Numerical simulations of laboratory astrophysics jet experiments

Andrea Ciardi

LERMA
Université Pierre et Marie Curie – Observatoire de Paris

Over a million years jets trace the creation of low-mass stars: from the embryonic emergence of proto-stars, still enveloped in their parental molecular cloud, to their birth as TTauri stars surrounded by proto-planetary disks. Understanding these outflows in terms of their formation mechanism, their role in mediating matter accretion, and their influence on the surrounding environment is fundamental, nonetheless it is far from complete.

The formation of jets is the result of a complex interplay between rotation and magnetic fields occurring on scales of tens of AU, and which is in general both difficult to observe, and to model. Complementary to the traditional tools of astrophysics, we have been studying in the laboratory the behaviour of radiatively cooled, magnetically collimated and accelerated jets. Produced on z-pinch machines [1], these flows consist of episodic plasma ejections that are structured by instabilities. The succession of "magnetic bubbles" and clumpy jets propagate and interact, burrowing a magnetised cylindrical channel through the surrounding plasma environment [2].

In this talk I will present three-dimensional, magneto-hydrodynamic simulations of laboratory flows, and results concerning the outflows produced in the early phases of star formation, during the collapse of a pre-setellar dense core. I will highlight their differences, similarities, and possible relevance to the jets observed during the later stages of (proto)stellar evolution.

References

[1] Lebedev S.V. et al, "Magnetic tower outflows from a radial wire array Z-pinch", 361, 97-108, 2005
[2] Ciardi A. et al, "Episodic magnetic bubbles and jets: astrophysical implications from laboratory experiments", 691, L147-L150, 2009