Space Weather Lecture 6: Interaction with Interplanetary Magnetic Field and Reconnection



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3D View	©The COMET Program

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Reconnection in the magnetotail



Reconnection

Brekke 2013



Reconnection

Brekke 2013



Reconnection



Sweet-Parker theory (1956-1958): reconnection occurs in the diffusion region via small-scale physics (resistive MHD) Petscheck theory (1964): diffusion region has been shrunk to a dot, acceleration at slow shocks

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Challenge: What physics can produce necessary electric fields to accelerate plasma?

Vasyliunas 1975



Observations by Magnetospheric Multiscale (MMS) mission





MMS trajectories: separation between spacecraft 10 km



Electron-scale measurements of magnetic reconnection

- Left side: electrons with velocities from 0 to 10⁴ km/s carrying current out of the drawing plane
- Right side: electrons flowing upward and downward along the reconnected magnetic field



Two magnetopause crossings of MMS2



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Reconnection in the magnetotail: Earth and Jupiter



X-line formation





- X-line formation is one of the key signatures of the reconnection
- A change of the flow direction is often observed during the energy release phase

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IMF northward: Reconnection at high latitudes



Nykyri+11

Reconnection: IMF with dawn-dusk component



Trattner+07

Reconnection: IMF with dawn-dusk component

Location of the reconnection at different IMF directions



Summary

- The IMF strongly influences the dynamics of the magnetosphere.
- Reconnection is a commonplace transformation process of magnetic energy to particle energy in plasmas.
- It changes the magnetic field topology and accelerates particles.
- It can be observed at the Sun, in the solar wind, in the magnetospheres of various planets, in Tokamaks...
- It leads to spectacular phenomena such as solar flares, CMEs, auroras...
 Some Settings Where Reconnection Occurs



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