DPP11-2011-000580
Abstract for an Invited Paper
for the DPP11 Meeting of
the American Physical Society

Gyrokinetic predictions of tearing mode turbulence in standard tokamaks

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For several years, it has been assumed that microtearing turbulence can destroy rational magnetic surfaces and contribute to the turbulent heat transport in spherical tokamaks. Recently, however, microtearing modes have also been found in various linear gyrokinetic studies for standard tokamaks, in contrast to conventional wisdom. In the present work, microtearing turbulence in such devices is studied for the first time by means of nonlinear gyrokinetic simulations, using the GENE code. The relevant case of weakly to moderately collisional plasmas in model geometries as well as real tokamak geometries is investigated, with a particular emphasis on the character of the nonlinear saturation process which determines the saturation levels. The resulting heat transport is dominated by the electron magnetic component, and the transport levels are found to be comparable with typical experimental fluxes. Microtearing modes are thus a candidate for explaining turbulent transport in standard tokamaks. In this context, pioneering studies of the nonlinear interplay between microtearing modes and other microinstabilities (like ITG modes) are presented, corresponding to experimentally relevant situations. Moreover, it is shown that field-line stochastization can also be caused by the nonlinear excitation (by ITG or trapped electron modes) of linearly stable modes with tearing parity, yielding significant magnetic transport levels for high performance discharges. The expected relevance of both types of tearing modes for ITER is discussed.