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Features of turbulence in proximity of the Heliopause and in the Local Interstellar Medium from Voyager 1 observations

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The Voyager 1 (V1) spacecraft is providing the first and unique in loco measurements of magnetic field (B) in the Local Interstellar Medium (LISM), since the crossing of the heliopause (HP), which occurred on August 25, 2012. The presented study addresses the question of the nature of turbulence at the edge of the helioshpere. We consider magnetic field fluctuations in the HP-to-LISM transition and in the LISM from day 180, 2011 to day 100, 2017. The LISM observed so far is characterized by high-frequency (2.5-3 kHz) plasma wave events related to shocks and to anisotropy of Galactic Cosmic Rays distribution. Here, possible coexistence of pristine interstellar turbulence and waves transmitted form the heliosheath (HS) across the HP is a still unclear and debated topic [Zank Hunana, ApJ 2017]. By considering several consecutive periods, we investigate the features of magnetic field fluctuations in terms of power spectra, spectral anisotropy and spectral compressibility level, probability density functions of B-increments. Differently from previous analysis, data with the highest available resolution (48 s) are used to observe up to five frequency decades ($5 \cdot 10^{-8} - -10^{-2}$ Hz). Since about 70% of data are missing, proper spectral recovery techniques are required for the analysis [Gallana et al, JGR 2016]. LISM fluctuations are mainly compressible thus directed the mean B field (up to 75%). This is also observed in the unipolar period between 2011 and 2012 (compressibility up to 85%), when V1 was likely measuring the field inside a magnetic barrier [Pogorelov et al, ApJ, 2017]. In the LISM, the fluctuating magnetic energy cascades as a power law with spectral index α in the range [-1.35, -1.65] in the whole range of frequencies unaffected by noise in the data ($f < 10^{-4}$ Hz). Inside the heliosheath instead, a spectral break at $f \approx 10^{-5}$ Hz is found to separate an energy-injection range ($\alpha \in$[-0.95, -1.3]) from a turbulent inertial regime ($\alpha \in$[-1.65, -1.85]).