Kinetic simulations of relativistic collisionless shocks

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We present simulation results for an ab-initio numerical study of collisionless shocks in electron-ion unmagnetized plasmas with fully relativistic particle in cell simulations. The main properties of the shock are shown, focusing on the implications for particle acceleration. Particle tracking is then used to analyze in detail the particle dynamics and the acceleration process. We observe an energy growth in time that can be reproduced by a Fermi-like mechanism with a reduced number of scatterings, in which the time between collisions increases as the particle gains energy, and the average acceleration efficiency is not ideal.

The main shock properties and formation process are compared to the structures obtained when ultra-intense laser beams interact with dense plasmas, of relevance to fast ignition configurations, for instance.

Finally, a new scheme to generate relativistic fireballs in the laboratory is described, with details on the magnetic field generation from the Weibel instability, and the dependence of the physical processes on the initial parameters of the plasma beam and plasma.

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