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Difference between active X-line and ordinary flow reversals in magnetotail

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Geotail observation over 20 years in magnetotail provides us with about 200 rapid flow reversal events where tailward flow (< -500 km/s) turns to earthward flow (> +300 km/s) within 10 minutes. Events when stationary plasma and/or tail lobe components are observed at the timing of flow reversals are removed to study the physics of X-line, and then we get 46 definite flow reversal events. Nagai et al. (2013) proposed that Vey < -1000 km/s is an important criterion to select "active" X-lines. As a result, we get 30 "active" X-line crossing events. "Active" X-line events show electron acceleration during flow reversals and existence of ion-electron decoupling region. These features are consistent with the collisionless reconnection model demonstrated by recent full kinetic numerical simulations. In contrast, other 16 flow reversal events do not present any of them. No visible ion-electron decoupling is found in these "ordinary" flow reversal events. However, it is a visual inspection since electron velocity is less accurate than ion moments. In order to evaluate the difference between "active" X-line events and "ordinary" flow reversal events, we have done a statistical survey of the wave activity around flow reversal events. We found that the wave activity in the electric field shows that only the X-line events are accompanied by strong wave activities, backing-up the validity of the event separation scheme, while no wave activity is found in "ordinary" flow reversal events. This new finding indicates that the strong wave activity in the electric field would be related to the ion-electron decoupling process and that wave activity is a possible indicator for liveliness of reconnection (= evidence of fast electron flow). In this presentation, we will discuss physical meaning of the difference between "active" X-line and "ordinary" flow reversal events.