Laser driven laboratory astrophysics: Accretion and outflows in young stellar objects

Starodubtsev M V[@], Soloviev A A, Burdonov K F, Zemskov R S, Sladkov A D, Korzhimanov A V and Fuchs J

Institute of Applied Physics of the Russian Academy of Sciences, Ulyanova 46, Nizhny Novgorod 603950, Russia

[@] mstar@ipfran.ru

We present experimental and numerical studies on laboratory modelling of accretion and outflow processes in young stellar objects (YSO). Experiments were performed using the nanosecond pump laser of the PEARL laser facility (IAP RAS) and unique 15 T magnetic system. High-velocity expanding plasma plume formed through ablation of a solid target by the ns laser pulse has interacted with the ambient magnetic field modelling the topology and dynamics of YSO plasma flows. The laboratory experiment shows that the laser-generated plasma plume propagating across the magnetic field is subject to the Rayleigh–Taylor instability, which leads to its decompositon into several narrow plasma "tongues" that are able to propagate efficiently perpendicular to the magnetic field. Based on numerical magnetohydrodynamic simulations, we show that similar instability could develop in the YSO accretion discs. As we verify that the laboratory plasma scales favourably to accretion inflows of YSOs, our laboratory results support the argument in favour of the possibility of the Rayleigh–Taylor-instability-caused equatorial tongue accretion scenario in the astrophysical case.
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