Occurrence of Electrostatic Solitary Waves in the Venusian Plasma Environment

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The interplay between solar wind and Venusian atmosphere results in an "induced magnetosphere" having plasma regions analogous to the terrestrial magnetosphere but differs largely in the spatial extent [1]. The interaction between solar wind and the Venusian atmosphere facilitates acceleration, heating and transfer of energy and momentum to the Venusian plasma particles as well as generation of numerous plasma waves [2]. Electrostatic solitary waves (ESWs) are prevalent in the space plasma environment. They occur as bipolar structures in the electric field parallel to the background magnetic field [3]. The ESWs provide a fundamental mechanism for the acceleration and heating of particles and generation of electrostatic turbulence in the space plasma environment

The existence of the ESWs in the Venusian plasma environment permeated by the solar wind is analyzed using a homogeneous, collisionless, and magnetized multicomponent plasma consisting of Venusian H^+ and O^+ ions, background electrons following Maxwellian distribution and streaming solar wind protons, and suprathermal electrons following drift κ – distribution. The model predicts the existence of positive potential O^+ and H^+ ion-acoustic solitons in the Venusian plasma environment. The evolution and characteristics of the solitons in the two sectors, i.e., dawn-dusk (DD) and noon-midnight (NM) sector of the Venus ionosphere at an altitude of (200–2000) km, is explored. The model supports occurrence of solitons with an amplitude ~ (0.067–56) mV, width ~ (1.7–53.21) m, velocity ~ (1.48–8.33) km s^{-1}, bipolar electric field amplitude ~ (0.03–27.67) mV m^{-1} with time duration ~ (0.34–22) ms. The Fast Fourier transform (FFT) of the soliton bipolar electric field pulse generates a broadband electrostatic noise (BEN), with frequency varying as ~(9.78 Hz – 8.77 kHz). The model can be applied to understand the electrostatic waves (frequency ~ 100 Hz–5.4 kHz) observed in the Venus ionosphere by the Pioneer Venus Orbiter (PVO) mission [4] and in the Venus magnetosheath by the Solar Orbiter during its first gravity assist manoeuvre of Venus [5].

Acknowledgments

This work is supported by Department of Science and Technology (DST), Government of India, India under INSPIRE Faculty Fellowship.

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