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Modeling of detachment bifurcation in HL-2M with X-Divertor by SOLPS

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Abstract

The control of detachment operation is very important for long pulse high power discharge. Partial detachment operation regime has been foreseen for ITER. But, since the T_e at the outer target drop rapidly from 20eV to 2eV observed experimentally (called detachment bifurcation) under given discharge conditions, it makes the detachment control a very big challenge [1-3]. The physical reason of detachment bifurcation in conventional divertor (CD) – DIII-D has been studied by SOLPS [4] and UEDGE [3]. Those results reveal that the four factors (including H-mode, normal-B_t, electric drift - $E \times B$ and radiation impurity) are the necessary conditions for producing it. The $E \times B$ completely depends on the radial and poloidal gradients of T_e and static pressure n_eT_e in SOL and divertor regions [5]. The interactions of impurity radiation loss P_{rad_imp}, T_e, $E \times B$ in H-mode with normal-B_t can lead to the outer target T_e cliff drops in CD.

Currently, some simulated results have shown that X-divertor (XD) can well screen carbon impurity particles near target region considering carbon physical and chemical sputtering, so that the impurity radiation loss mainly occurs near target region [6, 7]. The radiation loss near target region makes the poloidal gradients of T_e and n_eT_e in XD much larger than the both in CD. As a consequence, the effect of $E \times B$ on the detachment bifurcation is completely different from the CD. The production conditions in XD also may be very different from the CD. Thus, in this paper, we will predict and study the detachment bifurcation physical mechanism and production conditions in HL-2M with advanced XD by SOLPS [8].

Key words: X-divertor; Detachment bifurcation; $E \times B$; Detachment control

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