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The importance of mass injection boundary conditions for spheromaks, astrophysical jets, and solar coronal loops[1] PAUL BELLAN, Caltech — Spheromak formation physics, astrophysical jets, and solar coronal loops all involve electric current flow from a bounding surface (electrode) into an open magnetic flux tube. This current creates an azimuthal magnetic field that twists up the flux tube, i.e., magnetic helicity is injected. Because this process involves injection of azimuthal magnetic flux and because plasma is frozen to magnetic flux, there must be an associated mass flux from the boundary into the flux tube. This required mass source at the boundary is provided by gas puffing in our experiments. MHD forces accelerate mass into the flux tube resulting in an Alfvenic jet [1]. Axial compression of the azimuthal flux frozen into the jet frame pinches the jet and collimates it. The velocity, density, and magnetic profile of experimentally observed collimated jets depend on the ingested mass flux, the normal magnetic flux, and the current. Paschen breakdown constraints impose an undesirable lower bound for the mass flux in our existing experiments. Consideration is being given to pre-ionization schemes inside the gas injection nozzles to overcome the Paschen constraint and so enable access to regimes having lower densities, faster jets, and hotter plasmas.

[1] D. Kumar and P. M. Bellan, submitted for publication

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