2nd Asia-Pacific Conference on Plasma Physics, 12-17,11.2018, Kanazawa, Japan

Effect of polarization force on nonlinear excitations in dusty plasmas

Nareshpal Singh Saini
Department of Physics, Guru Nanak Dev University
E-mail: nssaini@yahoo.com

The study of nonlinear structures in laboratory, space and astrophysical dusty plasma environments has been a frontline area of research for the last many years. In a dusty plasma, the ion (electron) interaction with the negatively (positively) charged dust Debye sheath leads to its deformation. This deformation can generate an electric field around the polarized Debye sphere. This electric field can interact with the external electric field by opposing or enhancing it. Thus, the overall dynamics of the dust changes. So, it will be interesting to study the influence of polarization force on different kinds of nonlinear structures in a dusty plasma. The observations from various satellite missions have confirmed that most of the space and astrophysical plasmas contain different kinds of charged particles (superthermal particles) with non-Maxwellian velocity distributions, e.g., nonthermal, superthermal (kappa distribution) and Tsallis (q-nonextensive) distribution. These distributions are commonly found in the auroral region of the Earth's magnetosphere as well as other planetary magnetospheres, solar and stellar coronas, solar wind, etc. These particles with non-Maxwellian velocity distribution function are characterized by a parameter, e.g., in kappa-distribution function, the spectral index κ measure the superthermality of the particle. In the limit when $\kappa\rightarrow\infty$, the Maxwellian distribution is recovered. Similarly, in q-nonextensive distribution, when $q\rightarrow1$, the Maxwellian distribution is recovered. From various experimental and theoretical studies, it has been observed that the distribution followed by background plasma particles plays a significant role in modifying the characteristics of the nonlinear structures. Over the last many years, there have been a much interest in studying the different kinds of properties of the electrostatic/electromagnetic nonlinear excitations (solitons, double layers, rogue waves etc.) in dusty plasmas having superthermal particles. It has been analyzed that kappa/Tsallis distribution is more appropriate than Maxwellian distribution for the modeling of space data. We have focused on the study of arbitrary amplitude DA solitary structures, amplitude modulation and rogue waves in dusty plasmas. The Sagdeev potential method has been employed to setup an energy balance equation, from which we have studied the characteristics of large amplitude solitary waves under the influence of polarization force, superthermality of charged particles and other plasma parameters. In the past rogue waves have been observed in a number of environments, e.g., oceans, finance, super fluid Helium, parametrically driven capillary waves, Bose- Einstein condensates, optical cavities, optics, astrophysical environments, atmosphere, nonlinear fiber optics, optical systems and plasmas. It is of paramount importance to investigate the properties of rogue waves in a dusty plasmas under the influence of superthermality of charged particles in the presence of polarization force. Multiple scale reductive perturbation method has been employed to derive the nonlinear Schrödinger equation (NLSE). From the solutions of this equation, amplitude modulation of envelope solitons and rogue waves have been studied. The rogue waves are very high amplitude waves which arise as result of modulation instability. It is very hard to predict the formation of rogue waves in a medium. However, NLSE has been successfully used to study the modulation instability and formation of rogues waves. A rational solution to the NLSE is used to model the first order rogue waves which may have amplitude reaching up to two, three or more times the surrounding waves. Sometimes several first order rogue waves can interact with each other to form second order rogue waves. Amplitude of these second order rogue waves becomes higher than the individual first order rogue waves. The important features of different kinds of nonlinear structures will be discussed in detail in this talk.

References

1. W. M. Moslem, I. Zeba, and P. K. Shukla, Appl. Phys. Lett. **101**, 032106 (2012)
2. S. A. Maier, Plasmonics (Springer, Newyork, 2007)
3. M. Opher, L.O. Silva, D.E. Dauger, V. K. Decyk and J.M. Dawson, Phys. Plasmas **8**, 2454 (2001)
4. N. Kaur, M. Singh and N.S. Saini, Phys. Plasmas **25**, 043704 (2017)
5. F. Haas, Phys. Plasmas **12**, 062117 (2005)
6. R. Kohli and N.S. Saini, Phys. Plasmas **24**, 063701 (2017)
7. A.D. Marguilis, and V.A. Marguili, Sov. Phys.-JETP **66,** 1028 (1987)