Pulse Propagation and Fast Transient Transport Phenomena Models with Electric Field Shear and Noise

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A theoretical understanding of cold pulse propagation (1) and other fast transient phenomena has long remained elusive. Recent theoretical advances, such as the developing theory of turbulent spreading (2,3), have been motivated, at least in past, by the challenge of quantitatively modeling such pulse propagation phenomena. The most recent theoretical results (4) suggest that both: a) turbulence spreading – the turbulence diffusion, diffusion of the fluctuation intensity field; and b) fluctuation growth, with a critical gradient threshold, as well as self-consistent transport evolution; are required to model pulse propagation. The first capture nonlinear intensity spreading, while the second at least partially represents avalanche phenomena. Here we extend the theory to address the interesting questions of:

i) pulse propagation into a plasma slightly subcritical to an ITB transition;

ii) noise effects on pulse propagation.

In (i), we extend the model to incorporate $E \times B$ shear suppression effects on both thermal and fluctuation intensity transport, as well as on growth and local fluctuation decay. The need for all of these follows from the fact that shearing affects all of growth, nonlinear transfer and transport. Electric field shear is treated self-consistently via force balance. In (ii), we explore the effect of modest external noise on the system. In practice, all real physical systems are, to some extent, noisy for a number of reasons. Experience with self-organized criticality theory suggests that very modest amounts of noise can nucleate avalanches and other extended transport events. Here, we examine the effect of external noise and also explore the self-consistent treatment of nonlinear noise, which arises from nonlinear coupling. Ongoing investigations are focused on the impact of shearing on fast front propagation and on the effect of noise on the spectrum of transport events.

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