LABORATORY SIMULATION OF ASTROPHYSICAL JETS

V.I. Krauz

National Research Centre Kurchatov Institute, Moscow, Russia, Krauz\_VI@nrcki.ru

With the recent emergence of powerful lasers and Z-pinches the conditions have been created for intensive development of a new direction of experimental physics, namely the laboratory simulation of processes occurring in extreme astrophysical conditions [1]. Subject to certain laws of similarity, this approach allows one to obtain valuable information about fundamental processes in the Universe, which are inaccessible for direct studies in situ. In particular, this relates to one of the most notable and intriguing phenomena in the Universe – astrophysical jets. In a laboratory, it is possible to create jets having some dimensionless parameters, such as Mach, Reynolds, Peclet numbers, etc., similar to that ones observed in young star objects. The significant progress in understanding of astrophysical jets physics was achieved via Z-pinch installation MAGPIE (Imperial College, London) [2], where the extensive series of research were conducted on the modeling of various mechanisms of jets generation and collimation. In particular, by means of compression of conic wire assemblies having various twist angles, there were simulated such phenomena as the effect of rotation observed for protostar jets, the interaction of the high-speed radiation-cooled jets with environment, etc. On the laser facility in LULI Ecole Polytechnique laboratory (France) it was shown, that a strong poloidal field plays the essential role in the mechanism of formation of narrowly collimated plasma streams similar to the jets observed in protostars [3].

Facilities of the Plasma-Focus type, based on the principle of pinching of the non-cylindrical current-carrying plasma sheath at the system's axis, are known as sources of intense plasma flows. The analysis of the parameters of these flows shows that they also can be effectively used for simulation of jets in young stellar objects (YSO). In NRC "Kurchatov Institute", a new set of experiments on the simulation of jets propagation in the interstellar medium has been started recently [4]. Basic experiments have been performed on the plasma focus facility PF-3. The first results have been obtained to determine the shape and structure of the plasma flow, density and temperature of both the flow and the ambient plasma, the distribution of the trapped magnetic fields. In parallel, the experiments with gas-puff have been already started at the SFTI (Sukhum) and IPPLM (Warsaw). This regime allows to create a profiled initial gas distribution and, thus, to effectively control the "contrast" (the ratio of the jet density to the ambient plasma density). The key problem to be solved by our research is to determine the physical mechanisms of astrophysical jets collimation. The experiments are accompanied by analytical and numerical calculations.

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