Full-scale modeling of Weibel mediated collisionless shocks in laboratory scenarios

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Abstract

Weibel mediated collisionless shocks are believed to occur in many astrophysical scenarios, but the conditions for the generation of these shocks in laboratory are not yet fully understood. Using ab initio multi-dimensional relativistic PIC simulations, we show that Weibel mediated collisionless shocks can be driven in laboratory by the interaction of current/near-future high power laser pulses with overcritical plasmas. The laser acts like a piston, pushing the plasma and generating a flow of relativistic electrons that propagate through the target. The relativistic incoming flow and the cold counterstreaming flow (associated with the return current) go Weibel unstable leading to a strong compression and to the formation of a shock. The Weibel-driven magnetic fields reach 10We demonstrate the possibility of controlling the shock properties by tuning the laser intensity, the laser polarization, and the target density, opening the way for the first in situ study of Weibel mediated shocks.