Experimental studies of bow shocks formed in supersonic plasma flows with varying advected magnetic fields.

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Bow shocks are ubiquitous within astrophysics, formed when supersonic, magnetized material interacts with an obstacle and disruptions occur in the flow. These shocks are commonly observed around magnetized planets such as Saturn, Jupiter and Earth when the solar wind encounters the obstruction to its flow path. The effect of the magnetization of the plasma on the bow shock structure can be studied within a laboratory environment. In this presentation we discuss novel results collected from using from a pulsed power platform to control the magnetic fields carried within the plasma and influence the bow shocks created.

The supersonic, super-Alfvenic plasma flows (v_{flow} ~ 70 km/s, M_A >2.5) were produced using the MAGPIE facility at Imperial College driving a ~1 MA, 500 ns current pulse through either wire arrays [1] or planar foils [2]. The plasma flow carries a frozen-in magnetic field (B~ 1-2 T) which influences the bow shock structure formed at obstacle interfaces [3]. Obstacles of various dimensions are placed into the plasma flow and designed to mimic various scenarios including the understanding of bow shocks formed at the interface with projectiles sent through Earth's atmosphere. Further investigations have been performed to reduce the magnetic fields carried by the plasma using parallel bar grids orientated such that the bars are perpendicular to the frozen-in magnetic field direction.

We also discuss an instability developing at the obstacle in the layer of the stagnated plasma. The k-vector of the instability is oriented along the obstacle surface and is in the direction normal to the magnetic field. Faraday rotation measurements indicate that the instability leads to the modulation of the magnetic field strength in the plasma. Various diagnostics including Thomson scattering, two-colour laser interferometry, shadowgraphy and magnetic probes are used to characterize the flow velocity, temperature, density and magnetic field. By controlling the initial magnetic field magnitude, the density of the plasma and recording the temporal evolution of this feature a better understanding of the underlying seed of the instability can be gained.

[1] A. J. Harvey-Thompson *et al.,* PoP **16**, (2009)
[2] F. Suzuki-Vidal *et al.,* Astrophys. J. **815**, 2 (2015)
[3] G. C. Burdiak *et al.,* PoP **24**, 2017