5th Asia-Pacific Conference on Plasma Physics, 26 Sept-1Oct, 2021, Remote e-conference

Evolution of Breathers and Peregrine Solitons in Space Plasmas

Kuldeep Singh* and N. S.Saini
[1] Department of physics, Guru Nanak Dev University, Amritsar, India-143005
*e-mail (speaker):singh.kdeep07@gmail.com

The plasma physicists have rejuvenated the research in the dusty plasma after the confirmation of presence of dust grains in Saturnian rings by Cassini and Voyager space missions [1]. Numerous theoretical and experimental investigations have reported that charged dust reacts with electromagnetic as well as gravitational fields and gives rise to new low frequency modes like dust ion acoustic (DIA) waves, dust acoustic waves, and other modes. Hamaguchi and Farouki [2] explored one of such forces as polarization force which occurs due to the deformation of the Debye sphere around the dust in nonuniform plasma. They found that difference in positive ion density on either side of negative dust leads to occurrence of the polarization force. The direction of polarization force is opposite to the electrostatic force and independent of sign of charge on dust. Rogue waves have extremely large amplitude waves that evolve suddenly and then collapse without clue. Further, it is also illustrated that the breather solutions of NLSE can be categorized as Kuznetsov–Ma breathers (space localized patterns and periodic in time) and the second class of breathers is the Akhmediev breather (which is periodic in space and localized in time). The nonlinear superposition of first-order rogue waves yields a complex and localized nonlinear structure with excessively large amplitude known as higher-order rogue waves and becomes a fascinating area of research. Such kind of pecking-order of higher-order breather solutions with a huge amplitude is called SRWs. Moreover, the rogue waves are first-order rational solution while SRWs are higher-order solution of NLSE [3]. The nonlinear superposition of these TRWs forms the SRWs [4]. The amplitude of SRWs goes on rising as triplets are replaced by sextets and so on. In this theoretical investigation, we have examined the combined effects of nonthermally revamped polarization force on modulational instability MI of dust acoustic waves DAWs and evolution of different kinds of dust acoustic (DA) breathers in a dusty plasma consisting of negatively charged dust as fluid, Maxwellian electrons, and ions obeying Cairns' nonthermal distribution. The nonthermality of ions has considerably altered the strength of polarization force. By employing the multiple-scale perturbation technique, the nonlinear Schrödinger equation NLSE is derived to study modulational MI instability of dust acoustic waves DAWs. It is noticed that influence of the polarization force makes the wave number domain narrow where MI sets in. It is analyzed that combined effects of variation in the polarization force and nonthermality of ions have a comprehensive influence on the evolution of different kinds of DA breathers. It is remarked that outcome of present theoretical investigation may provide physical insight into understanding the role of nonlinear phenomena for the generation of various types of DA breathers in experiments and different regions of space (e.g., the planetary spoke and cometary tails) [4-6].

References

[1] C.K. Goertz, Rev Geophys, **27**, 271 (1989)
[2] S. Hamaguchi, R. T. Farouki, Phys Rev E, **49**, 4430 (1994)
[3] N. Akhmediev,A. Ankiewicz, M.Taki, Phys Lett A **675**, 373 (2009)
[4] K. Singh, N. S.Saini, Frontiers in Physics, **8,** 602229 (2020).
[5] K. Singh, N. S.Saini, Phys. Plasmas, **26**, 113702 (2019).
[6] K.Singh, P. Sethi, N.S. Saini, Phys Plasmas **25**, 033705 (2018).

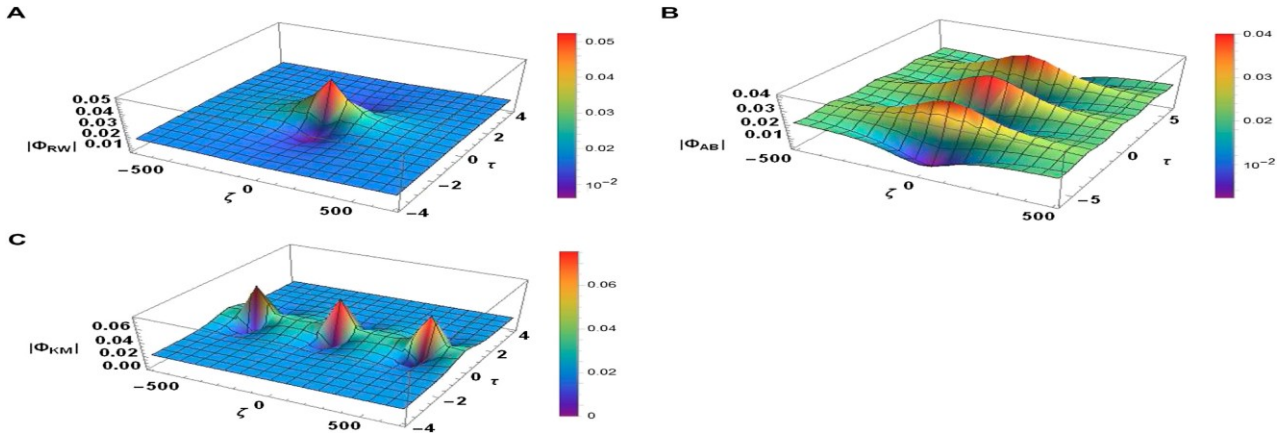

Figure 1. The 3D profile of (A) DA rogue waves (B) DA Akhmediev breather and (C) DA Kuznetsov–Ma breather in space-time plane