Dromion Solutions for Lower Hybrid Waves in Auroral Plasmas

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Present days' in situ measurements with high resolution, space borne instruments have revealed the existence of multidimensional structures in different regions of space. One such example is the observation of monopolar and bipolar pulses in the auroral region by POLAR and FAST satellites [1]. This has triggered lots of interest among the space plasma physicists. Whereas the previously observed one dimensional localized structures have been successfully modeled by the solitary wave theory, its direct extension to two dimension is found to have its own limitations. The authors have proposed *dromions* as a possible model for the highly localized and stable multidimensional structures observed in the space. Dromions are exponentially localized structures in two dimensions which are characterized by time dependent boundary conditions [2]. They appear as a solution of a class of nonlinear partial differential equations. Though the study of the mathematical aspects of dromions is already a decade old, its application to space plasma physics has received a scant attention so far. In a previous work, the authors have shown that the nonlinear evolution of an electron acoustic wave can be described by Davey-Stewartson (I) (DS-I) equations which are known to admit dromion solutions [3]. Analytical solutions for electron acoustic dromions were obtained for a chosen set of parameters relevant for the auroral plasma. It was shown that the shape and size of the analytical solutions are consistent with the satellite observations. However, such an analysis was strictly restricted within the boundary of the electron acoustic frequency regime whereas the observed monopolar and bipolar pulses are known to have much broader band of frequencies. This readily indicates the necessity of extending the application of dromion theory to different frequency regime. In the present paper, the nonlinear evolution of a lower hybrid wave in two dimensions is studied adopting the reductive perturbation method. The scaling has been chosen to satisfy the dispersion relation of a lower hybrid wave. A third order nonlinearity is assumed and the plasma is assumed to have warm ion and electron fluids. The generalized coupled nonlinear differential equations reduce to a DS-I type equation for the perpendicular propagation of the wave. The existence domain of the obtained DS-I equation will be delineated and the possibilities of analytical solutions for lower hybrid dromions will be explored in details in a physical parameter space relevant for the auroral plasma.

References

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