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Enhancement of 3D guide field magnetic reconnection by self-generated kinetic turbulence

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Kinetic plasma turbulence is ubiquitous in magnetic reconnection in laboratory, space and astrophysical plasmas. Most of previous investigations focused on the role of low-frequency/Alfvénic turbulence in homogeneous plasmas. High-frequency/electron-scale turbulence in the reconnecting current sheets, however, have been rarely addressed. Our aim is to investigate the role of this self-generated turbulence via kinetic instabilities in 3D magnetic reconnection. For this sake, we carried out 3D fully-kinetic Particle-in-Cell (PiC) code numerical simulations of force free current sheets with a guide magnetic field, a common situation in the plasmas of interest. We show that the dynamically evolving kinetic turbulence spectra is broadband, with a power-law spectrum between the lower hybrid and up to the electron frequencies with a spectral index near 2.7 at the reconnection site. This result is directly in the frequency-domain, without change of frame of reference assuming Taylor's hypothesis. The evolution of the turbulence correlates with the growth and rate of magnetic reconnection and can be explained by unstable waves caused by (kinetic) streaming instabilities driven by electron current. This provides a plausible explanation for the enhancement of magnetic reconnection due to turbulence observed in laboratory experiments like MRX, VTF and VINETA-II, as well as of in-situ measurements in the Earth's magnetosphere by the MMS spacecraft.