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Title: *Topological Complexity in 3D Magnetic Reconnection*

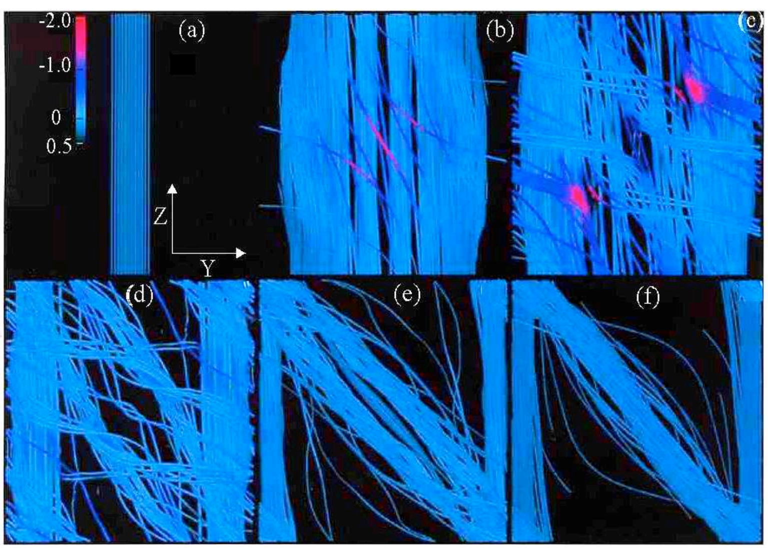
Cluster: *Cross-Theme Theory and Data Analysis/SECTP*

Principle Investigator: *S. Antiochus/NRL*

- **Field Line Tangling Discovered in 3D Magnetic Reconnection**

Magnetic reconnection in three dimensions is commonly believed to be the physical mechanism that heats the solar corona, heats and accelerates plasma in solar flares, and launches coronal mass ejections. Much has been learned about how reconnection works from 2-dimensional studies, but these are limited in that they generally focus on small-scale dynamics in the immediate neighborhood of a reconnection region. The NRL SEC Theory group has now developed the 3-D modeling capability for advanced global, 3-dimensional magnetic field studies to show how local reconnection regions connect to the larger scale. A recent analysis demonstrates how 2 colliding magnetic flux tubes can have multiple reconnection events develop with a consequent evolution of many small-scale twisted flux tube structures into a larger-scale unit. This new modeling is a necessary key for understanding solar magnetic field merging and how it modulates the energy released from the corona. This result has the obvious practical importance of providing an understanding of solar energy ejection processes, that, when coupled with NASA spacecraft Sun and solar wind observations, is needed for predicting Space Weather impacts on our near-Earth terrestrial environment.

Example of 3-D Magnetic Field Merging Process



(a) Two transverse magnetic flux tubes collide – the flux tube aligned along the Y direction is not shown in order to clearly see the reconnection structures. (b) Flux tubes flatten and sheet unstably splits into pieces, with several reconnections. (Color indicates field-aligned current. Reconnection occurs where the current, i.e., magnetic shear is high), (c)-(d) Twisted flux tubes develop, storing energy that is slowly released in corona. (e)-(f) Flux tubes merge into a single tube.

Reference: Linton, M.G., and Priest, E.R. 2003, Three-Dimensional Reconnection of Untwisted Magnetic Flux Tubes, **The Astrophysical Journal**, **595**, 1259-1276. 2003.