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Full particle simulations of the $2-D$ foreshock region: analysis of local electron distribution functions

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Features of electron foreshock are analyzed with the help of a two dimensional electromagnetic full particle code where ions and electrons are treated as individual particles. Curvature effects and foreshock formation are self-consistently reproduced without any simplifying assumption; time-of-flight effects are also fully involved. In the present case, the shock wave is in supercritical regime and only a part of the quasiperpendicular range is investigated ($90^\circ \geq \theta_{Bn} \geq 65^\circ$ where θ_{Bn} is the angle between the magnetic field and the normal of the shock front). The foreshock region is associated with electrostatic and electromagnetic fluctuations evidenced in the simulations. In agreement with experimental data, local "bump-in -tail" patterns are well recovered in parallel distribution $f_e(v_{//})$ and correspond to electrons backstreaming upstream along the magnetic field lines. More detailed analysis of the present simulations allows to precise that local f_e have two components: a high energy component (with field-aligned beam signature) and a low energy component (with loss-cone signature). In addition, two types of "bump-in-tail" distributions, respectively broad and narrow, are respectively identified at short and large distance from the curved shock; these are due to different respective contributions of these two components. This distinction allows to identify more precisely the nature of the bump-in-tail pattern commonly evidenced experimentally (narrow type), which tends to be smoothed out when moving further within the foreshock .