ASTROPHYSICAL COLLISIONLESS SHOCKS IN THE LABORATORY

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Abstract

Most shock waves in astrophysics are collisionles since they form due to plasma instabilities and self-generated magnetic fields. Laboratory experiments at large laser facilities can achieve the conditions necessary for the formation of collisionless shocks, and will provide a unique avenue for studying the nonlinear physics of shock waves. We are performing a series of experiments at the Omega and Omega-EP lasers in Rochester, NY, where collisionless shock conditions will be generated by the two high-speed plasma flows resulting from laser ablation of solid targets using 10kJ to 20 kJ of laser energy. The experiments will aim to answer several questions of relevance to collisionless shock physics: the importance of the electromagnetic filamentation (Weibel) instability in shock formation, the self-generation of magnetic fields in shock collisions, the influence of external magnetic fields on shock formation, and the signatures of particle acceleration in shocks. This paper will present simulations of our experimental conditions; scaling calculations; experimental configurations; and expected results. Our plan for experiments on the National Ignition Facility in Livermore, CA, using up to 1.8 MJ of laser energy will also be presented.

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