PIC simulation of high beta shocks: Microstructure and electron acceleration

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High beta shocks are present in a variety of circumstances in space such as pickup ion mediated heliospheric termination shock, cosmic ray modified sub-shcok of a supernova remnant shock, galaxy cluster merger shock, etc. We performed a seriese of two-dimensional full particle-in-cell simulations of high beta quasi-perpendicular shocks. Dependence of detailed structure of shock transition region on the shock angle, the angle between shock normal and upstream magnetic field, is investigated. A number of microinstabilities, modified two-stream instability, whistler instability, electromagnetic ion cyclotron instability, mirror instability, get excited in the transition region even for high beta (beta = 3). Dominant instability varies as the shock angle changes from 85 deg to 70 deg. We further examined the possibility that such high beta shocks can preferentially accelerate electrons having already non-thermal energies which are preaccelerated through some unknown mechanisms. In addition to the self-consistent plasma electrons and ions, test electrons whose temperature is one order higher than background upstream self-consistent electrons are introduced. We assume that these halo electrons are sufficiently tenuous so that they do not affect electromagnetic fields. We found that the halo electrons are well accelerated and heated, even though background self-consistent electrons are not, when the shock angle is 85 deg. In contrast, when the shock angle is 70 deg., not only the halo electrons but also the background electrons are accelerated, although their acceleration efficiency is low.

Keywords: high beta shock, PIC simulation, microstructure, electron acceleration

