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Astrophysically relevant radiatively cooled hypersonic bow shocks in nested wire arrays[1]

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We have performed laboratory experiments which introduce obstructions into hypersonic plasma flows to study the formation of shocks. Astrophysical observations have demonstrated many examples of equivalent radiatively cooled bow shocks, for example the head of protostellar jets or supernova remnants passing through the interstellar medium or between discrete clumps in jets. Wire array z-pinches allow us to study quasi-planar radiatively cooled flows in the laboratory. The early stage of a wire array z-pinch implosion consists of a steady flow of the wire material towards the axis. Given a high rate of radiative cooling, these flows reach high sonic- Mach numbers, typically up to 5. The 2D nature of this configuration allows the insertion of obstacles into the flow, such as a concentric "inner" wire array, as has previously been studied for ICF research. Here we study the application of such a nested array to laboratory astrophysics where the inner wires act as obstructions perpendicular to the flow, and induce bow shocks. By varying the wire array material (W/Al), the significance of radiative cooling on these shocks can be controlled, and is shown to change the shock opening angle. As multiple obstructions are present, the experiments show the interaction of multiple bow shocks. It is also possible to introduce a magnetic field around the static object, increasing the opening angle of the shocks. Further experiments can be designed to control the flow density, magnetic field structure and obstruction locations. In collaboration with: S.V. Lebedev, M.E. Cuneo, C.A. Jennings, S.N. Bland, J.P. Chittenden, A. Ciardi, G.N. Hall, S.C. Bott, M. Sherlock, A. Frank, E. Blackman

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