Abstract

Charged particle acceleration is a subject of active debate in space plasma, specifically in the Earth's magnetosphere. In the proximity of the reconnection region, Magnetospheric Multiscale (MMS) and other satellite missions have confirmed the existence of electron acceleration ranging from 100 keV to MeV. Additionally, the MMS mission recently reported counterstreaming beams of ions in plasma sheet boundary layer. Many researchers have proposed various mechanisms to explain the aforesaid particle acceleration phenomenon. Nonlinear structures like double layers (DLs) are considered important candidates responsible for charged particle acceleration. The Cluster satellite first observed DLs in the magnetotail reconnection region. Moreover, the MMS mission also observed magnetic field-aligned fluctuations of electric field up to 100 mV/m carried by DL at the magnetopause reconnection site in the Earth's magnetosphere. In addition, there are ample observations of particle distributions (non-Maxwellian) with superthermal tails and shoulders in the Earth's magnetosphere. Being motivated by these observations, we propose in this thesis a simple analytical model to explain the aforesaid charged particles acceleration phenomenon in space plasmas. Using this model, we investigate the stated nonlinear structures (i.e., DLs) associated with low frequency waves, particularly kinetic Alfv´en waves and coupled drift ion-acoustic waves using certain non-Maxwellian (i.e., Cairns, Tsallisand Cairns-Tsallis) particles distributions. For this purpose, the Sagdeev potential approach is used to construct a nonlinear extended Korteweg–de Vries equation. Furthermore, the effects of nonthermality and nonextensivity on the DL structure andits corresponding parallel electric field are explored. The nonextensive parameter (superthermality)of the Tsallis distribution and the nonthermal parameter of the Cairns distribution have a pronounced effect on the DL's strength and its associated parallel electric field. A comparison of our results with those of satellite observations as well as earlier studies is also presented. It has been found that our results are consistent with earlier studies on DLs. Additionally, we explore the implications of our results on charged particle energization in space plasmas.