Influence of safety factor on the radial electric field at the edge of tokamak plasmas

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The interest in studying the radial shape of the radial electric field comes from its impact on turbulence and turbulent transport reduction as well as its presumed role in the transition toward the High confinement mode. Experimentally, the radial shape of the perpendicular velocity of density fluctuations, dominated by the ExB velocity, appears significantly influenced by the magnetic topology and the plasma current both in limited [1] and diverted plasmas [2]. Measurements using Doppler Backscattering System in both Tore Supra and WEST tokamaks show a stronger impact of the plasma current when the magnetic B drift is directed away from respectively the contact point and the X-point. In this case, a well in the velocity profile forms at the edge when increasing the plasma current while no well is visible at low current. The interpretation of these results is addressed experimentally, analytically through reduced model [3] and numerically via gyrokinetic simulations exploring turbulence regime, large-scale flows and GAMs contribution related to safety factor and collisionality. GYSELA's simulations reproduce a consistent modification of the radial electric field profile when changing the safety factor. When decreasing the latter, the turbulence intensity decreases as well as the turbulent Reynolds stress tensor. The poloidal velocity, oriented in electron diamagnetic direction, decreases in absolute value when decreasing the safety factor until it changes sign. In parallel, a well forms at the edge in the toroidal velocity and radial electric field. Comparisons of these behaviours with both experiments and reduced model results are conducted in order to highlight physical mechanisms that prevail to influence the shape of the radial electric field in these plasmas.

[1] Hennequin P. *et al* 2010 The effect of SOL OWS on edge and core radial electric field and rotation in Tore Supra *37th EPS Conf. Plasma Physics* (21 – 25 June, 2010, Dublin, Ireland) vol 34A (http://ocs.ciemat.es/EPS2010PAP/html/)

[2] L. Vermare *et al* 2022 *Nucl. Fusion* **62** 026002 https://doi.org/10.1088/1741-4326/ac3c85

[3] M. Peret *et al* 2021 *Nucl. Fusion* **61** 046045 https://iopscience.iop.org/article/10.1088/1741-4326/abe6b3