A first look at reconnection in three dimensions

Swarthmore physicists perform the first fully 3D measurements of reconnection in merging spheromak experiments.

Magnetic reconnection is the process by which magnetic energy in a plasma is rapidly converted to heat and jets of energetic particles. The physical picture is of two strands of magnetized plasma with oppositely directed magnetic field merging together. Magnetic reconnection is thought to heat the solar corona is to temperatures 1000 times greater than the solar surface, as well as to accelerate particles to high energies, possibly even to cosmic ray energies. Magnetic reconnection is also an important process in the formation of some magnetic confinement fusion configurations. Until recently, this process has been studied only in two dimensions (theoretically, computationally, and experimentally). Physicists at the Swarthmore Spheromak Experiment (SSX) at Swarthmore College have reported the first fully three dimensional measurements of magnetic reconnection in the laboratory. SSX merges rings of magnetized plasma called spheromaks. The diagnostic set at SSX features the capability of measuring up to 600 magnetic field components more than a million times a second, which permits detailed studies of the dynamic 3D magnetic structures resulting from these experiments. With a compact array of probes, the merging reconnection studies reveal a swept and sheared magnetic structure in the reconnection region (see Figure). A distributed probe array for global magnetic structure measurements is used for complete merging experiments. Complete merging results in formation of an elongated object called a field reversed configuration (FRC) which persists for many Alfvén times before exhibiting an instablility growing much more slowly than the ideal rate. Studies at SSX hope to reveal fundamental plasma physics processes at work on the sun as well as understanding new structures for magnetic confinement fusion.

Please see invited talk UI1.001.

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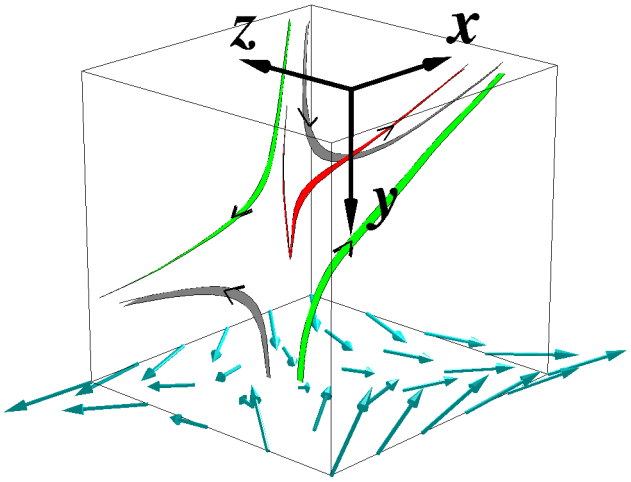

The bottom plane of magnetic field vectors represent just 15% of the data taken at SSX every millionth of a second during the reconnection of two partially merging spheromaks. The green and gray field lines represent private and reconnected field lines, respectively, and lie on a smooth surface. The interior of the reconnection region, however, shows a distinctly three-dimensional character: the red reconnected field line crosses normal to the reconnection plane, indicating a component of the magnetic field in the direction of the reconnection electric field.