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Nonlinear LF wave-particle interaction in a planetary foreshock

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The foreshock region is the first signature of the interaction of the solar wind with a planet's plasma environment when approaching its collisionless bow shock. Part of its structure and dynamic is determined by instabilities, which are created by the interaction of the solar wind with backstreaming ion populations. Large amplitude quasi-monochromatic low-frequency waves are often observed in the Earth's foreshock. Observations of associated backstreaming ion distributions often reveal the existence of gyrating ions with well-defined pitch-angle and gyrophase organization around the local magnetic field. Field-aligned ion beams observed in the region close to the gyrating ions region are quantitavely shown to be good candidate to generate the waves via the ion/ion right-hand mode instability. Subsequently the waves may mediate the shock structure and its reflection properties. Different mechanisms have been put forward to explain the existence of the gyrophase-bunched ions. The possibility of local nonlinear wave-particle interaction involving initially field-aligned beam ions have been quantitatively shown from some case studies. From a larger data set including Wind observations and mainly multi-spacecraft observations by Cluster, the physical properties of the gyrophase-bunched ions are used to test and discriminate these possible production mechanisms. The relative occurrence of wave trapping will be particularly emphasized.