



Filling of quasi perpendicular ion foreshock : 2D Full-Particle and Test-particles simulations

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Spacecrafts observations have clearly identified the presence of an ion foreshock upstream of the Terrestrial curved bow shock and formed by backstreaming ions propagating along the interplanetary magnetic field. Two distinct backstreaming populations have been firmly identified by spacecrafts within the quasi-perpendicular shock region (i.e. for $45^\circ \leq \Theta_{Bn} \leq 90^\circ$, 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. Savoini et Lembège (2015) have previously 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 gyroperiod.

(i) 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-particle 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 of self-consistent and test-particles results will be presented in more details.

References

Savoini, P., and B. Lembège, "Production of nongyrotropic and gyrotropic backstreaming ion distributions in the quasi-perpendicular ion foreshock region", *J. Geophys. Res.*, 120(9), 7154–7171, 2015, doi:10.1002/2015JA021018.