The effect of advected magnetic fields in jet propagation experiments

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Astrophysical jets are a common feature during star formation, flowing out along the rotational axis of an accretion disk. It is believed that magnetic fields play an important role in the formation of these jets. However, astrophysical observations show that far from the source, the self-interaction and interaction of the jet with the ambient medium are dominated by purely hydrodynamical processes [1]. The internal structure of these jets is complex, containing many radiative shocks, and appropriately scaled laboratory experiments can aid our understanding of these structures.

Supersonic, radiatively cooled jets, scalable to astrophysical systems, have been produced in the laboratory by the pulsed power-driven ablation of conical wire arrays [2]. In some of these experiments, the advected magnetic field was dynamically significant, which was most evident in the interaction of the jet with an ambient medium [3]. To enable the full range of jet dynamics to be studied, it is desirable to be able to modify the jet magnetisation within the same experimental setup.

Here we present experimental results from a new conical wire array jet-launching platform, in which the magnetic field advected by the jet is expected to be significantly reduced in comparison with previous experiments. The reduction in magnetic field is achieved by preconditioning the wires with a pre-pulse current [4], producing a radiatively cooled, supersonic jet. These experiments are carried out on the Magpie (~1 MA, 250ns) pulsed power generator, using a suite of high temporal and spatial resolution diagnostics. Faraday rotation polarimetry, Thomson scattering and laser interferometry, allow direct measurement of the magnetic field, electron and ion temperatures, flow velocities and electron density distributions.

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