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Toroidal drift modes in tokamaks: a new model for small ELMs
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— Toroidal drift instabilities, such as the ion-temperature gradient (ITG) mode, are likely drivers of turbulent transport in tokamaks. Depending on the radial drive profile, two distinct mode structures can emerge: for a peaked profile, the violent Isolated Mode (IM) exists on the outboard-midplane, whereas for a linear profile, the more benign General Mode (GM) sits at the top/bottom of the plasma. The IM only exists in special conditions, so we expect the GM to usually drive turbulence. A new global code, based on an electrostatic gyrokinetic toroidal ITG model, has been developed and benchmarked to study the time-evolution of these linear modes. While we consider the ITG mode, the results are expected to be valid for most microinstabilities. A key result is that as the flow-shear evolves through a critical value, the GM evolves into the IM and then back to the GM. Curiously, the mode structure transiently passes through the violent IM phase independent of how fast the equilibrium evolves! For a pedestal evolving between ELMs, if a GM-IM-GM transition occurs, the burst in linear growth during the IM phase could drive a small ELM. The associated transport would maintain the pedestal pressure gradient below the peeling-ballooning limit, avoiding Type I ELMs.

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