Impact of pick-up ions on the nonstationarity and the microstructures of a perpendicular supercritical shock: full PIC simulations

Z. Yang (1), B. Lembège (2), and Q. Lu (3)

(1) Sate Key Laboratory of Space Weather, National Space Science Center (NSSC), CAS, Beijing, P.R. China (email: zwyang@spaceweather.ac.cn)
(2) LATMOS/IPSL/UVSQ/CNRS, 78280 Guyancourt, France (email: bertrand.lembege@latmos.ipsl.fr),
(3) SESS, Univ. Science and Technology of China (USTC), Hefei, Anhui 230026, P. R. China (email: qmlu@ustc.edu.cn)

The nonstationarity of a perpendicular supercritial shock in the presence of pick up ions (PUI) is analyzed with the help of one-dimensional PIC (particle-in-cell) simulation code. Solar wind ions (SWI) and PUI are described respectively as Maxwellian and a shell distribution. Present work focusses on the nonstationary behavior of the shock front in presence of PUI (with different percentages) and its impact on the microstructures of the shock front region. Our results (i) evidence that the shock front is still nonstationary (self reformation of the shock front due to the accumulation of SW ions) even in the presence of a relatively large percentage of PUI (25%) and even for a moderate supercritical Ma regime, (ii) show that the multi-crossing of the shock is possible since associated with the change in the shock front location (and its velocity) due to the front self-reformation, (iii) the increasing percentage of PUI tends to smooth out the variation of the macroscopic fields amplitude at the overshoot, and the time variation of the scalelengths of the microstructures of the shock front, (iv) in contrast, an increase of the Mach regime renforces the amplitude of these time variations, (v) however, the width of the ramp is almost independant of the PUI presence and the Mach regime. Present results can apply to any planetary (or cometary) shock where the percentage/energy of PUI are large enough to affect the microstructures scales and the dynamics (nonstationarity) of the shock front.