Electrostatic shocks in astrophysics, in the laboratory and in particle-in-cell simulations

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Non-relativistic electrostatic shocks in collision-less plasma form when two unmagnetized plasma clouds collide at a speed that exceeds significantly the local ion acoustic speed. Such a collision results in a pair of shocks, the forward and reverse shocks, which move into opposite directions. Such shocks are now routinely generated in laser-plasma experiments, they can be modeled in multi-dimensional particle-in-cell simulations and analytic models of such structures exist, at least under idealized assumptions. Such shocks are typically not considered to be representative of supernova remnant shocks. The maximum Mach number of such shocks is limited to values well below those of SNR shocks. I will describe in my talk how electrostatic shocks form and how they are sustained in a self-consistent way. An overview of recent related laser-plasma experiments and simulations is given. I will then discuss how the shock-reflected ion beam can pre-heat the upstream plasma by means of instabilities or through the ambipolar electrostatic field of a plasma density gradient. It is discussed how this pre-heating could reduce the ion acoustic Mach number of SNR shocks to a value that allows the latter to be stable even in the absence of supporting magnetic fields.