Supplemental material to "Dissipative magnetic structures and scales in small-scale dynamos"

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In this Supplemental Material (SM), we present diagnostic material that was not included in the main paper (BRS) or the appendix. These include include comparison with the magnetic energy spectra of Kriel et al. (2022), hereafter KBSF.

1 Scaling of Re_λ with Re

The Taylor microscale Reynolds number Re_λ is expected to be proportional to $\mathrm{Re}^{1/2}$. Fig. 1 shows that the scaling in slightly steeper.

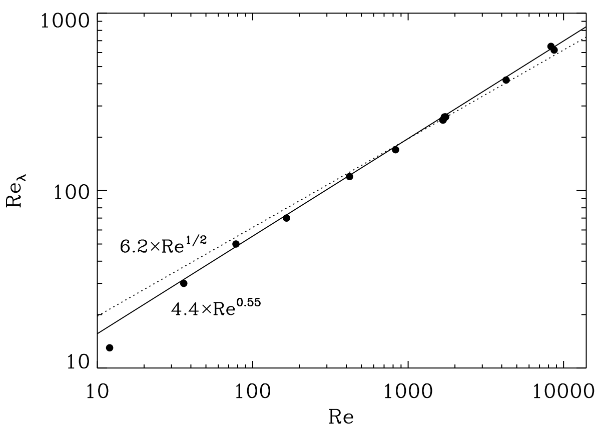

Figure 1: Scaling of Re_λ with Re.

2 Comparison with KBSF

In Fig. 2, we compare time-averaged magnetic energy spectra during the kinematic growth phase from BRS and KBSF. The nominal values of $\mathrm{Re_M} = u_{\mathrm{rms}}/\nu k_{\mathrm{f}}$ are different: 1680 for BRS and $3600/2\pi \approx 570$ for KBSF. The resolution is also different: 512^3 for BRS and 288^3 for KBSF.

We see that the run of KBSF extends further into the diffusive subrange while that of BRS extends further into the inertial range. In the diffusive

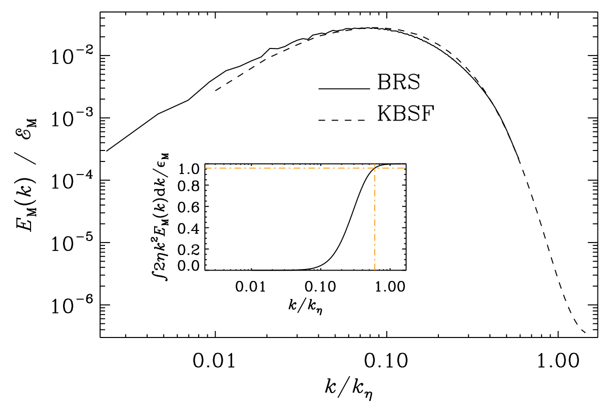

Figure 2: Comparison between BRS and KBSF for 512^3 and 288^3, respectively. The inset shows that at $k/k_\eta = 0.6$, about 96% of the magnetic energy dissipation has been resolved.

subrange, the spectrum of KBSF is slightly steeper than that of BRS.

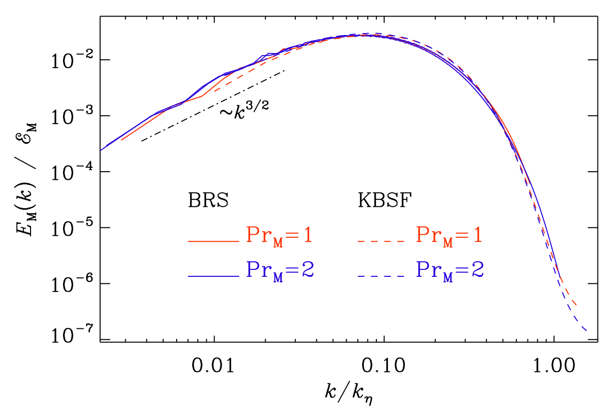

Figure 3: Comparison between BRS and KBSF for $\mathrm{Pr_M} = 1$ and 2.

The results are similar for $\mathrm{Pr_M} = 2$; see Fig. 3. They reproduce the $k^{3/2}$ Kazantsev spectrum in the inertial range, except that the range for KBSF is shorter.

3 Resolution dependence

To check whether the run of BRS was sufficiently well resolved, we compare with a simulation using 1024^3 mesh points; see Fig. 4. We see that the results for 512^3 and 1024^3 are very similar. The shape of the two spectra is the same and also the steepness of the spectra near the diffusive subrange is the same.

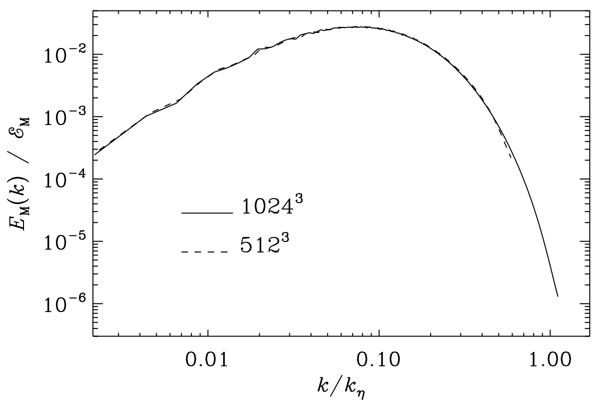

Figure 4: Comparison of Run G of BRS for 512^3 and 1024^3 mesh points.

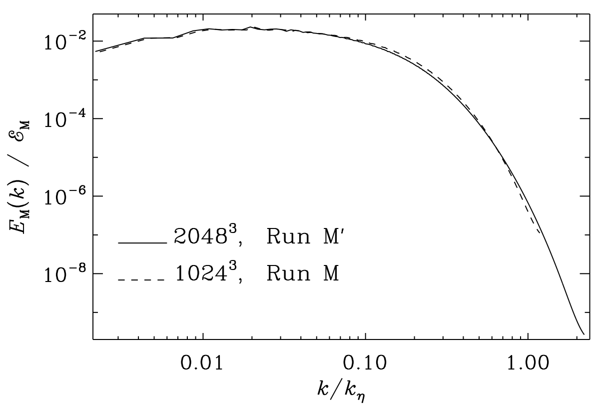

Figure 5: Comparison of Run M of BRS for 1024^3 and 2048^3 mesh points.

4 Kinetic energy spectra

For Run M, we showed kinetic energy spectra at resolutions up to 2048^3 in Appendix B of the main paper, referred to as Run M'. In Fig. 5, we also show the time-averaged compensated magnetic energy spectra in the kinematic regime. A comparison of the kinetic energy spectrum for Run M' of BRS with that of KBSF is shown in Fig. 6. For the latter, we used $k/k_1 = 55$ and $\epsilon_K = 1.2 \times 10^{-3}$ as fit parameters.

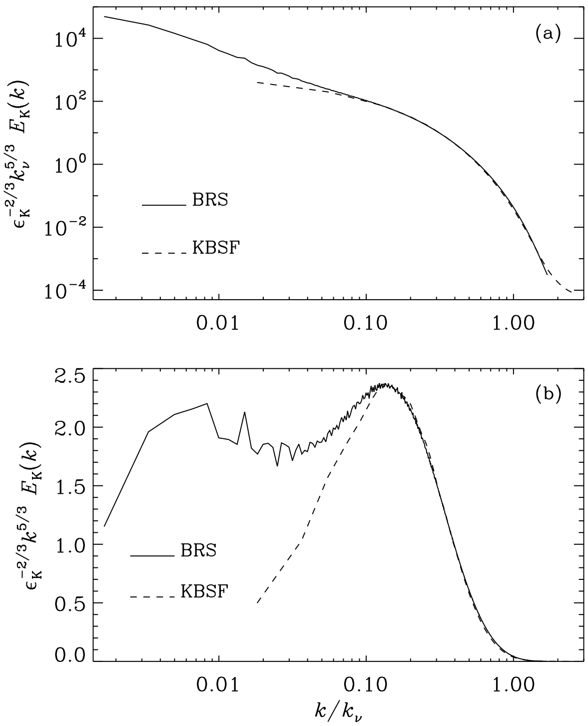

Figure 6: Comparison of the kinetic energy spectrum for Run M' of BRS using 2048^3 mesh points with that of KBSF using 288^3 mesh points.

References

Brandenburg, A., Rogachevskii, I., & Schober, J.: 2022, "Dissipative magnetic structures and scales in small-scale dynamos (BRS)," *Mon. Not. Roy. Astron. Soc.*, submitted

Kriel, N., Beattie, J. R., Seta, A., and Federrath, C.: 2022, "Fundamental scales in the kinematic phase of the turbulent dynamo (KBSF)," *Mon. Not. Roy. Astron. Soc.* **513**, 2457–2470