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Experimental Study of Equilibrium and Stability of Partial Toroidal Plasma Discharges

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We present detailed laboratory studies of stability and equilibrium characteristics of partially toroidal flux ropes which we consider relevant to solar coronal activities. At the existing Magnetic Reconnection Experiment Facility (MRX [1]) a set of electrodes are inserted to generate a variety of plasma flux ropes which contain variable toroidal guide field. Three dimensional evolution of the simulated flares is monitored by an ultra fast framing camera and magnetic structures of the flux ropes are monitored by a variety of magnetic probes on Alfven time scales. The time evolution of discharges with Argon, Helium and Hydrogen with peak currents of 10-30 kA show the stability condition for line-tied plasma flux ropes. The q value, which describes the rotational transform of field lines, is the key for characterizing the global stability. The stability condition is found to be the same as Kruskal-Shafranov limit for the external kink mode with the modified line -tied boundary condition. This limit is verified for various plasma lengths. Flux ropes maintain their equilibrium for time scales much longer than the Alfven time even in the absence of a strapping field. Internal relaxation of flux ropes are observed even after the flux rope stabilizes to the external kink mode. The basic features of this internal relaxation events will also be presented.

[1] E. Oz et al submitted to PRL 2010. In collaboration with M. Yamada, H. Ji, R. Kulsrud, C. E. Myers, and J. Xie.