Magnetised Jets & Reverse Shock Dynamics

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The recent development of platforms able to couple high-power-laser-produced and external magnetic fields has enabled many new astrophysical phenomena to be studied in the laboratory [1]. Experiments can produce radiative, compressible, magnetohyrodynamic (MHD) plasmas inaccessible through astronomical observations and computationally too expensive to simulate [2].

Here we demonstrate the collimating effect of a strong external magnetic field on a high-Mach-number, plasma jet and its subsequent collision with a solid obstacle. A shock wave is produced by the interaction of a high-power laser and a solid multilayer target. On breaking out of the rear surface of the target, this produces a jet that propagates into vacuum and impacts onto an obstacle located a few mm away. A reverse shock is formed which moves away from the obstacle. The collimating effect of the magnetic field increases the density of the plasma flow and hence the resulting properties of the reverse shock.

Both the magnetised plasma jet itself and its interaction with the obstacle have important astrophysical implications: jets are commonly observed in the universe along the axis of rotation of varied objects, such as young stellar objects (YSOs) and are thought to play a key role in the evolution of these objects. Moreover, the interaction of the jet with the obstacle mimics so-called magnetic cataclysmic variables (MCVs). Such systems are composed of a white dwarf (WD) and a companion star where a supersonic plasma flow coming from the companion star, falls down onto the WD, forming an accretion column [3, 4].

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