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1/f spectrum, otherwise referred to as “flicker” noise, is a notable feature of solar wind observations. It often spans several orders of magnitude in frequency, yet its generation mechanism remains unknown. Machlup [1] shows that a superposition of “purely random” signals (having a flat power spectrum at low frequencies followed by a power-law of index -2), whose correlation times as an ensemble follow an inverse scale-invariant distribution, yields an overall 1/f spectrum, thereby explaining its presence in various natural and man-made systems. However, in the context of the solar wind, two notable deviations from Machlup’s model apply: (1) correlation times follow log-normal distributions instead of inverse distributions, and (2) datasets typically display a Kolmogorov power-law spectrum with an index of -5/3 under the regime of incompressible, isotropic magnetohydrodynamic (MHD) turbulence with high Reynolds numbers. Montroll & Shlesinger [2] shows that a log-normal distribution with a sufficiently large variance has an extended, inverse-like proportion. Here, we present a derivation that superposing datasets with an arbitrary power-law index between -1 and -3 can give rise to a 1/f spectrum. We complement our derivation with superposing synthetic data, as well as analyzing decade-long (1998-2008) in situ observations from the Advanced Composition Explorer (ACE) mission. In both scenarios, 1/f scaling manifests in the expected frequency regions. Questions still persist regarding whether the interplanetary 1/f noise arises from spatial or temporal superposition, and whether it originates within the sun or lower solar atmosphere [3] or locally in the solar wind [4]. We present causality arguments suggesting that local mechanisms alone cannot account for the observed extension of 1/f noise into low frequencies, and discuss the possibilities of large-scale inverse cascade systems as well as superposition of reconnections in the corona as generation mechanisms of the observed 1/f noise.
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