



The structure of planetary foreshocks

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Foreshocks arise upstream of planetary bow shocks in the region connected to the shock by the interplanetary magnetic field. Both electron and ion foreshocks arise separately from particles streaming away from the bow shock. Electrons are found furthest from the planet on the field line that is tangent to the shock, accelerated by a mechanism that has been called fast Fermi acceleration. This tangent field line is a source of Langmuir oscillations at the plasma frequency that are convected downstream by the solar wind and rapidly disappear. Ions travel upstream into the solar wind more slowly so that the ion foreshock boundary is swept downstream from the tangent field lines. A large variety of ion beams are formed that in turn generate an equal variety of wave types. The ULF waves generated by the ions are convected backward against and through the shock and magnetosheath. In front of the quasiparallel shock these waves slow down as they approach the shock, grow and reform the shock. This review is illustrated with examples of upstream waves observed in front of planetary bow shocks, including recent Cassini observations at Saturn.