Seminar

Institute for Plasma Research

Title : The potentially important role of ∇**B** in divertor detachment control

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Date : 6th March 2020 (Friday)

Time : 10.30 AM

Venue : Seminar Hall, IPR

Abstract :

Control of the detachment ‘front’ edge or extent between the target and the X-point is necessary for minimizing the effect of detachment on the core plasma (impurities, confinement, etc.) and maximizing the divertor functions (reduction of target heat load, He pumping). However, such control has been difficult in experiments. The SOLPS-ITER code has been utilised to study the issue for MAST-U Super-X [1] plasmas where detachment is engendered through two separate scans of ‘control’ parameters - outboard upstream density (n_u) and the divertor impurity concentration (f_I). We find for either n_u or f_I scans that initially, as in current tokamaks, the detachment front moves quickly away from the target after detachment initiation. However, in the case of the equilibrium shown in Fig 1(a), the detachment front (corresponding to the target side of the radiation profile) stops moving as the n_u or f_I are further increased. Fig 1(b) shows the extent of the detachment front, z_f, for the entire N-seeding scan as a function of f_I normalised to its level at the onset of detachment from the target, $f_I/f_{I,t}$.

A thermal front model [2] of the sensitivity of the detachment front movement to controls including n_u and f_I has been generalised to obtain z_f for an arbitrary divertor total magnetic field profile and applied to the case shown in Fig 1(a). f_I includes both C (tile material) and seeding gas (N) and the model predicted $z_f(f_I/f_{I,t})$ approximates the SOLPS results for both detachment through N-seeding and n_u scans (not shown). In particular, a significant drop in the sensitivity of the front location to $f_I/f_{I,t}$, $\delta z_f/\delta(f_I/f_{I,t})$ is predicted in a region of high $|\nabla \mathbf{B}|$ – which also happens to be near the divertor entrance/baffle equilibrium studied. Additional divertor equilibria with different strong $|\nabla \mathbf{B}|$ locations and magnitude are being developed for further tests of the thermal front model.

Such slowing down and/or stopping of the detachment movement, if further substantiated, could provide a route to much improved control and the potential to passively stabilizing the detachment location in the strong $|\nabla \mathbf{B}|$ region for a wide range of core plasma transients (P_{SOL}, loss of seeding, ELMS, etc.).

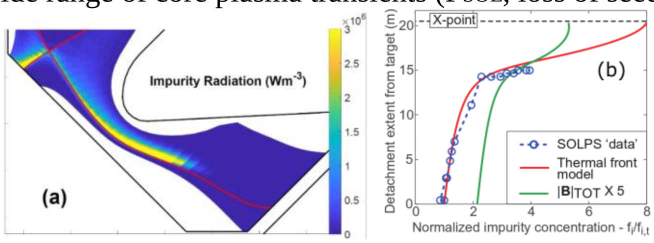

Figure 1

[1] E. Havlickova et al. *Journal of Nuclear Materials*, 438 545 (2013)
[2] B. Lipschultz, et al. *Nuclear Fusion*, 56(5) 056007 (2016)