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Kinking and merging of flux ropes in the Relaxation Scaling Experiment[1]

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In solar, space, laboratory and astrophysics, magnetic fields and currents coexist, and frequently align and twist themselves into current ropes, and form the building blocks of magnetohydrodynamics (MHD). Their relaxation is bound up with the dynamics, which is omitted from the Taylor relaxation picture. For instance, magnetic fields and currents on the Sun are sheared and twisted as they store energy, experience instability, open into interplanetary space, eject the plasma trapped in them, and cause a flare. At LANL, the Relaxation Scaling Experiment (RSX) provides a simple means to systematically characterize the linear and non-linear evolution of driven, dissipative, unstable plasma-current filaments. The topology evolves in three dimensions, supports multiple modes, and can bifurcate to quasi-helical equilibria. We observe saturation to a helical state that is a candidate for a general relaxation process. We characterize experimentally magnetic structure of a kinking, rotating and merging flux ropes. We show that non line tied flux ropes are more unstable than line tied ones, i.e. at half the Kruskal-Shafranov threshold for J/B, and sketch a theoretical model for this.

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