

NONLINEAR COHERENT WAVES AT THE PROTON CYCLOTRON FREQUENCY AT MARS FROM MGS OBSERVATIONS

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Low frequency waves at the proton cyclotron frequency (f_c) are very frequently observed by the MAGER experiment onboard Mars Global Surveyor (MGS) in the plasma environment of Mars. The waves are left-handed circularly polarized in the spacecraft frame. Their wave vectors lie at moderate angles from the ambient magnetic field and the observed periods (spacecraft frame) always closely fit the local proton cyclotron periods. These waves are usually interpreted as generated by a resonant helical beam instability fed by the planetary pick-up protons, which can lead to derive constraints on the hydrogen density in the Martian exosphere. However, these 'proton cyclotron waves' are frequently revealed as wave packets embedded inside a regular lower frequency 'wave envelope' at about $f_c/10$. They can have large amplitude (up to 5 nT peak-to-peak) even at large distance from the planet (more than 6 R_M). The large observed wave amplitude seems difficult to reach e.g., from the nonlinear saturation of the proton cyclotron instability using realistic pickup ion densities (consistent with those derived from the up-to-date exosphere models). Moreover, a satisfactory mechanism is also needed for both the lower frequency 'envelope' signature and the high coherence of the ion gyrofrequency signature. These waves can be interpreted as nonlinear stationary structures in the bi-ion plasma but apparent as temporal structures in the spacecraft frame recently described as 'oscillitons'. They can be produced (in the flow regimes in which they are permitted) by the existence of two ion populations (solar wind + planetary) with different densities, velocities and/or temperatures. This implies that direct connection between wave amplitude at the cyclotron frequency and neutral densities in the planetary exosphere is not always ensured.