13th INTERNATIONAL STELLARATOR WORKSHOP

Tracking singularities in a dynamical model of plasma mass action. The path to the top of the hill.

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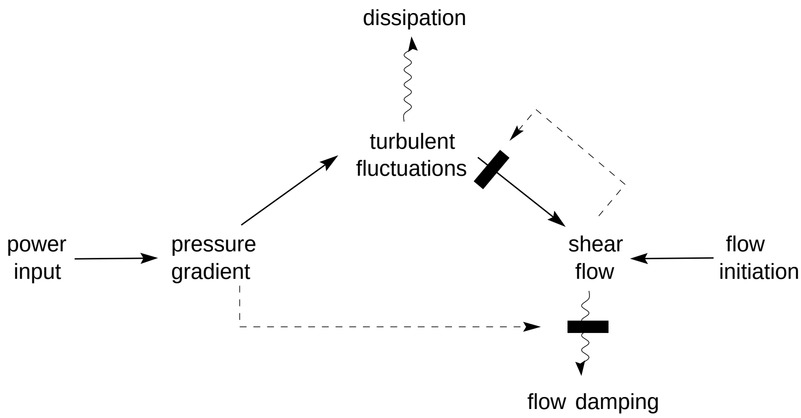
The L–H transition is a more-or-less sudden change in the state of a confined plasma with increasing power input, having the desirable, but counter-intuitive, quality that confinement is dramatically improved. We are interested in understanding why this transition to good confinement properties occurs and how to control it. In this work we present a singularity and stability analysis of an economical model for L–H transition dynamics and clarify the relationship between the qualitative structure of the model and the physics of the process.

By economical, or minimal, model we mean the smallest, functionally simplest, and mathematically consistent model that captures qualitatively the dynamical traits that are typically observed over many experiments in different machines. The strength and power of a minimal model is just this universality; its apparent disregard for numbers and unit dimensions is sometimes perceived as a weakness.

In keeping with this ideology we compose a consensus dynamical model that incorporates coupled rates and feedback processes as indicated in the following schematic.



A constant power input creates a pressure gradient, which feeds the turbulent density fluctuations, which in turn feed energy into the poloidal shear flow via the Reynolds stress. The shear flow has an external source, and is damped through viscosity. Nonlinear behaviour arises through the bipartite, pressure-gradient dependent form of the viscosity function. A high pressure gradient has the effect of reducing or blocking the shear flow damping. Under these circumstances shear flow energy can "accumulate", but having no other avenue for egress it feeds back into suppressing the turbulence. It can readily be appreciated how such processes can balance out — or rather, *un*-balance out — so as to give rise to the oscillatory and hysteretic dynamics that are characteristic of L–H transitions.

Workshop Topics: 2. Transport and confinement improvement, 4. Turbulence and transport.

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