Geophysical Research Abstracts
Vol. 15, EGU2013-4978, 2013
EGU General Assembly 2013

Formation of the Earth's Ion Foreshock in the quasi-perpendicular collisionless shock region: Full-particle 2D simulation results

Philippe Savoini (1), Bertrand Lembege (2), and Joel Stienlet (1)

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

The ion foreshock located upstream of the Earth's shock front is populated with ions having interacted with the shock and then are reflected back with an high energy gain. In situ spacecrafts measurements have firmly established the existence of two distinct populations in the foreshock usptream of 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): (i) field-aligned ('FAB') ion beams characterized by a gyrotropic distribution, and (ii) gyro-phase bunched ('GPB') ions characterized by a NON gyrotropic distribution, which exhibit a non-vanishing perpendicular bulk velocity. Then, the purpose of the present work is to identify the different possible sources of backstreaming ions and is based on the use of 2D PIC simulations of a curved shock, where full curvature effects, time of flight effects and both electrons and ions dynamics are fully described by a self consistent approach. Our analysis evidences that these two populations mentionned above may have different origins identified both in terms of interaction time and distance of penetration. In particular, ours simulations evidence that "GPB" and 'FAB' populations are characterized by a short ($\Delta T_{inter} = 1$ to $2\tau_{ci}$) and much larger ($\Delta T_{inter} = 1$ to $10\tau_{ci}$) interaction time respectively, where τ_{ci} is the upstream ion gyroperiod. A deeper analysis of both individual and statistical ion trajectories evidences that:

(i) both populations can be discriminated in terms of injection angle into the shock front (i.e. defined between the normal to the shock front and the gyration velocity vector when ions reach the shock). Such a behavior explains how reflected ions can be splitted in the observed two populations "FAB" and "GPB".

(ii) ion trajectories differ between the "FAB" and "GPB" populations at the shock front. In particular, 'FAB' and 'GPB' ions suffer respectively multi-bounces and one bounce only.

(iii) the drift associated to the "FAB" ions allows them to scan a Θ_{Bn} range between 10° and 20° (in the quasi-perpendicular domain) which accounts for their gyrotropic distribution (loss of their initial gyro-phase which is not the case for the "GPB" ions). Consequences on parallel energy gain will be illustrated with particles trajectories typical of each population.