# Seminar

# Institute for Plasma Research

**Title :** Sculpted Ultracold Neutral Plasmas

**Speaker:** Dr. Vikram Dharodi
Michigan State University, USA

**Date :** 23rd October 2020 (Friday)

**Time :** 3.30 PM

**Venue :** Online - Join the talk:
https://meet.ipr.res.in/Dr.VikramDharodiv_PDFtalk

**Abstract :**

Ultracold neutral plasma (UNP) experiments allow for careful control of plasma properties across Coulomb coupling regimes. Here, we examine how UNPs can be used to study heterogeneous, non-equilibrium phenomena, including non-linear waves, transport, hydrodynamics, kinetics, stopping power and instabilities. Through a series of molecular dynamics simulations, we have explored UNPs formed with spatially modulated ionizing radiation. We have developed a computational model for such sculpted ultracold neutral plasmas that includes an ionic screened Coulomb interaction with a spatiotemporal screening length, and Langevin-based spatial ion-electron and ion-neutral collisions. We have also developed a hydrodynamics model and have extracted its field quantities (density, flow velocity and temperature) from the molecular dynamics simulation data, allowing us to investigate kinetics by examining moment ratios and phase-space dynamics; we find that it is possible to create UNPs that vary from nearly perfect fluids (Euler limit) to highly kinetic plasmas. We have examined plasmas in three geometries: a solid rod, a hollow rod and a gapped slab; we have studied basic properties of these plasmas, including the spatial Coulomb coupling parameter. By varying the initial conditions, we find that we can design experimental plasmas that would allow the exploration of a wide range of phenomena, including shock and blast waves, stopping power, two-stream instabilities and much more. Using an evaporative cooling geometry, our results suggest that much larger Coulomb couplings can be achieved, possibly in excess of ten.

References

[1] Vikram S Dharodi and Michael S Murillo. Sculpted ultracold neutral plasmas. Physical Review E, 101(2):023207, 2020.