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**Experimental Optimization of High Magnetic Reynolds Number, Two-Vortex Flows on the Madison Plasma Dynamo Experiment**

DAVID WEISBERG, CHRISTOPHER COOPER, MIKE CLARK, KEN FLANAGAN, IVAN KHALZOV, JASON MILHONE, MARK NORNBERG, JOHN WALLACE, CARY FOREST, Univ of Wisconsin, Madison — Laminar counter-rotating two-vortex flows, predicted to excite a large-scale dynamo, are generated and optimized in the Madison plasma dynamo experiment (MPDX). Numerical simulations show that the topology of these simply-connected flows may be optimal for creating a plasma dynamo in the lab and predict a critical threshold of $Rm_{crit} = \mu_0 \sigma L V = 250$ for optimal flows. MPDX plasmas are shown to exceed this critical $Rm$, generating large ($L = 1.4\,\mathrm{m}$), hot ($T_e > 10\,\mathrm{eV}$) plasmas where $Rm = 600$. Plasma flow is driven using eight thermally emissive $LaB_6$ cathodes which generate a $J \times B$ torque at the magnetized edge of spherical He plasmas. Mach probe measurements show counter-rotating flows at speeds of $V > 10\,\mathrm{km/s}$; the driven flow at the plasma edge viscously couples inward to the unmagnetized core via ion-ion collisions, and flow measurements along radial chords compare favorably to hydrodynamic calculations using Braginskii viscosity. To optimize flow for dynamo generation, cathode bias and positioning are varied along with plasma viscosity ($\nu \sim T_i^{5/2}/n_i$) and the frictional neutral-ion drag force ($\mu = L^2/(\nu \tau_{in})$). Prospects for observing a dynamo, hydrodynamic transitions to turbulence, and eventual large Rm fast dynamos will be presented.

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