# Spectral Direct Numerical Simulations of low Rm MHD channel flows based on the least dissipative modes

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We put forward a new type of spectral method for the direct numerical simulation of flows where anisotropy or very fine boundary layers are present. The mean idea is to take advantage of the fact that such structures are dissipative and that their presence should reduce the number of degrees of freedom of the flow, when paradoxically, their fine resolution incurs extra computational cost in current methods. We overcome this problem by describing the flow using a basis of eigenvectors of the linear part of Navier Stokes equation. As the computational cost of the resulting method does not depend on the intensity of the magnetic field, it allows us to significantly reduce the computational cost incurred by traditional methods in the regime of high magnetic fields.

We applied the new method to calculate the evolution of freely decaying MHD turbulence between walls. First we validate our code by calculating the cases characterised by low magnetic field and comparing the results against ones obtained with finite volume code. The results showed very good agreement between the two codes both in terms of global quantities like energy dissipations rates and in terms of the resulting energy spectra. We also demonstrated the potential of the new scheme to efficiently resolve flows in the presence of high magnetic fields with a limited number of modes, as predicted by the theoretical considerations.

Next we use the potential of the new method to study the behaviour of MHD turbulence in a set of calculations with higher values of the magnetic field. We investigate the properties of the flow in this regime. We analyse the evolution of kinetic energies and integral lengthscales in directions perpendicular and parallel to the magnetic field and provide the interpretation of their behaviour. Comparing our results with the cases calculated in a 3D periodic domain enables us to quantify the influence of the channel walls on the character of a freely decaying MHD turbulence for the first time.

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