Turbulence in the Pedestal Driven by Higher-Quantum-Number Modes

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Microturbulence in the pedestal has been identified as an essential factor in whether high-confinement operation can be maintained, while exhibiting a variety of features that cannot be explained when applying core plasma intuition. An important example is the excitation of tearing-parity modes, where the electrostatic potential has odd parity along the background magnetic field with respect to the outboard midplane. In high-gradient scenarios, such modes – rather than those with microtearing drive – are often merely standard modes such as the ion-temperature-gradient instability in their first higher-harmonic quantum state. Standard microinstability theories describe such modes as higher-order Hermite polynomial basis functions.

Higher harmonics – with alternating mode parities – of typical microinstabilities become excited and potentially dominant at strong gradient drive, with larger critical gradients but simultaneously stiffer growth. In the turbulent state, many different quantum numbers tend to be excited simultaneously, complicating scaling interpretations. Among other consequences for nonlinear physics, higher-excitation modes exhibit little electromagnetic transport.

Insofar as the concurrent excitation of many eigenmodes with sometimes exotic mode structures is concerned, similar situations occur in stellarator turbulence. We apply a quasilinear transport modeling approach that yields good predictions for the stellarator [M.J. Pueschel et al., PRL 2016] to the JET-ILW pedestal magnetic geometry.