2-D filament dynamics in high and low shear flows in the edge of the RFX-mod tokamak

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The edge and Scrape-Off-Layer (SOL) transport is dominated by filaments [1]. They can carry turbulent energy from the edge to the SOL, impacting the local SOL fluctuation and enhancing the interaction with plasma-facing components. In addition, they can affect the SOL decay width, by increasing the cross-field transport, which can be a critical issue for future fusion reactors [2]. On the other hand, filaments can be strongly modified by the background shear flow, as well as modify it [3]. In this work, we study the filaments dynamic in different background shear flows using a set of 2-D electrostatic and magnetic sensors array in the plasma edge of the RFX-mod device operated as a tokamak. In addition, first wall poloidally symmetric electrostatic sensors. Through advanced statistical techniques, we detect filaments in different scales and track them from the edge to the SOL, in a 2-D floating potential map. Filaments relevant parameters are computed in the proper plasma frame (in contrast to the laboratory frame) and compared for different scenarios, including ohmic L-mode to H-mode ELMy and ELM-free, the latter induced by edge electrode biasing technique [4]. Their measured features in the different scenarios are compared and discussed in the framework of theoretical and simulation predictions [3]. In L-mode, their radial velocity and size at near SOL region, close to separatrix, are typically $v_r \approx 2\ km/s$, $\delta_r \approx 10\ mm$ and $\delta_\theta \approx 15\ mm$, so their convection time ($\delta_r^2/(v_r\delta_\theta) \approx 4\ \mu s$) is shorter than the shear time ($B/dE_r/dr \approx 100\ \mu s$). In contrast, during the ELM-free H-mode, the shear time is $\approx 2\ \mu s$, so only smaller and/or faster filaments survive. Whereas, in the ELMs phase, the relaxation of the transport barrier allows bigger and/or slower structures to endure the background flow shear. Finally, the role of the sheath connection for the three scenarios is addressed, highlighting the potential structure tilt angle and ellipticity as function of the radius and the measurement of the local parallel density current.

References

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