Cross-phase control as a mechanism for the I-mode and other enhanced confinement regimes

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New confinement regimes such as the I-mode offer good confinement properties with reduced density limit issues and better control. A number of different mechanisms have been identified for the formation and maintenance of enhanced confinement regimes. Few if any allow enhanced confinement in one channel but not another which is seen in the I-mode. We propose cross-phase as a possible mechanism for different transport in different channels. Simple dynamical models have been able to capture a remarkable amount of the dynamics of the core and edge transport barriers found in many devices, including the often disconnected nature of the electron thermal transport channel sometimes observed in the presence of a standard ("ion channel") barrier. By including in this rich though simple dynamic transport model an evolution equation for electron fluctuations we have investigated the interaction between the formation of the standard ion channel barrier and the somewhat less common electron channel barrier. Further adding to this framework a simple model for phase effects, due to multiple instabilities, between the transported fields such as density and temperature, we can investigate whether the dynamics of more continuous transitions such as the I-mode can be captured and understood. This is backed up by multi-scale simulations on full gyro-kinetic codes. If this mechanism is valid, what can the model tell us about control knobs for these promising regimes?