Relaxation of the turbulent magnetosheath

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Large-scale plasma phenomena can be adequately described by using magnetohydrodynamics equations that potentially involve turbulence when the nonlinear terms are of the order of (or greater than) the linear terms. In turbulence, nonlinear terms drive energy transfer from large-scale eddies into small scales through the so-called energy cascade. Turbulence often relaxes toward states that minimize energy; typically these states are considered globally. However, turbulence can also relax toward local quasi-equilibrium states, creating patches or cells where the magnitude of nonlinearity is reduced and energy cascade is impaired. We show, for the first time, compelling observational evidence that this "cellularization" of turbulence can occur due to local relaxation in a strongly turbulent natural environment such as the Earth's magnetosheath, see Fig.1. This work[1] closes a gap left in the past, namely the lack of experimental evidence assessing the potential alignments predicted by the MHD theory. This is made possible by employing more than 1000 intervals from the Magnetospheric Multiscale (MMS) Mission. In addition, turbulence in the Earth's magnetosheath can be imagined as "young" since it is freshly modified by the solar wind passing through the bow shock. Identifying relaxed states in the magnetosheath strongly suggests that such states either emerge quite rapidly or can survive the shock passage; or both. A future extension to the solar wind awaits upcoming multispacecraft missions such as Helioswarm.

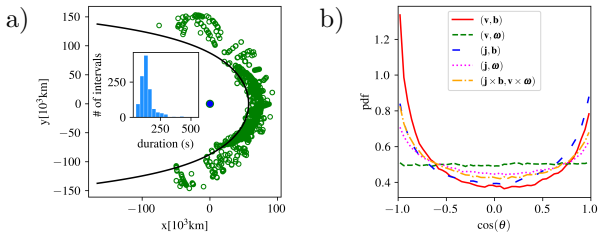

Figure 1: (a) Analyzed intervals in the magnetosheath. (b) Degrees of alignment found between different relevant field pairs.

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[1]Pecora et al., *arXiv* **arxiv.org/abs/2302.00634** (2023)