EGU21-9861, updated on 19 Aug 2022
https://doi.org/10.5194/egusphere-egu21-9861
EGU General Assembly 2021

Spectral evolution of Alfvénic turbulence

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Alfvénic turbulence denotes a regime of MHD turbulence in which Alfvén waves propagating in a given direction along the mean field are dominant, as commonly found in polar regions/coronal holes/fast solar wind.

Generalization to Alfvénic turbulence of the Iroshnikov-Kraichnan (IK) weak theory concluded that one should observe a time increase of the imbalance between both Alfvén species and observe the so-called “spectral pinning”, i.e., steep spectra (with spectral index m_+>3/2) for the dominant energy E_+ and flat spectra (with index m-<3/2) for the sub-dominant energy E-.

Since then, observations in the inner heliosphere have shown on the contrary a decrease of imbalance with time, with both species showing the same flat spectra ($m_\pm$ -> -3/2) when imbalance is large.

We show here using direct MHD simulations that both behaviors may occur, the control parameters being the solar wind expansion rate as well as initial conditions of the plasma close to the Sun.