Present Progress of Transport Studies on HL-2A

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Recent HL-2A tokamak experiments are focused on the plasma confinement and transport studies. Some new results have been obtained during ohmic and high power ECRH discharges. 2MW/68GHz ECRH system has been used on the device. The experiments of ECRH show that the suppression of m/n=2/1 tearing modes can be sustained by off-axis ECRH with low modulation frequency of about 10 Hz. The continuous rise in central plasma density and temperature as well as the confinement improvements, can be attributed to the additive effect of internal transport barrier (ITBs) formed after each ECRH switch-off.

A natural and quasi-steady state particle transport barrier has been evidenced firstly in the ohmic plasmas in HL-2A without any auxiliary heating and external momentum input. The barrier is located around *r/a*=0.6-0.7 with a width of 1-2 *cm*. A threshold in central line averaged density has been found for the observation of the particle transport barrier with $n_c=2.2\text{x}10^{19}m^{-3}$. By analysing the propagation of a particle wave generated by SMBI modulation across the barrier, the particle diffusivity and the convective velocity have been separately determined. The diffusivity *D* is rather well-like than step-like with important reduction inside the barrier. The convection is found to be inward outside of the barrier, and outward inside the barrier. The density threshold can be correlated to the TEM/ITG transition via the collisionality.

With the good flexibility and easy controllability of the supersonic molecule beam injection (SMBI)[1] conditions (gas pressure, modulation frequency, duty cycle, etc.), modulated SMBI has been proved to be an effective tool to study the non local effet. The pulsed SMBI as new perturbation source has been used successfully for the non-local heat transport phenomena [2,3]. Repetitive non-local effect induced by modulated SMBs allows Fourier transformation of the temperature perturbation, yielding detailed investigation of the pulse propagation. Profiles of amplitude and phase at the first three harmonics are independent of frequency. The steeper profiles around the interface, which means a reduction of heat transport, indicate that an internal transport barrier is formed in this area. The investigation also indicates that, although the fast core T_e response to edge cooling in higher density (larger than 2×10^{19} m^{-3}) is opposite to that in low density, the non-locality of electron heat transport appears in both conditions.

References

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[2] Mantica P et al 1999 *Phys. Rev. Lett*. 82 5048
[3] N.Tamura et al 2007 *Nucl.Fus.* 47 449