Search for zonal structures on the radial electric field and Reynolds stress profiles on COMPASS

O. Grover[1,2], J. Seidl[1], J. Adamek[1], P. Vondracek[1,3], M. Tomes[1,3], J. Havlicek[1], P. Junek[1], V. Weinzettl[1], M. Hron[1], R. Panek[1] and the COMPASS team[1]

[1] *Institute of Plasma Physics, The Czech Academy of Sciences, Prague, Czech Republic*

[2] *FNSPE, Czech Technical University in Prague, Czech Republic*

[3] *Faculty of Mathematics and Physics, Charles University, Prague, Czech Republic*

The recent observation of stationary zonal-flow-like structures on JET with Doppler backscattering [1] has motivated the search for similar structures in the radial electric field E_r well on COMPASS [5]. The diagnostic used on COMPASS is a complex probe head mounted on a horizontal reciprocating manipulator on the outer midplane which enables a direct measurement of E_r as well as the perpendicular component of the Reynolds stress tensor $\langle \tilde{v}_r \tilde{v}_p \rangle$. The Reynolds stress has been identified in recent models and experiments [2] as a likely driver of poloidal zonal flows which are expected to play a key role in the L-H transition and the associated limit cycle oscillations (LCO) [3]. The probe head features both Langmuir and ball-pen probes [4] which enables a correction for the effect of the electron temperature on measurements of E_r.

It was demonstrated that the probe diagnostic can measure radial profiles of E_r which cover the full extent of the E_r well and remain stationary during both the inward and outward reciprocations. The search for stationary structures on the E_r profile was complicated by saw-teeth crashes which modulate E_r. For this reason, dedicated scenarios were developed. A statistical method based on the bootstrapped Kernel regression was used to asses the statistical significance of any spatial features on the profiles.

While no statistically significant, stationary zonal-flow-like structures have been observed on the E_r profile inside the E_r well, near-stationary zonal-like structures were observed on the profile of the Reynolds stress. The structures do not appear to be correlated with saw-teeth crashes. The structures show a strong correlation between the local poloidal shear $\partial_r v_p \approx \partial_r E_r / B_\phi$ and the Reynolds stress force $-\partial_r \langle \tilde{v}_r \tilde{v}_p \rangle$.

References

[1] J. C. Hillesheim, E. Delabie, H. Meyer, et al., Physics Review Letters **116**, 065002 (2016)

[2] G. R. Tynan, I. Cziegler, P. H. Diamond, et al., Plasma Physics and Controlled Fusion **58**, 044003 (2016)

[3] J. Cheng, J. Dong, K. Itoh, et al., Nuclear Fusion **54** 114004 (2014)

[4] J. Adamek, H. W. Müller, C. Silva, et al., Review of Scientific Instruments **87**, 043510 (2016)

[5] R. Pánek, J. Adámek, M. Aftanas, et al., Plasma Physics and Controlled Fusion **58**, 014015 (2016)