Laboratory Studies of Supersonic Magnetized Plasma Flows: Jets and Collisionless Shocks

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In recent years there has been an increasing interest to modeling astrophysical phenomena in laboratory experiments on high energy laser and z-pinch facilities [1]. The astrophysical connection is provided by using appropriate scaling considerations based on dimensionless parameters such as the plasma beta, the Reynolds and the magnetic Reynolds numbers.

In this talk I will discuss results of laboratory studies of magnetically driven supersonic plasma flows and jets at the MAGPIE facility at Imperial College. The jets in these experiments are driven by toroidal magnetic fields in a radial foil z-pinch set-up [2,3], and highly collimated (opening angle ~2 deg.), quasi-laminar, radiatively cooled plasma outflows are produced. The collimation of the jets is provided by the distributed toroidal magnetic fields which are controlled by the presence of low density halo plasma surrounding the dense central jet [4].

I will also discuss studies of reverse shocks developing in supersonic magnetized plasma flows (V_{flow}~100km/s, plasma β~1, Alfven Mach number M_A~5) colliding with planar conducting obstacles. The collision leads to formation of a stationary shock feature with thickness smaller than the collisional ion-ion mean free path. The plasma parameters in the shock (n_e, B, V_{flow}) are measured with laser interferometry, miniature inductive magnetic probes and with Thomson scattering. The analysis of the data shows that the shock is formed at a distance from the foil comparable to the ion skin depth ($\sim c/\omega_{pi}$), and that the shock formation is mediated by the pile-up of the magnetic field advected by the plasma flow.

References

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