



Study on Nonlinear Electric Field Structures Observed in Space Plasmas

J. K. Shi ^{*(1)}, N. Qureshi ⁽²⁾, K. Torkar ⁽³⁾

(1) National Space Science Center, CAS, Beijing, China, e-mail: jkshi@nssc.ac.cn

(2) Government College University, Lahore 54000, Pakistan

(3) Space Research Institute, AAS, A-8042, Graz, Austria

The nonlinear electric field structures were observed by many satellites, such as Cluster, Polar, Fast, S3-3, and so on. They were observed in various space plasma regions, such as ionosphere, magnetosphere, and solar wind. Indeed, the observed nonlinear electric field structures are solitary waves which can be mono-polar structure or bi-polar structures. The mono-polar structure of electric field has only one peak which can be positive or negative. The bi-polar structure of electric field has two peaks that can be positive (negative) then negative (positive). The bi-polar electric field structure can be continuous bi-polar structure in which the two peaks are close and the separative bipolar structure in which the two peaks are separated. Many authors have proposed nonlinear models to interpret the observed plasma density solitary waves. In this study, a model for the nonlinear electric field structures were proposed to interpret the satellite observed electric field structures.

A MHD model is established with ion motion in a magnetic tube. By exactly deriving the MHD equations in a cylindrical coordinate system, the “Sagdeev potential” is obtained and the electric field structure is analyzed. The analyzed results show that, in the space plasmas the nonlinear electric field structure could be nonlinear periodic electric field wave which is different from the sine or cosine shape, mono-polar electric field structure and bi-polar electric structures. According to the initial disturbing conditions, the mono-polar structure can be positive structure or negative structure, and the bi-polar structure can be positive (negative) then negative (positive) and continuous one or separative one.

Using the satellite observed plasma parameters in different space plasmas, the model results for the nonlinear electric field structure parameters are consistent with the satellite observation.

(1) Mozer, F. S., R. Ergun, et al., New features of time domain electric-field structures in the auroral acceleration region, *Phys. Rev. Lett.*, Vol. 79, 1281–1284, 1997.

(2) Dombeck, J., C. Cattell, et al., Observed trends in auroral zone ion solitary wave structure characteristics using data from Polar, *J. Geophys. Res.*, Vol. 106, 19013–19022, 2001.

(3) Matsumoto, H., X. H. Deng, et al., Observation of electrostatic solitary waves associated with reconnection on the dayside magnetopause boundary, *Geophys. Res. Lett.*, Vol. 30, 1326, 2003, doi:10.1029/20002GL016319.