DPP13-2013-000152

Abstract for an Invited Paper
for the DPP13 Meeting of
the American Physical Society

The impact of Hall physics on magnetized high energy density plasma jets[1]

PIERRE-ALEXANDRE GOURDAIN, Cornell University

Magnetized high energy density (HED) plasma jets produced by radial foil explosions on pulsed power machines have improved our understanding of the fundamental mechanisms driving flowing matter under extreme conditions. Experiments and simulations indicate that magnetic fields are crucial in the formation and stability of strongly collimated plasma jets, a property also shared by astrophysical jets originating from black holes and protostars. It is understood that these magnetic fields also generate electric fields, often associated with the dynamo effect. In fact, when the Lundquist number is large enough, the dynamo effect is frequently seen as the dominant electric field driver of flowing plasmas. This is true inside the collimated jet where the density ($> 10^{19}$ cm^{-3}), velocity (< 200 km/s) and temperature (> 50 eV) are high enough to preclude the dominance of any other type of electric fields. However, the ion flow speed is much lower than the speed of light. As a result, dynamo electric fields do not impact noticeably fluid motion since electric stresses are negligible compared to magnetic stresses. On the other hand, Hall physics dominates the low density plasma surrounding the jet ($< 10^{18}$ cm^{-3}). In this region, electron speeds can be orders of magnitude higher than the bulk flow velocity as ion and electron fluids are decoupled. As a result, electric stresses can rival with magnetic stresses and Hall physics does impact the overall plasma dynamics. This talk will discuss how HED plasmas are subjected to Hall physics and how it impacts the particle confinement as well as the MHD stability of plasma jets. After focusing on experimental results and numerical simulations from the PERSEUS code, the talk will extend its conclusions to inertial fusion regimes where Hall physics could also alter plasma confinement and stability.

[1]Research supported by NNSA/DOE Grant Cooperative Agreements DE-FC52-06NA 00057, DE-NA 0001836 and NSF Grant PHY-1102471.