New experimental findings of non-local transport in J-TEXT and KSTAR

Y.J.Shi[1*], Z.Y.Chen[2], Z.J.Yang[2], J.M.Kwon[3], P.Shi[2], K.J.Zhao[4], P.H.Diamond[5], Z.F.Cheng[2], X.Y.Zhang[2], W.Yan[2], H.Zhou[2], X.M.Pan[2], Z.P.Chen[2], S.C.Hong[1], C.Zhang[2], D.Li[2], Y.B.Dong[6], L.Wang[2], Y.H.Ding[2], Y.F.Liang[2], S.H.Hahn[3], J.Y.Jang[1], Y.S.Kim[1], H.G.Jhang[3], Y-S.Na[1]

[1] Seoul National University, Seoul, Korea; [2] Huazhong University of Science and Technology, Wuhan, China; [3] National Fusion Research Institute, Daejeon, Korea [4] East China University of Technology, Nanchang, China; [5] University of California, San Diego, USA; [6] Southwestern Institute of Physics, Chengdu, China;
* yjshi@ipp.ac.cn

A fast increase of the central electron temperature caused by the edge cooling in ohmic heating plasmas, the so-called non-local heat transport (NLT) was first observed in the TEXT [1] and in many fusion devices afterwards [2-13]. NLT phenomenon shows the limitation of transport theory based on local transport model and is regarded as one challenging issue for plasma transport. The underlying physics mechanism of NLT is still unclear.

One typical characteristic of NLT is this effect disappears with increasing electron density. The ECH experiments in KSTAR show the close correlation between NLT and intrinsic rotation reversal. The cutoff density of NLT and threshold density for rotation reversal can be significantly increased by ECH (as shown in fig.1a). The characteristic of linear confinement and saturated confinement for ECH plasma, which is similar to LOC and SOC of OH plasma, is also found. The transition density in ECH plasma from linear to saturated confinement is much higher than the density for LOC-SOC transition, which is consisted with the higher cut-off density of NLT in ECH plasmas. Moreover, the collisionality is almost constant for OH and ECH plasmas, which means that collisionality is the key parameter to determine these critical densities.

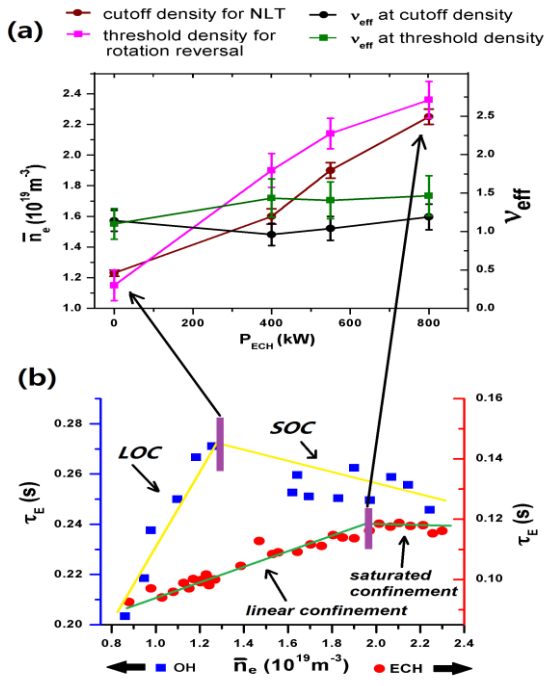

Fig.1a The cutoff density of NLT and threshold density for rotation reversal in OH and ECH power scan shots. The normalized effective collisionality (veff) at ρ ~ 0.5.
Fig.1b Energy confinement time versus line averaged density.

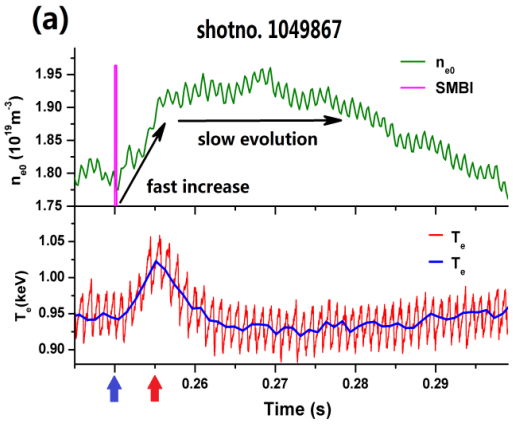

Fig.2 The fast response of core density (n_{e0}) in cold pulse experimental on J-TEXT also cannot be explained by local transport mode.

On the other hand, the latest experimental results in J-TEXT tokamak show a steep rises of core density and acceleration of core rotation, which are accompanied by rapid electron temperature increases. These simultaneous increments in three confinement channels are found for the first time in experimental fusion plasmas. These new experimental findings of non-local transport phenomenon in J-TEXT and KSTAR in this paper provide a key clue to reveal more clear background physics mechanism for NLT.

1. References

[1] K.W.Gentle *et al*, Phys. Rev. Lett. **74**, 3620(1995)
[2]M.W.Kissick *et al*, Nucl. Fusion **36,** 1691 (1996)
[3]P.Mantica *et al*, Phys. Rev. Lett. **82**, 5048(1999)
[4]F.Ryter *et al*, Nucl. Fusion **40**,1917(2000)
[5]X.L.Zou *et al*, Plasma Phys. Control. Fusion **42**, 1067(2000)
[6]P.Mantica *et al*, Plasma Phys. Control. Fusion **44**, 2185(2002)
[7]N.Tamura *et al*, Phys. Plasmas **12**, 110705(2005)
[8]H.J.Sun *et al*, Plasma Phys. Control. Fusion **52**, 045003 (2010)
[9]J.E.Rice *et al*, Nucl. Fusion **53**, 033004 (2013)
[10]C.Gao *et al*, Nucl. Fusion **54**, 083025 (2014)
[11]K.Ida *et al*, Nucl. Fusion **55**, 013022 (2015)
[12]Y.J.Shi *et al*, Nucl. Fusion **57**, 066040 (2017)
[13] Y.J.Shi, *et al*, Nucl. Fusion **58**, 044002 (2018)