KBMs in W7-X

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Wendelstein 7-X stellarator (W7-X) aims to demonstrate steady state operation at high β (ratio of kinetic to magnetic pressure) values. This implies high plasma densities up to $2 \cdot 10^{20}$ m^{-3} since the confinement scales beneficially with the density. In recent W7-X experiments, injection of hydrogen pellets was successfully applied for core fuelling [1]. The realization of such densities is complicated due to a limited control of the profile shape. During high-β phases of these discharges MHD-like events were observed, which may indicate a stability limit. In addition, linear GENE simulations suggest that the density and temperature gradients in that phases were large enough to destabilise kinetic ballooning modes (KBMs). Although these plasmas are stable to ideal-MHD instabilities, including ballooning modes, gyrokinetic effects on the latter render them unstable.

The possibility of KBMs limiting the performance motivates an extensive study of different W7-X configurations with regard to, first, electromagnetic modifications of microinstabilities and the so-called “stability valley”, and, second, the connection between global MHD configuration properties and local gyrokinetic stability. In particular, we consider the effects of the vacuum rotational transform, ι, and the mirror ratio. This analysis is instrumental for the design of up-coming high-β operation scenarios.

[1] Bozhenkov, S., et al. Nuclear Fusion 60.6 (2020): 066011.