Learning the magnetic ropes

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At the Sun's edge, in a region called the heliosphere, magnetic fields and electrical currents align and twist themselves in massive three-dimensional structures called "magnetic flux ropes." As these ropes kink, they become twisted and unstable.

Occasionally, one of the rope's ends--which was previously "tied" to the Sun's surface--breaks loose, ejecting electrically charged gas, or plasma, and producing solar flares that can wreak havoc with everything from satellites to electrical power grids. Once only observed remotely, flux ropes are now being created in the laboratory, making it possible to tie experimental data to prior theoretical analyses.

In a recent *Physical Review Letters* paper, members of the Los Alamos Relaxation Scaling Experiment, describe their studies of these bench-top flux ropes. These studies of the magnetic structure of kinking, rotating, and coalescing flux ropes have shown that having a free rope end and a fluid flow along the length of the flux rope substantially reduces the electrical current required to drive a property known as kink stability and induces rotation of the helically unstable flux rope.

According to Tom Intrator, principal investigator for the Relaxation Scaling Experiment, "Because past models of the Sun's coronal field have been based principally on remote observations, this work is valuable as a close-up study of the dynamical behavior of flux ropes. Understanding how the coexistence and alignment of magnetic fields and currents work in flux ropes is an important step in understanding the effects of flux ropes in everything from the Earth's magnetosphere to incredibly distant and huge astrophysical jets."

The Relaxation Scaling Experiment uses a small plasma gun in a vacuum to produce unstable flux ropes in the form of plasma-current filaments, like flexible wires composed of plasma. These "mini ropes" are then photographed and studied with probe measurements as they wind helically around an imaginary central axis. The experimental system provides a relatively simple means for systematically characterizing the evolution of these short-lived rope structures.

In addition to Intrator, the Relaxation Scaling Experiment team includes Ivo Furno, Leonid Dorf, T. Madziwa-Nussinov, Xuan Sun, and Giovanni Lapenta from Los Alamos, and Dmitri Ryutov from Lawrence Livermore National Laboratory. At Los Alamos, the experiment is supported by Laboratory-Directed Research and Development funding.

Source: Los Alamos National Laboratory