2nd Asia-Pacific Conference on Plasma Physics, 12-17,11.2018, Kanazawa, Japan

Rotation and momentum transport in magnetic confined plasmas

Won-Ha Ko[1], J. Kim[1], J.H. Lee[1], J. M. Kwon[1], P. Diamond[2], K. Ida[3], Y. M. Jeon[1], Y. In[1], S.W. Yoon[1], and Y.K. Oh[1]

[1] National Fusion Research Institute Korea, [2] CMTFO and CASS UC in San Diego USA, [3] National Institute for Fusion Science Japan

e-mail (speaker): whko@nfri.re.kr

Plasma rotation plays an essential role in determining transport related in rotation shear which can reduce fluctuation driven transport and produce transport barriers and confinement improvement [1]. Tokamaks often exhibit plasma rotation either due to external momentum input such as neutral beam or 'spontaneously' so called intrinsic torque which is dominant rotation source in ITER. Intrinsic rotations have been observed in many kinds of magnetic confined plasmas with a lot of heating sources [2-3]. The toroidal rotation has quite unique pedestal in KSTAR H-mode which is advantage for rotation and momentum transport physics [4]. The first prediction and estimation of core intrinsic flows in strong external momentum input is reported, using a Charge Exchange Spectroscopy in KSTAR [5].

A strong co-current intrinsic rotation layer in the core region is found and characteristic structures of pedestal are observed in counter-NBI heated H-mode plasma. A clear disparity of the core toroidal rotation in between co-NBI heated and counter-NBI heated H-mode plasmas gave us a clue of intrinsic rotation. Core rotation increased by enhanced momentum confinement in co-NBI heated plasma while it saturated by slightly enhanced confinement in counter-NBI heated H-mode plasma.

Whole toroidal rotation has big drop and damping during mode locking by the resonant RMPs. All rotation close to zero but edge has small rotation which may be from intrinsic rotation despite the RMPs strongly attack from edge region. This rotation may be related the edge rotation near separatrix in the DIII-D plasmas heated co-NBI, ECH, and counter-NBI [5] and XGC result from a simple orbit-loss model at outboard midplane [6].

Observation of core and edge rotation is important role in understanding physical mechanism and its generation of intrinsic torque.

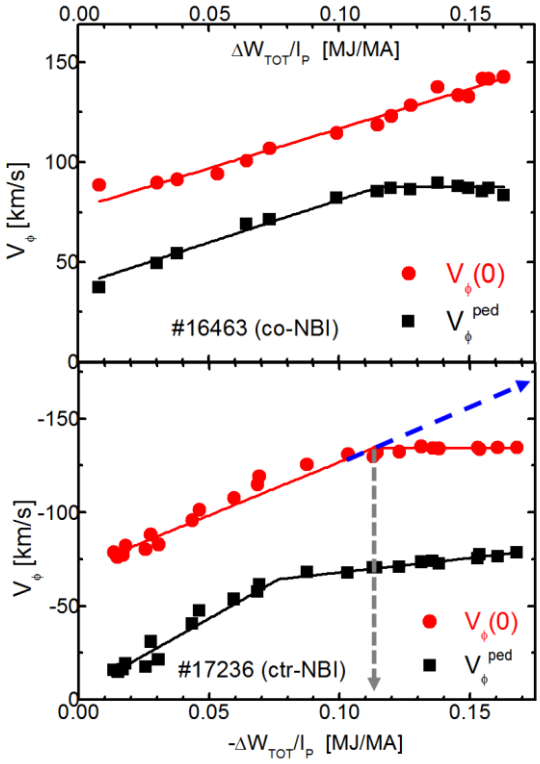

Figure 1. Normalized store energy is propotional to core rotation in co-NBI heated plasma while it is saturated for ctr-NBI heated H-mode by core intrinsic torque. The core rotation is especially saturated with rotation of pedestal top in counter-NBI heated H-mode. This is an indirect evidence of the core intrinsic rotation with co-direction.

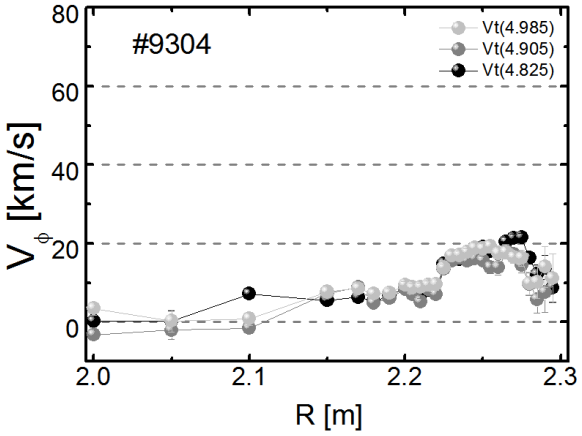

Figure 2. Toroidal rotation globally damped except edge region with co-current direction during mode-locking by RMP in KSTAR H-mode plasma heated NBI

References

[1] J.W. Connor et al, Plasma Phys. Control. Fusion **46** B1–B11(2004)

[2] P.H. Diamond et al, Nucl. Fusion **53**, 104019 (2013)

[3] K. Ida et al, Nucl. Fusion **54**, 045001 (2014)

[4] W.H. Ko et al, Nucl. Fusion **55**, 083013 (2015)

[5] S. H. Mu¨ller et al, Phys. Rev. Lett **106**, 115001 (2011)

[6] Seo et al., Phys. Plasmas **21**, 092501 (2014)