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

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The recent observation of stationary zonal-flow-like structures on JET with Doppler back-scattering [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 radial-poloidal component of the Reynolds stress tensor R_{rp}. 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. No stationary zonal-flow-like structures have been observed when the E_r well is so narrow that its radial scale is comparable to the expected radial scale of the structures.

The probe diagnostic was also used to measure fluctuations of the density δn_e and the electric field E_r during LCO with a frequency of 2-5 kHz. The $\delta n_e, E_r$ evolution is found to be consistent with type-J LCO [3] where the E_r is mostly driven by the pressure gradient and not by the Reynolds stress. The magnetic signature of the LCO is toroidally symmetric and propagates from the LFS to the HFS, i.e. left-right asymmetric (as opposed to top-down on other devices).

References

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