DPP15-2015-001420

Abstract for an Invited Paper
for the DPP15 Meeting of
the American Physical Society

Gyrokinetic studies of core turbulence features in ASDEX Upgrade: Can gyrokinetic simulations match the fluctuation measurements?

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Worldwide, gyrokinetic codes are used to predict the dominant micro-instabilities as well as the resulting anomalous transport in fusion experiments. A careful verification and validation of these codes is crucial to develop confidence in the model and improving the predictive capabilities of the numerical simulations. To date, the validation of gyrokinetic simulations versus experiments is mainly done at a macroscopic level, namely, by comparing turbulent heat fluxes. This is usually achieved by varying the profile gradients within the experimental error bars until a match with the experimental heat fluxes is obtained. However, since the turbulent fluxes are caused by plasma fluctuations on microscopic scales, it is also necessary to validate gyrokinetic codes on a microscopic level. We will describe a recent step in this direction by presenting simulation results with the gyrokinetic code GENE for an ASDEX Upgrade discharge. In particular, after flux-matched simulations are achieved, density fluctuations measured by means of Doppler reflectometry are compared with results of gyrokinetic simulations. We will also show that density and temperature fluctuation amplitudes and even the fluctuation spectra can be very sensitive to small changes in the profile gradients. This implies that a match of gyrokinetic simulations with experiment measurements for these quantities can be very difficult to achieve. However, it is observed that cross-phases between different quantities are robust to changes in this parameter, indicating that cross-phases could be a better observable for comparisons with experimental measurements.