Seminar

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Institute for Plasma Research

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Title: Experimental Investigation of Self-Organized Criticality in Complex Space Charge Structure Formations in Glow Discharge Regime

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Date: 15th September 2023 (Friday)

Time: 11:00 AM

Venue: Seminar Hall, IPR

Abstract

Plasma sheath dynamics during complex structure formations and related self-organized criticality (SOC) have remained subjects of great interest to understand the relation between complex structure formations in plasma with nonlinear aspects of glow discharge, as they are source dependent and they play vital roles in many complex plasma phenomena. These are investigated widely to understand their mechanism and to improve the efficiency of various plasma-based applications. The interest of investigation is the dynamics of charged particles during the selforganized critical behavior in different compact plasma sources so designed to generate the ambient plasma whilst triggering multiple potential double layer (MDL) structure formations in glow discharge regimes. The discharge characteristics of a semi-transparent coaxial mesh-type plasma source are investigated in the glow discharge regime which reveals various interesting features like the space charge phenomena, sheath dynamics, complex structure formations, trapping of charged particles, the presence of energetic electrons, etc. In the glow discharge regime of operation, the plasma source forms distinct localized visible multiple potential layer structures near the mesh surface. A critical discharge state appears during the progressive anode potential variation through the expansion of plasma inside the whole vessel. The presence of long-range correlation in the discharge could be identified through nonlinear analysis like Hurst exponent and autocorrelation of time series that indicates the self-organized scenario during the discharge, which turns into a critical state of discharge through the collapse of localized MDL structures. The discharge characteristics of a ball anode plasma source placed inside a large vessel acting as a ground cathode provide insight into the self-organization behavior of discharge during the discharge state transition inside a vacuum vessel. The mixed-mode oscillations present in the frequency spectrum disappear in presence of an external magnetic field. The coupling and decoupling of MDL structures in the glow discharge regime in presence of a cusp magnetic field turn largely oscillatory in presence of mirror magnetic field configuration, which reveals the presence of SOC behavior in this dynamical system through nonlinear analysis of the glow discharge. A compact version of the latter, source forms self-organized MDL structures in absence of a magnetic field that transforms into multiple anode spots during progressive anode potential variation in different vessel boundary. The evolution of energy in different coherent modes with anode potential during self-organization is an attentive feature in the glow discharge regime, which is of vital importance in the various investigation of complexities in space plasma. The study of such discharges is also important for applications associated with self-organized patterns often formed during the plasma-surface interactions.