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Study of higher order effects on dust kinetic Alfvén waves in polarized plasma

Sunidhi Singla[1] and N. S. Saini
Department of Physics, Guru Nanak Dev University, Amritsar-143005, India
e-mail (speaker): singla.sunidhi94@gmail.com

A dust particle experiences a variety of forces in dusty plasmas, including electromagnetic, drag, gravitational, thermophoretic, and radiation pressure forces. The study of how polarisation force affects various nonlinear structures in a dusty plasma has drawn more attention during the past several years. The shift in plasma density on the two sides of the dust grains, causes the polarisation force in dusty plasmas. Finite dust pressure plays important role here. This density non-uniformity causes the Debye shield of dust grains to lose its spherical shape. Due to a partial charge separation that results, an electric field is produced. This electric field, which in the present investigation is parallel to the external electric field, can either counter or strengthen it. The linear and non-linear dynamics of dust kinetic Alfvén (DKA) waves in a dusty plasma have attracted a lot of interest during the past several years. Dust particles are extremely sensitive to changes in the magnetic field that is provided externally and is present naturally in the majority of space plasmas as well as laboratory plasmas. Dust kinetic Alfvén waves (DKAWs) are produced by the polarisation drift of dust fluid in response to magnetic field disturbances. For the kinetic Alfvén waves, dust dynamics alters the dispersion relation. When the dust is considered as being cold and immobile in a dusty plasma, dust modified kinetic Alfvén waves ap pear with a frequency in the range. However, at limited dust temperatures, dust kinetic Alfvén waves appear with a frequency that is lower than that of the dust cyclotron. The number density and temperature of positively charge d ions define the Debye shielding distance for dusty plas mas that contain negatively (positively) charged dust grai ns (electrons). However, the strength of F_p for a plasma c ontaining either positively or negatively charged dust gra ins remains the same for a certain value of other paramet ers and is always oriented in the opposite direction of the electric field. Therefore, the kind of charge on dust grain s has no effect on the polarisation force. The observations of various satellite missions have confirmed the omnipresence of non-Maxwellian particles with suprathermal tails at higher energies in most of the astrophysical and space plasma environments. Such kinds of nonthermal particles are naturally found in solar wind, Jupiter, and Saturn environments.

Also to remove the discrepancies between theoretical predictions and experimentally observed characteristics of nonlinear waves, many authors have proved the requirement of inclusion of higher-order nonlinearity and dispersion effects in studying nonlinear structures in plasma. The reductive perturbation method is employed to derive the Korteweg-de Vries (KdV) and KdV- type inhomogeneous equations. From the solution of KdV-type inhomogeneous equation, it is seen that a new type of higher order structure named as “dressed soliton” is observed due to higher contributions. The effects of various plasma parameters on the characteristics of different kinds of nonlinear structures are analyzed numerically. The investigation will be useful for understanding the energy transport phenomenon of nonlinear KAW in space and laboratory plasmas.

References

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