Non-local analysis of kinetic ballooning modes in pedestal

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The H-mode pedestal height plays an important role in determining the global confinement of the tokamak plasma. In type I ELMy H-mode the ultimate limit for the pedestal is set by the ideal MHD peeling-ballooning modes that are thought to be the trigger for the ELMs. However, the peeling-ballooning mode criterion does not uniquely determine the pedestal. Varying the width of the pedestal, the marginally peeling-ballooning stable pedestal height varies as well. The second criterion for the pedestal is set by the transport processes in the pedestal that limit the gradient between the ELMs.

One candidate for driving this transport is the kinetic ballooning mode (KBM) that is driven by the pressure gradient [1]. The KBM growth rate increases very rapidly after the critical pressure gradient is exceeded leading to very stiff profiles with pressure gradient near the stability limit. In the local linear gyrokinetic analysis of experimental MAST and JET plasmas we have found that like the $n=\infty$ ideal MHD ballooning modes, also the KBMs can access so called 2nd stability if the magnetic shear becomes low enough [2.3]. However, in the pedestal region the local assumption that the equilibrium can be considered radially constant for the investigated modes is no longer justified. In this paper we revisit the KBM analysis using a global code ORB5 [4,5] to investigate whether the 2nd stability access exists also for KBMs that span radially across the pedestal.

We find that opposite to the local analysis, the global KBM stability is not sensitive to the magnetic shear in the pedestal region. At sufficiently high β (but still below the ideal peeling-ballooning limit) the pedestal region becomes KBM unstable regardless of the amount of bootstrap current taken into account in the equilibrium reconstruction. However, just as in local analysis, the mode is stabilised by reducing the pressure gradient. This suggests that KBMs can regulate the pedestal pressure gradient during the ELM cycle even when local analysis finds them stable due to high bootstrap current.

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