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Dynamics of Plasma Jets and Bubbles Launched into a Transverse Background Magnetic Field[1]

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A coaxial magnetized plasma gun has been utilized to launch both plasma jets (open B-field) and plasma bubbles (closed B-field) into a transverse background magnetic field in the HelCat (Helicon-Cathode) linear device at the University of New Mexico [1]. These situations may have bearing on fusion plasmas (e.g. plasma injection for tokamak fueling, ELM pacing, or disruption mitigation) and astrophysical settings (e.g. astrophysical jet stability, coronal mass ejections, etc.). The magnetic Reynolds number of the gun plasma is ~ 100, so that magnetic advection dominates over magnetic diffusion. The gun plasma ram pressure, $\rho_{jet}V_{jet}^2 > B_0^2/2\mu_0$, the background magnetic pressure, so that the jet or bubble can easily penetrate the background B-field, B_0. When the gun axial B-field is weak compared to the gun azimuthal field, a current-driven jet is formed with a global helical magnetic configuration. Applying the transverse background magnetic field, it is observed that the $n = 1$ kink mode is stabilized, while magnetic probe measurements show contrarily that the safety factor q(a) drops below unity. At the same time, a sheared axial jet velocity is measured. We conclude that the tension force arising from increasing curvature of the background magnetic field induces the measured sheared flow gradient above the theoretical kink-stabilization threshold [2], resulting in the emergent kink stabilization of the injected plasma jet. In the case of injected bubbles, spheromak-like plasma formation is verified. However, when the spheromak plasma propagates into the transverse background magnetic field, the typical self-closed global symmetry magnetic configuration does not hold any more. In the region where the bubble toroidal field opposed the background B-field, the magneto-Rayleigh-Taylor (MRT) instability has been observed. Details of the experiment setup, diagnostics, experimental results and theoretical analysis will be presented.

∗ This work performed in collaboration with D. Fisher, A. G. Lynn, M Gilmore, and S. C. Hsu.

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[1] M. Gilmore et al., J. Plasma Phys. 81, 345810104 (2015).

[2] U Shumlak et al., Phys. Rev. Lett. 75(18):3285 (1995).

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