DPP16-2016-001579

Abstract for an Invited Paper
for the DPP16 Meeting of
the American Physical Society

Helicity Transformation under the Collision and Merging of Magnetic Flux Ropes[1]

TIMOTHY DEHAAS, University of California, Los Angeles

A magnetic flux rope is a tube-like, current carrying plasma embedded in an external magnetic field. The magnetic field lines resemble threads in a rope, which vary in pitch according to radius. Flux ropes are ubiquitous in astrophysical plasmas, and bundles of these structures play an important role in the dynamics of the space environment. They are observed in the solar atmosphere [1] and near-earth environment [2] where they are seen to twist, merge, tear, and writhe. In this MHD context, their global dynamics are bound by rules of magnetic helicity conservation, unless, under a non-ideal process, helicity is transformed through magnetic reconnection, turbulence, or localized instabilities. These processes are tested under experimental conditions in the Large Plasma Device (LAPD). The device is a twenty-meter long, one-meter diameter, cylindrical vacuum vessel designed to generate a highly reproducible, magnetized plasma. Reliable shot-to-shot repetition of plasma parameters and over four hundred diagnostic ports enable the collection of volumetric datasets (measurements of n_e, T_e, V_p, $\mathbf{B}$, $\mathbf{J}$, $\mathbf{E}$, $\mathbf{u_{flow}}$) as two kink-unstable flux ropes form, move, collide, and merge. Similar experiments on the LAPD have utilized these volumetric datasets, visualizing magnetic reconnection through a topological quasi-separatrix layer, or QSL [3]. This QSL is shown to be spatially coincident with the reconnection rate [4], $\int E \cdot dl$, and oscillates (although out of phase) with global helicity. Magnetic helicity is observed to have a negative sign and its counterpart, cross helicity, a positive one. These quantities oscillate 8% peak-to-peak, and the changes in helicity are visualized as 1) the transport of helicity ($\phi B + E \times A$) and 2) the dissipation of the helicity $-2E \cdot B$. [1] J. W. Cirtain, *et al.* Nature 493, 501–503 (2013). [2] P.D. Henderson, *et al.* Ann. Geophys., 24, 651 (2006) [3] W. Gekelman, *et al.* ApJ, 753:131, (2012) [4] W. Gekelmen, *et al.* Phys. Rev. Lett. 116, 235101 (2016)

[1]This work is supported by LANL-UC research grant and done at the Basic Plasma Science Facility, which is funded by DOE and NSF.