Geophysical Research Abstracts
Vol. 21, EGU2019-18226-1, 2019
EGU General Assembly 2019

Magnetic Reconnection and Turbulence: Triggers, Coherent Structures, Phenomenologies

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For thin current sheets of length L (assumed to be of the same order as the macroscopic length scale of the system), the specific dependence of the inverse aspect ratio a/L on the Lundquist number S determines when a reconnection instability becomes fast or “ideal”, where by the latter term it is implied that the growth rate no longer depends explicitly on the Lundquist number. The latter is typically a plasmoid instability, in the sense that it leads to the disruption of the sheet into a number of islands. A number of phenomenologies have been developed describing how naturally forming current sheets in a turbulent cascade will alter the cascade phenomenology once a similar criterion is established, where a coherent structure instability time-scale becomes competitive with the nonlinear cascade time. On the other hand, the stability of simple current sheet equilibria is dramatically dependent on the details of the current profiles, the magnetic field structure, and the nature of the surrounding flows. Here we provide a critical discussion of phenomenologies and provide new insights into the interplay of turbulence and reconnection via numerical simulations and modeling.