bow shock, the flow is easily influenced by the IMF asymmetry in the magnetosheath. An asymmetric configuration appears in the magnetosphere and this tendency is enhanced for strong IMF. For non-zero IMF Bx component, magnetic reconnection occurs in different manners on the dawn and dusk sides. The IMF lines on the dusk side are more straight to increase the magnetic pressure and strongly compress the plasma sheet. On the other hand, the IMF lines on the dawn side are bent sharply to decrease the magnetic pressure in tail lobes and less compress the plasma sheet. This tendency is largely enhanced for smaller Alfven Mach number. This dawn-dusk asymmetric occurrence of dayside reconnection and induced magnetospheric convection become main causes to create inclination of plasma sheet, up and down of plasma sheet, rotation magnetotail and also asymmetric plasma flows in the tail. As the results, tail reconnection favorably occurs in dusk side due to the effects of the IMF Bx component namely, the Parker spiral effect.