Width–amplitude variations of positive amplitude electron acoustic solitary waves in a multiion plasma

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ABSTRACT

A fully nonlinear solution of electron acoustic wave has been obtained for a magnetized plasma assuming fluid approximation. A detail parametric study has been carried out. It is shown that the analytical estimation of the width-amplitude variation pattern agrees well with the recent satellite observations.

INTRODUCTION

Electron mode solitary structures are observed in different region of magnetosphere. In most of the cases they were interpreted as BGK (Bernstein-Greene-Kruskal) mode solitary structures. However, the presence of electron acoustic mode cannot be ruled out. In the present work a fully nonlinear solution of the electron acoustic solitary wave has been obtained by adopting the Sagdeev pseudopotetial technique and the corresponding width-amplitude variation pattern has been compared with recent satellite observations.

FORMULATION

The Sagdeev pseudopotential for fully nonlinear electron acoustic solitary wave in a single/multi-ion magnetized plasma has been obtained by assuming charge neutrality condition, $n_i=n_{es}+n_{eb}$, where the subsripts i, es, eb denote ions, bulk and beam electrons respectively, β_i, μ_i (ν_i) are the ion temperature ratio and ambient cold (hot) ion densities, σ_{ej}, ρ_{ej} are the (normalized) electron temperatures and ambient densities (j=s,b) and u_{eb} is the velocity of the beam electron. The ions are assumed to obey Boltzmann distribution ($T_i>T_{es,eb}$). The magnetic field is assumed to be parallel to the z axis and the wave travels in the y-z plane with the obliqueness θ, $k_{y,z}$ being the respective direction cosines [1].

$$y(f) = \frac{a_e^2 N_{es}^6}{\left\{(3s_{es} N_{es}^4 - M^2)\dfrac{dN_{es}}{df} - N_{es}^3\right\}^2}\left[\left\{-k_y^2 f + \frac{1}{2}M^2\left(\frac{s_e}{N_{es}}\right)^2 + \frac{3}{2}s_{es}(N_{es}^2-1) + s_e' - s_{es}(N_{es}^3-1)\right\} + k_z^2\left\{-\frac{1}{2}s_{es}(N_{es}^2-1) + \frac{1}{N_{es}}(s_{es}s_e - s_e')\right\} + \frac{k_z^2}{2}\left\{\frac{s_e' - s_{es}(N_{es}^3-1)_e}{M}\right\}^2\right] \qquad (1)$$

$$N_{es} = \frac{1}{r_{es}}\left[\left\{m_i \exp\left(-z_1\frac{f}{z_1 m_i + z_2 n_i b_i}\right) + n_i \exp\left(-z_2\frac{b_i f}{z_1 m_i + z_2 n_i b_i}\right)\right\} - \frac{r_{eb}}{2\sqrt{3s_{eb}}}\left\{\left(\frac{M-k_z u_{eb}}{k_z} + \sqrt{3s_{eb}}\right)\left(1+\frac{2f}{M_{b+}^2}\right)^{1/2} - \left(\frac{M-k_z u_{eb}}{k_z} - \sqrt{3s_{eb}}\right)\left(1+\frac{2f}{M_{b-}^2}\right)^{1/2}\right\}\right] \qquad (2)$$

where, $N_{es,eb} = n_{es,eb}/r_{es,eb}$; $s_e = N_{es} - 1$; $s_e' = N_{es}' - N_{es}'(f=0)$; $N_{es}' = \int N_{es}\,df$; $a_e = \Omega_{ce}/w_{pe}$

CONCLUSIONS

The solitary wave solutions obtained from Eqs. 1 have been studied in detail. The corresponding width-amplitude variation pattern is found to be consistent with the observations of Ergun *et al* [2].

REFERENCES

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