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O2.110 Stationary ELM-free H-mode in ASDEX Upgrade

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The H-mode is the preferable operation regime for a fusion reactor due to its superior confinement properties, but it comes with a major drawback: edge-localized modes (ELMs). These instabilities lead to unacceptably high heat loads on the divertor when extrapolated to large-scale machines [1]. The ELM-free phases traditionally observed in poorly heated H-modes are not a viable solution to this problem due to their transient nature and impurity accumulation. Therefore alternative regimes must be found or further studied to allow the successful operation of future reactors. This contribution reports on a stationary H-mode without ELMs recently achieved in the ASDEX Upgrade tokamak at moderate fueling by applying central electron cyclotron resonance heating with a power slightly above the L-H power threshold. This low-torque scenario has high Greenwald fraction, fGW ~ 0.8, and good energy confinement, with an enhancement factor H98y2~1, but no tungsten accumulation despite the absence of ELMs. It was naturally obtained in favorable B configuration without boronization for wall conditioning but it is sensitive to the fueling level and heating power. Additional experiments are planned to widen its parameter space and achieve higher performance. The ELM-free regime always features an edge electromagnetic quasi-coherent mode whose density fluctuations are measured by several diagnostics. Its magnetic signature is detected only by the pick-up coils closest to the plasma, probably because of the strong radial decay due to the high mode number as estimated with microwave reflectometry. The quasi-coherent mode seems to be responsible for enhanced transport losses as its appearance and disappearance are correlated with changes in edge and divertor parameters. This instability is likely a key player in the stationary ELM-free H-mode, which is a promising mode of operation for future reactors.

[1] Leonard, A. W. (2014). Edge-localized-modes in tokamaks. Physics of Plasmas, 21(9), 090501

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