Seminar

Institute for Plasma Research

Title : Study of Multiple Anodic Double Layers in Glow Discharge Plasma

Speaker : Dr. Prince Alex
Pondicherry University, Puducherry

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Time : 03.30 PM

Venue : Committee Room 4, (New Building), IPR

Abstract :

Double layer (DL) in plasma represents a non-neutral region of opposite charges separated by a small distance with a potential drop of the order of $|\phi 0 \geq kT/e|$ across the layer. They are suggested to be responsible for energizing auroral particles in ionosphere, solar flares, intergalactic double layer radio sources and acceleration of charged particles in space and laboratory plasma. Numerical simulations and satellite observations suggest DLs in auroral region and space plasma constitute a sequence of many DLs rather than a single DL. In this work, I present results from DL structure consisting of more than one layer generated in front of anode of a dc discharge in laboratory known as Multiple Anodic Double Layers (MADLs). The MADLs was generated in laboratory by accelerating electrons towards a positively biased electrode (anode) submerged in cathode plasma in a glow discharge setup consisting of separate power supplies for both cathode and anode. The study performed to obtain the boundary conditions for the MADL existence shows that MADL formation triggered at a lower critical value of anode bias with an explosive increase in anode discharge current~100 times the electron thermal current. For the condition $v_d \geq 1.3\ v_{te}$, rise of an instability along with formation of MADL is observed. The analysis of fluctuations in floating potential showed that the instability has all the characteristics of Buneman instability. The MADL found to exist within the range, $3\ v_{te} \leq v_d \geq 1.3\ v_{te}$, beyond $v_d \geq 3\ v_{te}$ MADL become unstable and begins to decay. Further detailed study revealed that the bipolar MADL potential structure is formed by the interaction of time domain structures (TDS) (electron hole, ion hole, DLs) i.e., a growing positive pulse similar to the electron hole typically observed in space plasma and decay of negative pulse similar to the ion holes. The obtained bipolar MADL potential structure is formed by the interaction of time domain structures (TDS) (electron hole, ion hole, DLs) i.e., a growing positive pulse similar to the electron hole typically observed in space plasma and decay of negative pulse similar to the ion holes. The obtained bipolar DL structure has striking characteristic similarity with DL recorded by FAST satellite in the auroral region. A nonlinear study performed to understand MADL dynamics reveals that MADL undergoes an order-chaos-order-chaos transition when MADL evolution takes place. Another study performed in the background of MADL indicate direct evidence for the existence of self-organized critical behaviour in cold plasma possibly for the first time. Analogous to the sandpile avalanches generated by random addition of sand grains, the MADL approaches a critical stage and collapses when the drift velocity of electrons streaming from low potential side to high potential side exceeds a certain threshold value. Analysis of electrostatic potential fluctuations reveals the existence of long range time correlations and the existence of power law tail in the PDF of the fluctuations. The measured Hurst exponent and the power law tail in the rank function are strong indication of the self-organized criticality behaviour of the system.