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Compressible MHD turbulence in the Earth's magnetosheath: estimation of the energy cascade rate using in-situ spacecraft data

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Compressible turbulence has been a subject of active research within the space physics community for the last three decades, it is actually believed to be essential for understanding the physics of the solar wind (for instance the heating of the fast wind), of the interstellar medium (in cold molecular clouds) and other astrophysical and space phenomena.
Using the exact law of compressible isothermal magnetohydrodynamic (MHD) turbulence, we give the first estimation of the energy cascade rate ($|\varepsilon$ C $|$) in the Earth's magnetosheath using THEMIS and CLUSTER spacecraft data. We show that $|\varepsilon$ C $|$ is at least three orders of magnitude larger than its value in the solar wind. We identify different types of turbulent fluctuations (magnetosonic and Alfvénic-like) with different properties and similar scaling laws relating the turbulent Mach number and the energy cascade rate. Eventually we show the role of the density fluctuations in increasing the spatial anisotropy in the Earth magnetosheath. This observational study can actually help improving current models of astrophysical turbulence by addressing the role of compressibility behind astrophysical shocks, in the interstellar medium or in supernova remnants [Hadid et al. PRL, 2018]