Acceleration of halo electrons at a high beta low Mach number quasi-perpendicular shock

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High beta and low Mach number shocks are often observed in various circumstances in space such as pickup ion mediated heliospheric termination shock, cosmic ray modified sub-shock of a supernova remnant, galaxy cluster merger shock, etc. It in known that some of the upstream incident thermal electrons are accelerated at this type of collisionless shock through the mechanism called shock drift acceleration and reflected back toward upstream. The process is also known as fast Fermi acceleration. For appropriate parameters, accelerated electrons can have relativistic energy after the reflection. However, the region of parameter space where the mechanism works is limited.

Here, we examine the possibility that such high beta and low Mach number shocks can preferentially accelerate the electrons having already non-thermal energies which are often called halo component. We first discuss detailed microstructure of the transition region of high beta and low Mach number quasi-perpendicular shock by performing two-dimensional full particle-in-cell simulation. In addition to the self-consistent plasma electrons and ions, halo electrons whose temperature is one order higher than background upstream self-consistent electrons are introduced as test particles. 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 energized, even though background self-consistent electrons are not. Mechanism and efficiency of energization of the halo electrons are discussed.