Analyzing magnetic helicity in parts of a dynamo domain

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1 Introduction

Magnetic helicity is an important characteristic of a turbulent dynamo. For an α effect dynamo, for example, the magnetic field is known to have a bihelical spectrum, i.e., the magnetic helicity spectrum has different signs at different wave numbers. This feature is not expected for other types of dynamos. The large-scale dynamo of the Sun is expected to be of the former type, i.e., an α effect dynamo, but it can also be of some other nature. An example is the Roberts flow II dynamo, which works based on the memory effect of turbulent pumping. Whether or not this can also happens in the Sun, however, is an open question. Here we address the question to what extent we can tell such dynamos apart by only measuring the magnetic field in parts of the domain. As an example, we consider here the Roberts flows I and II in a periodic cubic domain, which allows us to compute magnetic energy spectra.

By restricting ourselves to subvolumes, we can still compute magnetic helicity spectra for those, but this can only be an approximation, because these subvolumes are no longer periodic, which is required when performing a Fourier decomposition. Nevertheless, it will be of interest to find out how different such a spectrum will be and what can be learned from such as spectrum. Moreover, it will be of interest to know the properties of various one-dimensional spectra, which might be accessible under the Taylor hypothesis through a time series representing a chunk of turbulence passing by a spacecraft. Such a method was originally developed by Matthaeus et al. (1982) and was also applied to the solar wind at high heliographic latitudes (Brandenburg et al., 2011).

References

Brandenburg, A., Subramanian, K., Balogh, A., & Goldstein, M. L. 2011, ApJ, 734, 9

Matthaeus, W. H., Goldstein, M. L., & Smith, C. 1982, Phys. Rev. Lett., 48, 1256

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