Electric Field Turbulence in the Solar Wind from MHD down to Electron Scales: Artemis Observations

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Recent observational and theoretical work on solar wind turbulence and dissipation suggests that kinetic-scale fluctuations are both heating and isotropizing the solar wind during transit to 1 AU. The nature of these fluctuations and associated heating processes are poorly understood. Whatever the dissipative process that links the fields and particles - Landau damping, cyclotron damping, stochastic heating, or energization through coherent structures - heating and acceleration of ions and electrons occurs because of electric field fluctuations. The dissipation due to the fluctuations depends intimately upon the temporal and spatial variations of those fluctuations in the plasma frame. In order to derive that distribution in the plasma frame, one must also use magnetic field and density fluctuations, in addition to electric field fluctuations, as measured in the spacecraft frame (s/c) to help constrain the type of fluctuation and dissipation mechanisms that are at play.

We present here an analysis of electromagnetic fluctuations in the solar wind from MHD scales down to electron scales based on data from the Artemis spacecraft at 1 AU. We focus on a few time intervals of pristine solar wind, covering a reasonable range of solar wind properties (temperature ratios and anisotropies; plasma beta; and solar wind speed). We analyze magnetic, electric field, and density fluctuations from the 0.01 Hz (well in the inertial range) up to 1 kHz. We compute parameters such as the electric to magnetic field ratio, the magnetic compressibility, magnetic helicity, compressibility and other relevant quantities in order to diagnose the nature of the fluctuations at those scales between the ion and electron cyclotron frequencies, extracting information on the dominant modes composing the fluctuations. We also use the linear Vlasov-Maxwell solver, PLUME, to determine the various relevant modes of the plasma with parameters from the observed solar wind intervals. We discuss the results and the relevant modes as well as the major differences between our results in the solar wind and results in the magnetosheath.