

Abstract

This work involves the study of nonlinear structures formed in solitary drift waves in the B ring of Saturn using the tangent hyperbolic method. Theoretical and numerical analysis presented here gives the results in regions of Saturn's ring for which the satellite observation data is already available. Therefore, the comparisons between data from satellites and theoretical analyses are possible. One of the most significant aspects of the analysis is a new theoretical and independent suggestion for understanding the through nonlinear dispersive dust drift waves in the presence of rotation. Such waves are suggested as the progenitors of the spokes observed in the Saturn's B ring which is justified through detailed mathematical and analytical study. The compression and depletion of the dust number density corresponding to a rarefactive and compressive nonlinear dust drift potential is suggested to be the physical reason behind the formation of bright and dark spokes in the B ring. The theoretically obtained temporal values are found to be in good agreement with the observed phenomena of the spokes. Next, it is found that shocks formation become significant if the frequency of the ring particles is less than or around the orbital frequency otherwise they get inconsequential. The linear and nonlinear propagation of drift waves are also investigated in the plasma consisting of oxygen ions with electrons that are considered both thermal as well as nonthermal. The system is found to admit rarefactive shocks. An increase in ion-neutral collision frequency and magnetic field strength increases the rarefactive drift shock potential whereas an increase in nonthermal population mitigates it. Further, we investigate the nonlinear propagation characteristics of the dust drift waves in the presence of Maxwellian, Cairns, and Kappa distributed ions while assuming the electrons to follow the Boltzmann's distribution. The linear dispersion relation and nonlinear equation are derived for the dust drift shock waves which reduce to a KdV-like equation in the co-moving frame of reference. The nonthermal ion population, dust neutral collision frequency and the inverse dust density scale length inhomogeneity are found to alter the propagation characteristics of the nonlinear dust drift shock waves. The drift shock strength is weaker for nonthermal population of ions as compared to the Maxwellian population. The analysis of Kappa distributed ions has been also extended in two dimensions.