Weibel-instability mediated collisionless shock experiment on the National Ignition Facility

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Collisionless shocks, in which the coulomb mean-free-path is longer than the shock-front thickness, are ubiquitous in the universe and believed to be the source of high-energy particles and cosmic rays. In such collisionless plasmas, wave-particle interactions and collective effects play an essential role in shock formation. Laboratory experiments can be used to study the formation of collisionless shocks [1].

In this paper, a Weibel-instability mediated collisionless shock in a self-generated magnetic field is investigated on the National Ignition Facility (NIF). In the experiments, CD/CD and CD/CH planar double-foil target separated by 6–10 mm were irradiated with laser energies of ~250 kJ per foil, generating ~1000 km/s counter-streaming plasma flows [2]. The transition from collisional to collisionless flows is observed as the foil separation gets larger. Excess neutrons, when comparing the CD/CD and CD/CH interactions, indicate a strong thermalization has occurred. We used D-3He proton radiography for the first time on the NIF and investigated temporal evolution of the Weibel-instability and shock formation.

References

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