Perturbative Transport Studies with pulsed SMBI

X.T.Ding, W.W.Xiao, H.J.Sun, L.H.Yao, W.Chen, Z.T.Liu, B.B.Feng
Q.W.Yang, X.R.Duan
Southwestern Institute of Physics, Chengdu, Sichuan, China
dingxt@swip.ac.cn

The pulse propagation method is a very powerful tool to study the plasma transport [1]. The pulsed supersonic molecular beam (SMB) as new perturbation source has been used successfully for the particle transport and non-local heat transport study on HL-2A. Experiments have confirmed that the SMB injection has deeper penetration and better locality than conventional gas puffing[2,3]. The penetration depth can reaches to about 0.5 of the normalized miner radius with the gas pressure 6Mpa and the higher the gas pressure the deeper the penetration. After the FFT, the amplitude and the phase profiles of the first harmonic and its high harmonics can be obtained, respectively.

Using the modulated SMBI perturbative transport analysis, 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 $n_c=2.2\times10^{19}m^{-3}$. 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 change of sign for the convective velocity may be explained by the turbulence TEM/ITG system. The density threshold can be correlated to the TEM/ITG transition via the collisionality.

The modulated SMBI perturbative transport analysis is very suitable to study the non-local heat transport phenomena [4,5]. Repetitive non-local effect induced by modulated SMBs allows Fourier transformation of the temperature perturbation, yielding detailed investigation of the pulse propagation. The investigation 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 nonlocality of electron heat transport appears in both the two conditions. Analytic results suggest a common underlying physical mechanism between the 'non-local' transport phenomena in the two different conditions.

References

[1] N.J.Lopes Cardozo, et al Plasma Phys. Control. Fusion **37**.799 (1995)
[2] Yao Lianghua et al *Nucl. Fusion* **38** 631 (1998)
[3] Yao Lianghua et al *Nucl. Fusion* **41** 817 (2001)
[4] Mantica P et al 1999 *Phys. Rev. Lett*. 82 5048
[5] N.Tamura et al 2007 *Nucl.Fus.* 47 449