Astrophysics of collimated jets

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The ejection of powerful jets of matter is ubiquitous in the universe. There is now growing evidence that jets originate as wide-angle winds that are magneto-centrifugally accelerated by a large scale magnetic field anchored in an accretion disk. Theoretically, it is the amplification of this magnetic field by differential rotation that generates highly wound helical field lines which self-collimate the wind into a jet. Self-collimation however, cannot account for the confinement of the entire outflow. The wind solutions in these radially self-similar models formally extend to infinity, and have difficulties for example, in accounting for the observed jet widths. Furthermore, jets dominated by an azimuthal magnetic field are prone to current and pressure-driven instabilities which may disrupt the flow. Efforts to improve on these models, and understanding the collimation of jets, has lead to studies of truncated disk winds, where the whole outflow structure is confined by the thermal pressure of an external medium. In this context, but somewhat overlooked, are the models where the collimation is due to a poloidal magnetic field anchored in a disk, or present in the external environment.

In this talk I will present results related to the generation of jets from protostars, within the framework of self-collimation and poloidal collimation. I will discuss a new scenario of jet collimation which may naturally explain the puzzling presence of stationary x-ray emission sources observed at the base of a number of stellar jets. In particular, the astrophysical models will be confronted to results from astrophysically scaled experiment performed on high-power lasers and pulsed-power facilities. These experiments can in fact produce flows that are well approximated by the Euler MHD equations, and whose invariant properties allow meaningful scaling of laboratory to astrophysical fluid dynamics.