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Oblique foreshock waves and their self-structurization through beam trapping.

Urs Ganse (1), Yann Pfau-Kempf (1), Lucile Turc (1), Markus Battarbee (1), Thiago Brito (1), Maxime Dubart (1), Maxime Grandin (1), Minna Palmroth (1,2)

(1) Department of Physics, University of Helsinki, Helsinki, Finland (urs.ganse@helsinki.fi), (2) Finnish Meteorological Institute, Helsinki, Finland

Upstream of Earth's quasi-parallel bow shock, shock-reflected protons excite beam instabilities, leading to the creation of well-known 30-second waves. The resulting waves do not form in neat parallel wavefronts, but tend to present a complex spatial obliquity structure, which has been notoriously difficult to image and understand using satellite measurements alone.

We investigate the processes affecting global-scale foreshock structure formation by employing the global hybrid-Vlasov simulation system Vlasiator, in which full and noise-free information about proton distribution functions is available at every point of the simulation, and their kinetic behaviour and interaction with electromagnetic field is solved.

Our results indicate multiple processes are affecting and co-interacting in global-scale structure formation in the foreshock, including beam instabilities, wave-particle trapping and scattering. We find that oblique wave structures are the norm rather than the exception, and that details of the resulting structure sizes vary strongly with solar wind parameters.