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Particle acceleration in magnetic reconnection: Observation in the Earth's magnetotail and particle simulation resluts

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Magnetic reconnection has been considered as one of the most important agents for producing energetic particles in various environments in space such as the pulsar magnetosphere, the solar corona, and the Earth's magnetosphere, since it rapidly converts the magnetic field energy into the plasma energy. The Earth's magnetosphere, where abundant and precise information on both fields and plasmas is available from in-situ observations, gives important clues to understand nonthermal particle acceleration in magnetic reconnection. Recent spacecraft observations as well as particle simulations have revealed detailed electron acceleration processes in the Earth's magnetotail [e.g., Imada et al., 2005; Hoshino, 2005]. However the ion acceleration in magnetic reconnection still remains to be poorly understood in both observational and theoretical studies.

We first report on the observations of nonthermal particles accelerated in magnetic reconnection in the Earth's magnetotail. Nonthermal protons accelerated up to several hundreds keV exhibit a power-law energy spectrum with typical spectrum index 3-5. By conducting a statistical study on reconnection events in the Earth's magnetotail, we found efficient ion acceleration when the reconnection electric field is strong. On the other hand, the statistical study indicates that the efficiency of electron acceleration is rather controlled by the thickness of the reconnection current sheet. We also present particle simulation results of driven reconnection, which has been performed in order to investigate in detail acceleration mechanisms of both ions and electrons.

Keywords: magnetic reconnection, particle acceleration, nonthermal ions, Earth's magnetotail, particle simulation