Seminar

Institute for Plasma Research

Title : Ion acoustic rogue waves

Speaker: Dr. Pallabi Pathak
Institute of Advanced Study in Science and Technology, Guwahati, Assam

Date : 26th February 2020 (Wednesday)

Time : 3.30 PM

Venue : Seminar Hall, IPR

Abstract :

Plasma, being a nonlinear and dispersive medium supports variety of wave modes. One of the fundamental wave modes in plasma is the ion acoustic (IA) mode. This is an electrostatic mode where ions provide the inertia and electron pressure drives the wave. In the nonlinear regime IA waves may transform into solitary waves by balancing the nonlinear steepening with dispersive spreading under certain plasma conditions. Such solitary structures in plasmas are similar to the tsunami waves in the ocean. There are other nonlinear structures/waves in the ocean commonly known as Rogue waves which represent a very high local concentration of wave energy compared with average of the field. Good number of mechanisms are known to produce such large waves in hydrodynamics. D. H. Peregrine in 1983 worked out a localized rational solution of Nonlinear Schrodinger Equation (NLSE), now known as Peregrine soliton which has been accepted as a prototype of oceanic rogue waves. This is a doubly localized (space and time localization) soliton with amplitude enhancement of ~ 3 times that of the background wave. Rogue waves are naturally observed waves by human on the sea surface that represent an inseparable feature of the Ocean. Rogue waves appear from nowhere, cause threat and disappear at once. Active studies on the rogue waves have been started 30 – 40 years ago and have increased during the recent decades in different branches of science viz. physics, geoscience and ocean and costal engineering.

In plasmas we have observed the evolution of first and second order ion acoustic Peregrine soliton and multi-Peregrine soliton [1-3]. A double plasma (DP) device with a cusp shape magnetic field to confine the plasma is used to carry out the experiments. For the experiments, we have produced a multicomponent plasma (plasma composed of Ar^{+},e, F^{-}) with critical density of negative ions – a delicately balanced nonlinear dispersive medium in which the ion acoustic wave is unstable with respect to modulation. The experimental observations have been compared with the solution of NLSE. We have performed continuous wavelet transformation (CWT) technique to analyze the time series signal and examine the localized breather characteristics in the generalized time frequency domain. We have also studied the effects of enhanced Landau damping on the evolved Peregrine soliton. The strength of the Landau damping is controlled by heating the ions (applying an rf signal ~ ion plasma frequency to the separation grid).

References:

[1]H. Bailung, S. K. Sharma and Y. Nakamura, Phys. Rev. Lett. 107, 255005 (2011).
[2] Pallabi Pathak, S. K. Sharma, Y. Nakamura and H. Bailung, Phys. Plasmas 23, 022107 (2016).
[3] Pallabi Pathak, S. K. Sharma, Y. Nakamura and H. Bailung, Phys. Lett. A 381, 4011 (2017).