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Advances in understanding of turbulent transport and confinement improvement in the HL-2A tokamak

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Turbulence dynamics and the associated transports are an important topic as they play the important roles on realizing and maintaining high confinement of the tokamak plasma. Recently, significant progress has been achieved on the HL-2A in understanding the modulation of turbulence by MHD [1,2], turbulent particle transport [2-4], turbulent stress and momentum transport [5], as well as formation of internal transport barrier in the situation with low central magnetic shear [6]. It was found that residual stress drives an off-diagonal turbulent momentum flux and its divergence defines an intrinsic poloidal torque [5]. On the mechanism of Greenwald density limit, the study reveals that the damped zonal flow and then enhanced turbulent transport results in edge cooling which excites MHD instability and even disruption [7]. In H-mode plasma of magnetically confined devices, the pedestal plays a key role in governing the performance of the core plasma by providing a boundary condition for the stiff core transport. In HL-2A, the pedestal dynamics and the underlying physics have been extensively studied. It was demonstrated that the increase of the mean E×B shear flow plays a key role in L-H transition [8] and an inward particle flux induced by quasi-coherent mode (QCM) was found to be responsible for the increases of density and its gradient in the edge transport barrier prior to each ELM. More recently, a record of normalized toroidal beta (β_N~3) of HL-2A has been realized by using two tangential NBI, LHCD and ECRH heating systems. It provides a more advanced platform for studying turbulence, MHD and energetic particle physics in the high confinement plasmas. The relevant physical studies will be presented.

References

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