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Solitary electromagnetic waves in space plasmas

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Starting from the discussion of Hall-MHD solitons in an usual proton-electron plasma, a classification of solitary electromagnetic waves (SEW) is given for a plasma which contains two or more ion populations. It is shown that a new type of nonlinear stationary structures occurs as result of mode splitting which is caused by the minor ion population near the cross-over frequency creating a point in the omega-k space where phase and group velocity coincide. The so-called oscillitons are characterized by an oscillating spatial structure superimposed on the spatial growth or decay associated with the single-ion soliton. By solving the full nonlinear Hall-MHD equations describing stationary multi-ion flows, solitons and oscillton profiles are obtained in different parameter regimes. Oscillitons may also exist in plasmas which are linearly unstable. As an example, SEW's are considered in an ion-beam plasma which is relevant for planetary foreshock regions. Cluster observations are discussed under the viewpoint of beam-excited SEW's. Finally, the influence of kinetic effects on the main features of slow-mode solitons in a high-beta plasma is studied with the help of hybrid simulations.