Stellar jets: comparison between laboratory experiment and numerical simulations

Date de mise en ligne : Saturday 1 March 2008
Researchers from the European network JETSET, including astronomers from Paris Observatory, have just studied the jets produced by young stars ejecting matter, the Herbig Haro objects. For this study they reproduced these jets, on one hand by laboratory experiments, on the other hand by numerical simulations. This double, experimental and virtual, approach allows to show that the interstellar wind plays a fundamental role while interacting with the jet, by creating these nodules and these structure breaks.

Figure 1: Image of the Herbig Haro 47 jet, taken with the Space Telescope. © HST. NAS/ESA. Click on the image to enlarge it

Figure 1: Image of the Herbig Haro 47 jet, taken with the Space Telescope. © HST. NAS/ESA. Click on the image to enlarge it

To study the dynamics and the structure of these jets and the origin of these curves, the international team of researchers has just carried out a double approach: the experiment in laboratory and the numerical simulation. As regards the experiment in laboratory, the experimental jets were produced on the generator of pulsed current MAGPIE of the Imperial College. The experimental jet has the required characteristics of HH jets in young stars, but with time scales and distances different, of the order of nanoseconds and centimetres. The typical propagation velocity is about 100 to 200 km/s. The interaction of this experimental jet with a lateral wind (30 to 50 km/s) is obtained thanks to an ablation plasma generated on a sheet by a strong XUV radiation. With regard to the numerical simulation, the virtual astrophysical jet was obtained with typical parameters of the stellar jets, for example with flow times of hundreds of years and distances equivalent to hundreds of astronomical units (an astronomical unit = 150 million km).
Stellar jets: comparison between laboratory experiment and numerical simulations

Figure 2: Design of the laboratory experiment (Left) Emission XUV from the experiment which reveals an internal shock and a curved jet (Right). © LERMA. SNL. BLIC. Click on the image to enlarge it

Figure 3: Simulation of an astrophysical jet (100 km/s, 1 000 particules per cm3) interacting with a latéral wind (25 km/s, 100 particules per cm3). The scale is 2 004 x 4 864 astrooomical units. © LERMA. SNL. BLIC. Click on the image to enlarge it

An important result is that the structure observed in the "pseudo HH jet" and the destruction of the bow shock result only from the interaction with the wind and are not related to some variability of the injection of the jet. It is the same for the internal shocks. The jet is prone to instabilities which tend to separate the jet in filaments.

Figure 3: Simulation of an astrophysical jet (100 km/s, 1 000 particules per cm3) interacting with a latéral wind (25 km/s, 100 particules per cm3). The scale is 2 004 x 4 864 astrooomical units. © LERMA. SNL. BLIC. Click on the image to enlarge it

Reference