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Core transport improvement in stable detachment with RMP application to the edge stochastic layer of LHD

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Significant core plasma transport improvement is observed in the detachment divertor operation, which is stabilized by application of resonant magnetic perturbation (RMP) to the edge stochastic layer of LHD. Pressure profile becomes peaked and the heat transport coefficient, chi_eff, estimated from transport analysis, reduced in the entire confinement region. The RMP amplitude scan experiments show change of detachment transition density and of resulting chi_eff, while attained divertor particle flux reduction and radiated power are independent of the RMP amplitude. The results are new systematic study of RMP effects on detachment as well as on the core plasma transport. It suggests compatibility of good core plasma performance with divertor power load reduction in 3D magnetic field configuration with RMP application.

Compatibility of good core plasma performance with enhanced edge radiation to mitigate the divertor power load is a crucial issue for magnetically confined fusion reactors. It is, however, commonly observed that the core confinement degrades with increasing radiation fraction. It is also not clear yet how RMP affects the core plasma transport during detachment, where no systematic RMP amplitude scan experiments have been performed so far in either tokamaks or stellarators in this respect. In LHD, stable detachment control is realized with RMP application of m/n=1/1 mode, where the core plasma transport is found to improve in the detached phase. The present paper reports, for the first time, analysis of the core transport, edge radiation, and divertor particle/power flux reduction with systematic scan of RMP amplitude (B_r/B_0).

The RMP application creates a magnetic island of m/n=1/1 in the edge stochastic layer, where the impurity radiation is enhanced due to increased volume of cold plasma region. The divertor power and particle flux exhibit n=1 mode pattern in toroidal direction. With RMP application, the radiated power increases at lower density compared to the no-RMP case, and thus it results in earlier detachment transition. There appears a plateau region of radiation against density rise. This leads to a wide density operation range and thus provides a stable detachment control. RMP amplitude scan experiments show celar change of detachment transition density and resulting energy transport coefficients.

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