Stabilization of a classically-unstable current-carrying magnetic flux tube by helical flows

S. You, J. von der Linden, E. S. Lavine, E. Carroll, A. Card, M. Azuara-Rosales

University of Washington, Seattle, WA 98195, USA

e-mail: syou@aa.washington.edu

Current-carrying magnetic flux tubes and Z-pinches are classically unstable to low order modes, but this analysis rests on static configurations without the presence of flows and flow shear. Experiments have confirmed the theoretical prediction that Z-pinches would be stabilized by flow shears and have observed kinks in flux ropes that would saturate in the presence of flows. The recent Mochi.LabJet experiment has produced straight, collimated current-carrying magnetic flux tubes over 1 m long classically kink unstable but, with helical shear flows, are stable over many Alfvén times. The experiment is designed to observe the interaction between flows and magnetic fields within a new theoretical framework of relative canonical helicty transport. The theory generalizes helicity transport to kinetic and relativistic regimes, and suggests that magnetic helicity can be converted to flow helicities in large current-carrying magnetic flux tubes with flat density profiles or in steep density gradients such as the edges of toroidal magnetic configurations.