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Plasma instabilities and vortex turbulence in boundary layers of earth's magnetosphere

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One of important problems in plasma physics is to understand anomalous transport. Can the anomalous transport be understood only by coupling between macro-scale and micro-scale phenomena? Do meso-scale phenomena really play important roles in the anomalous transport? Plasma, momentum and energy are often transported from the solar wind into the earth' smagnetosphere with very high efficiency through narrow boundary layers where physicalquantities changes sharply. In particular magnetopause and plasma sheet are known as typical boundary layers to generate large amplitude fluctuations in association with the anomalous transport.

For southward IMF, magnetic reconnection occurs in the dayside magnetopause and plasma sheet, and the processes are most dominant in solar wind-magnetosphere interaction. However, magnetic reconnection is not sufficiently understood as transport processes. For northward IMF, Kelvin-Helmholtz instability can be excited due to velocity shear at magnetopause and there are several observations reported periodic wavy phenomena which come from the instability. Moreover, local simulations clearly show the vortex formation from the instability. However, there is no clear global simulation to show occurrence of the instability for northward IMF condition. On the other hand, several global simulations show wavy phenomena and vortex formation during southward IMF. Thus it is needed to study relationship between magnetic reconnection and Kelvin-Helmholtz instability.

Therefore, we have studied plasma instabilities and their nonlinear evolution in boundary layers of the earth's magnetosphere by using a high-resolution and three-dimensional global MHD simulation of interaction between the solar wind and earth's magnetosphere. For southward IMF, filamentary and streamer structure is formed in the plasma sheet due to patchy and intermittent reconnection. Moreover, irregular vortex train appears at the dayside magnetopause. On the other hand, Kelvin-Helmholtz instability is excited to generate wavy train or vortex train rolled up in the low latitude boundary layer for northward IMF. Relationship between the vortex train and high latitude reconnection is discussed and energy transport processes are also examined.

Keywords: solar wind-magnetosphere interaction, plasma instabilities, nonlinear evolution, magnetic reconnection, Kelvin-Helmholtz instability, vortex turbulence in boundary layers