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Building Laboratory Astrophysics Experiments from Laser-Driven Jets

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This talk will explore some of the advantages and disadvantages to using plasma jets driven by rear-surface irradiation in laboratory astrophysics experiments. In many respects, rear-driven jets are a natural choice for laboratory astrophysics experiments: they are reliable, and they require simple beam configurations—a distinct advantage in laboratory astrophysics investigations where the full experiment can be quite complex. Compared to jets driven by front surface irradiation, rear-driven jets are fairly long-lived, lasting for 10s of nanoseconds, which allows for astrophysically relevant structures to form in a laboratory experiment. However, one downside of rear-driven jets that they change significantly over the dynamic timescale of the jet. Our group observed this directly with optical Thomson scattering on OMEGA laser (Laboratory for Laser Energetics, Rochester, NY). Over a timeframe of just 6 nanoseconds, mass density increased by three orders of magnitude while velocity fell by a factor of three. This sort of rapid change can be scientifically useful, as it was when we used it to observe a transition between interpenetration and stagnation. But it can also present a serious challenge when attempting to scale astrophysical phenomena to the laboratory environment, as I will demonstrate with our group's experience investigating accretion shocks. This work is funded by the U.S. Department of Energy, through the NNSA-DS and SC-OFES Joint Program in High-Energy-Density Laboratory Plasmas, grant number DE-NA0002956, and the National Laser User Facility Program, grant number DE-NA0002719, and through the Laboratory for Laser Energetics, University of Rochester by the NNSA/OICF under Cooperative Agreement No. DE-NA0001944.