Seminar

Institute for Plasma Research

Title : Modelling of Flow Patterns of Impurity Particulates following a Disruption in the Fusion Reactor Chamber

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Date : 17th June, 2019 (Monday)

Time : 03.30 PM

Venue : Seminar Hall, IPR

Abstract:

The study focuses on the adiabatic expansion and hyper-velocity acceleration of impurity particulates in the post-disruption and thermal quench scenario inside the vacuum chamber of a fusion reactor. A pulsed electrothermal plasma (ET) capillary source has been used as a source term simulating the surface ablation of the divertor or other interior critical components of a tokamak fusion reactor under hard disruption-like conditions. The capillary source generates particulates from wall evaporation by depositing transient radiant high heat flux onto the inner liner of the capillary. The particulates form a plasma jet moving towards the capillary exit at high speed and high pressure. Computational work, backed by the data from actual electrothermal source experiments from the in-house facility "PIPE" (Plasma Interactions with Propellants Experiment) at North Carolina State University, shows the supersonic bulk flow patterns for the temperature, density, pressure, bulk velocity and the flow Mach number of the impurity particulates as they get ejected as a high-pressure, high-temperature and hyper-velocity jet from the simulated source term. It also indicates the uniform steady-state subsonic expansion of bulk aerosol inside the expansion chamber. Electrothermal plasmas exhibit highly non-linear nature as a bulk; and thus effect of temperature and the non–linearity of the adiabatic compressibility index on the supersonic flow patterns for high density metal vapor plasma have been presented, where the study shows significant changes in flow parameter values in the extreme limits of suggested nonlinearities. The variation in plasma bulk parameters indicates towards finer aspects like agglomeration, recombination and particulate precipitation from the dense bulk plasma as it undergoes isentropic expansion. The analytical expressions to represent the 2-D steady-state spatial evolution of polycarbonate ablated plasma have been also prescribed and the same is expected to enable us in predicting the spatial distribution of the debris from the plasma facing components (PFC) or the migrated dust in an efficient manner. The study of dust particulate flow adds qualitative information to plasma diagnostics database and helps in safe, undeterred operation of the fusion devices.
