Formation Condition of Ion Internal Transport Barrier in Large Helical Device

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An improved confinement in the ion heat transport has been recently observed in the plasma core of neutral beam heated discharges in the large helical device (LHD). A peaked profile of ion temperature is clearly observed with steep gradient, so called ion internal transport barrier (ion ITB), which is similar to parabolic ITB appeared in tokamak plasmas with positive magnetic shear, whereas it is not observed in electron temperature profile. In tokamaks, in order to identify the ITB formation, the threshold temperature gradient and peaking factor of ion temperature profile are studied in ASDEX-Upgrade and in JET, respectively. However, there seems to be no common definition in identifying the ITB formation, so far.

In this paper, we propose a new definition on ITB formation, which is expressed by the reversal of the local temperature gradient, i.e., grad $T_i(\rho_0)$ > grad $T_i(\rho_1>\rho_0)$. The idea of this definition is based on the profile stiffness (grad $T_i(\rho_0)$ < grad $T_i(\rho_1>\rho_0)$) in L-mode, which is similar to one of the tokamak ITB definitions expressed by the peaking factor. The threshold value of the temperature gradient is not necessary in the present definition and radial position of the ITB foot point can be automatically identified. The parameter regime of the ITB formation is thus evident in the analysis. The density dependence, power threshold, collisionality regime are discussed on the ITB formation in LHD.