Exercise on turbulent helical dynamos

Use the PENCIL CODE from `http://pencil-code.googlecode.com` to simulate the saturation behavior of a dynamo from helically forced turbulence with forcing wavenumber $k_{\rm f}=3$ in units of the box wavenumber $k_1=1$. To start with, make sure `samples/helical-MHDturb` works. Note that there is a manual. To speed things up, compile with 16^3 meshpoints. In `run.in`, you may use, for example, `nu=2e-2` and `eta=2e-3`, To run for longer, set `nt=20000, it1=50`.

1. Determine the critical value of the magnetic diffusivity above which there is a growth of the rms magnetic field, `brms`, in the file `data/time_series.dat`.

2. Determine the corresponding vaue of the magnetic Reynolds number, $R_{\rm m}=u_{\rm rms}/\eta k_{\rm f}$.

3. Determine the growth rahe of the magnetic field for a choseen value of the magnetic diffusivity that is about half the critical value. Do this by plotting the logarithm of `brms` versus time.

4. Determine the structure of the magnetic field. Consider the evolution of 3 different magnetic field averages. In the file `data/time_series.dat` the evolution of rms values of three different magnetic field averages is being written: the xy average is called `bmz`, the yz average is called `bmx`, and the zx average is called `bmy`. Run the simulation until saturation and determine which of the three averages dominates in the end.

5. Fit the resulting $\langle\overline{\boldsymbol{B}}^2\rangle$ to the expression

$$B_0^2\left[1-e^{-2\eta k_1^2(t-t_{\rm s})}\right]$$

   Here you should use the rms value of the strongest of the three field averages found in question 4.