Seminar

Institute for Plasma Research

Title : Laboratory studies of stationary and non-stationary structures in flowing complex plasmas

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Time : 03:30 PM

Venue : Online - Join the talk: https://meet.ipr.res.in/Thesisdefencetalk

Abstract :

Transcritical plasma flows is a common situation in astrophysical [1] as well as laboratory plasmas [2]. Interaction of flowing plasmas with stationary objects leads to excitations of many interesting structures such as bow shocks, solitons, wakes, etc. [3]. An attempt is made to study these spectacular phenomena in the laboratory by using flowing complex plasmas. The presence of micron or sub-micron charged particles in the electron-ion plasmas increases the complexity of the system and has led to the development of the new field of dusty or complex plasmas [4]. The experiments are carried out in the Dusty Plasma Experimental (DPEx) device in which a DC glow discharge Argon plasma is produced in between a circular anode and a grounded tray cathode. A dusty plasma is then generated either using mono-dispersive MF particles or poly-dispersive Kaolin particles. The flow in the dust fluid ranging from subsonic to supersonic over an electrostatic potential is achieved by using different techniques. Subsonic flow generates normal wake patterns whereas a slightly supersonic flow leads to excitations of various structures in the fore-wake region called precursor solitons [5]. The shape and size of the charged object over which the dust fluid flows play an important role to determine the characteristics of the precursor solitons and there exists a threshold value of object height below which the dust fluid simply flows over the object without exciting any nonlinear structures [6]. Generation of highly supersonic flow changes the complete dynamics of fore wake structures which leads to the excitation of stationary structures called pinned solitons. The experimental findings of precursor and pinned solitons are qualitatively compared with the numerical model of the forced-KdV equation. The study of the nonlinear structures in an inhomogeneous dusty plasma is also carried out by investigating the propagation characteristics of shock waves when they travel downhill along a density gradient. The modified-KdV-Burger equation is derived for such a case and numerically solved for a dusty plasma medium with a dust density gradient and where the dissipation effect comes from the strong coupling induced viscosity as well as neutral damping. The numerical results show a good agreement with the experimental findings.

References

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[2] JD Richardson, EC Stone, JC Kasper, JW Belcher, and RB Decker. Geophysical Research Letters, **36(10)**, 2009.
[3] Guazzotto, L., Betti, R., Manickam, J., & Kaye, S. *Physics of Plasmas*, *11*(2), 604-614, 2004.
[4] Gregor E. Mor_ll and Alexei V. Ivlev. Rev. Mod. Phys., **81:1353-1404**, Oct 2009.
[5] Surabhi Jaiswal, P. Bandyopadhyay, and A. Sen. Phys. Rev. E, **93:041201**, April 2016.
[6] Garima Arora, P Bandyopadhyay, MG Hariprasad, and A Sen Phys. of Plasmas**, 26(9):093701**, 2019.