Ion temperature effects on the coexistence regions of positive and negative solitons in a negative ion plasma with superthermal electrons

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Negative ion plasmas are observed in space and astrophysical environment (D and F layers of Earth’s Ionosphere, Titan’s atmosphere, Cometary comae) and in laboratory plasmas (e.g. plasmas processing reactors). In such plasmas, propagation of ion acoustic solitary waves have been observed experimentally in laboratory by Ludwig et al. [1] and Adhikany et al. [2].

Theoretical and experimental investigations of the propagation of ion acoustic waves have shown that positive and negative solitons can exist in a negative ion plasma; see for example Kumar and Mishra [3] and Rouhani and Abbasi [4]. From these and previous studies, it is known that only positive solitons propagate at low fractions of negative ion density to positive ion density f, positive and negative solitons coexist at middle values of f and only negative solitons survive at high ratios of f. However no deep investigation of the coexistence regions of positive and negative solitons has been reported yet, particularly the effects of ion temperatures on existence of these regions. Using the pseudopotential method, we have carried out analytical calculations followed by numerical analysis and investigated the effects of ions temperatures on the solitons coexistence regions in a negative ion plasma composed of adiabatic ions and kappa distributed electrons. Our results show that the existence of the above mentioned three regions strongly depend on the ions temperatures. It is found that coexistence regions may vary depending on ion temperatures and other plasma parameters.

References