Laboratory Experiments to Study Collisionless Shocks

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Abstract

Collisionless shocks are often observed in astrophysical plasmas. For example in a shock wave observed in a supernova remnant, a coulomb mean-free-path is much longer than the shock-front thickness. Large amplitude turbulent waves and energetic particles are

also observed in the shock environments. Diffusive shock acceleration is considered to be a standard model for non-thermal acceleration of energetic particles or cosmic rays in the universe. A laboratory experiment can be an alternative approach to study collisionless shocks and particle acceleration.

In this paper we investigate laboratory experiments to study collisionless shock generation in counter-streaming plasmas using Gekko XII HIPER laser system (352 nm (3), 500 ps, $\sim$100 J/beam, $< 10^{15}$ W/cm^2). The plasmas and shocks were sutdied by optical diagnostics, such as interferometry, shadowgraphy, self-emission measurements, and by Thomson scattering measurements. We also investigate OMEGA and OMEGA EP experimental results to study collisionless shocks, and an experimental proposal to demonstrate the formation of Weibel-mediated collisionless shocks using the National Ignition Facility.