L-H transitions and intermediate behaviours on MAST and MAST-U

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Beyond a critical net power threshold P_{LH}, tokamak plasmas transition to a state of reduced turbulence and improved confinement. This high confinement regime (H mode) allows for a higher core pressure and thus fusion power, and is therefore the favoured operating regime for future, reactor-scale tokamaks. One important goal is to predict P_{LH}. There does not yet exist a quantitative model for P_{LH} and attempts at finding an empirical scaling law have not yet produced one which captures all the parameter dependencies.

The work on the density dependence of P_{LH} for a set of experiments on MAST presented at the previous EPS conference [1] has been updated and refined. The components of the net power P_{net} can each be calculated using different methods, including through making use of the EFIT and TRANSP codes and varying smoothing window sizes in the calculation of the rate of change of stored energy. The findings suggest a combination of TRANSP and EFIT used together with diagnostic data provides the best estimates, though the overall trend of a U-shaped density dependence for P_{LH} is captured by all methods. In addition to different types of H modes and L modes, plasmas near the threshold exhibit a variety of behaviours, which have been classified based on a combination of quantitative and qualitative characteristics. The contrasting plasma responses are shown to occupy distinct regions of parameter space.

Recent studies (e.g. [2]) have shown that L-H transitions occur at a critical energy transfer from turbulence to zonal flows. The generality of this result as well as the link between this and divertor configurations will be explored, as separate studies on C-Mod [3] have shown a dependence of P_{LH} on divertor geometry parameters. As part of a study into the effects of divertor configuration on the L-H transition, experiments comparing H-mode access in conventional and Super-X divertors on MAST-U have been set up. First results from L-H transition studies on MAST-U using the Super-X divertor are presented.

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References

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