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Microstructure of high beta quasi-perpendicular shock and associated electron dynamics

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Electron acceleration in a high beta and low Mach number quasi-perpendicular collisionless shock is investigated by using one- and two-dimensional full particle-in-cell [1,2]. In contrast to low beta or high Mach number shocks, relativistic shock drift acceleration followed by reflection occurs. While the acceleration and reflection are efficient in one-dimensional simulation, they are suppressed due to the effect of shock surface rippling in two-dimensional simulations. Structure of the shock transition region is far from laminar, in spite of the high beta and low Mach number situation. Not only ion scale fluctuations, including the ripple, but also electron scale fluctuations are seen. Among these, downstream fluctuations are dominated by electromagnetic ion cyclotron instability and/or mirror instability, electron scale fluctuations in the overshoot (foot) are due to whistler instability (modified two-stream instability). Relative importance of the instabilities changes with the shock angle. We further studied the behavior of halo electrons whose temperature is one order higher than background upstream electrons. By assuming that relative density of the halo electrons is sufficiently low, their dynamics do not practically affect the behavior of electromagnetic fields. We found that the halo electrons are preferentially reflected after being accelerated even if the shock surface ripple is present. They are also heated more efficiently than the background electrons.

References

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