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Origin of energetic ions observed in the terrestrial ion foreshock : 2D full-particle simulations

Philippe Savoini (1) and bertrand Lembege (2)

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

Collisionless shocks are well-known structures in astrophysical environments which dissipate bulk flow kinetic energy and accelerate large fraction of particle. Spacecrafts have firmly established the existence of the so-called terrestrial foreshock region magnetically connected to the shock and filled by two distinct populations in 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 magnetic field) : (i) the field-aligned ion beams or " FAB " characterized by a gyrotropic distribution, and (ii) the gyro-phase bunched ions or " GPB " characterized by a NON gyrotropic distribution. The present work is based on the use of two dimensional PIC simulation of a curved shock and associated foreshock region where full curvature effects, time of flight effects and both electrons and ions dynamics are fully described by a self consistent approach.

Our previous analysis (Savoini et Lembège, 2015) has evidenced that these two types of backstreaming populations can originate from the shock front itself without invoking any local diffusion by ion beam instabilities. Present results are focussed on individual ion trajectories and evidence that "FAB" population is injected into the foreshock mainly along the shock front whereas the "GPB" population penetrates more deeply the shock front. Such differences explain why the "FAB" population loses their gyro-phase coherency and become gyrotropic which is not the case for the "GPB". The impact of these different injection features on the energy gain for each ion population will be presented in détails.

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