Investigations of Bow-shock Formation in Radiatively-cooled Supersonic Plasma Flows

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Abstract

The development of shocks in plasma flows occurs in a wide range of environments, particularly in astrophysical systems. In wire array experiments, the plasma accelerated from the wire via the Lorentz force rapidly exceeds both the local sound and Alfven speeds, providing an interesting source for shock studies. Recently, the plasma flow in a 1 MA wire array z-pinch demonstrated both the formation of bow shocks around an obstacle in the plasma, and the feasibility of testing the effect of magnetic fields and radiation cooling on the shock formation in these systems [1]. We present a new project which examines bow shock formation in wire array plasma flows. The plasma densities produced (ne $\sim 10^{17} - 10^{19}$/cc) are sufficiently low to allow continuous 2-dimensional quantitative measurements of the electron density, whilst remaining in the collisional (hydrodynamic) regime. A close examination of the shock structure and evolution is therefore possible, and results are compared with both analytical theory and simulation work. By changing the wire material, the effect of the radiative loss rate on the shock structure can be directly evaluated. Data from recent experiments will be presented and discussed, along with future plans to include B-fields into the shock region.

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[1] D. J. Ampleford et al, Phys. Plasmas, 17, 056315 (2010)