Magnetic Behaviour and Information Geometry Across the L-H Transition

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When a heating power threshold is exceeded in a magnetically confined fusion (MCF) plasma, the plasma transitions from a highly turbulent, low-confinement mode (L-mode) into a regime of improved confinement (H-mode). Plasmas that are in H-mode have a transport barrier at the separatrix due to sheared flow that dramatically reduces the turbulent transport of energy and particles out of the core. The mechanism for the access to H-mode is not fully understood, but since H-mode is seen as a promising regime for an operational, electricity producing fusion reactor, an understanding of the dynamics of the transition from L- to H-mode, and the reverse transition from H-mode to L-mode, is desirable [1].

The majority of investigations into the L-H transition focus on suppression of electrostatic turbulence from sheared flows, but not much work has focused on magnetic activity over the transition, and especially for dithering transitions, where there are limit cycle oscillations between L-mode and H-mode. It has recently been reported that there are bursts of MHD activity accompanying the dithering L-H transition [2]. Additionally, the backward H-L transition has not been focused on in as much depth as the forward transition.

This presentation will report on both forward L-H and backward H-L transitions from experimental data, including sharp transitions and dithering transitions. A novel statistical method [3] is applied to the very fast (time-varying) dynamics of the L-H transition with the construction of time-dependent probability density functions (PDFs) of dynamical variables (density fluctuations, zonal flow velocity, magnetic fluctuations), and then calculation of information geometry of those variables. Information geometry shows how much the statistical state of these variables changes, and gives insight into the complex behaviour of the transition that would be inaccessible otherwise, and could have been overlooked. Additionally there will be a comparison of the forward and backward transitions.

References

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