Stochastic simulations of the L-H transition in fusion plasmas

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The Low-to-High confinement (L-H) transition is an extremely important phenomenon in magnetic confinement fusion (MCF) research. It involves a sudden improvement in the confinement conditions of a fusion device when an input power threshold is reached. The work here presents a stochastic prey-predator model of the L-H transition, and builds on the work carried out in [1]. The model involves the interplay of turbulence, zonal flow shear, mean flow shear and the (ion) pressure gradient. The (transformed) turbulence and zonal flow shear are treated as stochastic variables and a corresponding Fokker-Planck equation for the time-dependent probability density function (PDF) is solved numerically. As well as studying the time evolution of the PDF, information length and entropy diagnostics are employed to study the changes to the system and the environment. Hysteresis associated with the L-H transition and its backward, H-L transition is studied by using three input power functions, which are symmetric around a time t_*. The results highlight the importance of non-Gaussian PDFs and time-varying fluctuations in the transitions.

References

[1] R. Hollerbach, E. Kim and L. Schmitz, "Time-dependent probability density functions and information diagnostics in forward and backward processes in a stochastic prey–predator model of fusion plasmas", Phys. Plasmas **27**, 102301 (2020)