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How is the quasi perpendicular ion foreshock filled in ? Self-consistent 2D Full-Particle and Test-particles simulations

Philippe Savoini (1) and Bertrand Lembege (2)

(1) LPP-Ecole polytechnique-CNRS, Palaiseau, France (philippe.savoini@upmc.fr), (2) LATMOS-IPSL-CNRS, Guyancourt, France (bertrand.lembege@latmos.ipsl.fr)

Backstreaming ion populations propagating along the interplanetary magnetic field are evidenced upstream of the Terrestrial curved bow shock and form the ion foreshock. Two distinct backstreaming populations have been firmly identified by spacecrafts within the quasi-perpendicular shock region (i.e. for $45° \leq \Theta_{Bn} \leq 90°$, where Θ_{Bn} is the angle between the shock normal and the upstream magnetostatic field): so called (i) field-aligned ion beams (« *FAB* ») characterized by a gyrotropic distribution, and (ii) gyro-phase bunched ions («*GPB* »), characterized by a NON gyrotropic distribution. The origin of these backstreaming ions can be analyzed within an « enlarged » upstream region near/around the front with the help of 2D PIC simulation of a curved shock, where full curvature effects, time of flight effects and both electrons and ions dynamics are fully included by a self consistent approach.

Our previous analysis (Savoini et Lembege, 2015) has evidenced that these two populations can be generated directly by the macroscopic fields at the shock front itself (i.e. without invoking any local ion instability process). Both individual and statistical ion trajectories analysis based on our PIC simulations results confirm:

(i) the importance of the interaction time ΔT_{inter} spent by ions with the shock front which allows to discriminate these two populations. "GPB" population is characterized by a very short interaction time ($\Delta T_{inter} =$ 1 to $2\tau_{ci}$) in comparison to the "FAB" population ($\Delta T_{inter} = 2\tau_{ci}$ to $10\tau_{ci}$), where τ_{ci} is the upstream ion gyro period.

(ii) the key role of the injection angle (i.e. defined between the normal of the shock front and the gyration velocity at the time incoming ions hit the shock front) which strongly differs between FAB and GPB ions.

(iii) that "FAB" ions drift along the shock front and « scan » a large Θ_{Bn} range (up to $20°$) which explains the loss of their initial gyro-phase, before being re-injected into the upstream region. Moreover, present complementary test-particule simulations evidence the importance of the shock wave profile for both the « FAB » and « GPB » populations. Such results show that the reflection process is not continuous in time and in space, but strongly depends of the local shock front profile met by incoming ions at their hitting time.

Present simulations aim to clarify the respective roles of the shock curvature and the variation of the macroscopic field profiles at the front in the efficiency for reflecting ions which fill-in the ion foreshock. A comparison between self-consistent and test-particles results will be presented in more details.