Gyrokinetic simulation of collisionless trapped-electron mode turbulence

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The trapped electron mode (TEM) is one important microinstability which drives turbulence. It is supposed that this TEM driven turbulence is responsible for most of the electron heat transport in nowadays experimental fusion devices. We investigate this kind of turbulence with massively parallel gyrokinetic Vlasov simulations. Its spatial structure and the energy and transport spectra are presented. An analysis of the phase relations of different plasma quantities and comparison with their linear counterparts leads to the result that the linear mode structure nearly persists in the nonlinear simulations. By artificially suppressing the zonal flows, we can demonstrate that the influence of zonal flows on the transport level is negligible. Therefore a (quasi-)linear transport model is presented and benchmarked against the nonlinear calculations. In most cases the simple model leads to good approximation of the nonlinear results.

The effect of the variation of the safety factor on the transport level is described and found to match qualitatively experimental results. Dependence of transport on magnetic shear and the inverse aspect ratio is shown. Furthermore the dependence of the electron heat transport on the electron temperature gradient is analyzed and an effective critical temperature gradient is found, which only varies with mass ratio and magnetic shear for density gradients above a certain threshold. For sufficiently high gradients, we find a decoupling of heat and particle transport.