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New observations and new thoughts on solar wind turbulence

Chuanyi Tu[1] and Xin Wang[2]

[1] School of Earth and Space Sciences, Peking University, Beijing 100871, PRC

[2] School of Space and Environment, Beihang University, Beijing 100083, PRC

e-mail (speaker): chuanyitu@pku.edu.cn

Abstract: We here present a summary of our new analysis on the observational data of solar wind turbulence: **1.** We find that there is usually a large drop on the z-autocorrelation function when the solar wind fluctuations are highly Alfvénic. These features of the z-correlation function may suggest that z-fluctuations consist of two components: high-frequency white noise and low-frequency pseudo structures, which correspond respectively to the flat part and steep part of z-power spectrum. This explanation is not consistent with the widely believed assumption that z-represents inward propagating Alfvén waves and interacts nonlinearly with z+ (outward propagating Alfvén waves) to generate energy cascade. **2.** We found that when the intermittency in the turbulence is removed from a wavelet analysis, the spectral indices of the power spectra of the field and velocity resulted from the wavelet analysis turn out to be independent of the angle between the direction of the local scale dependent background magnetic field and the heliocentric direction. These results may suggest that the recently found spectral anisotropy of solar wind power spectra in the inertial range which was previously explained as an evidence for the presence of a "critical balance" type turbulent cascade could result from turbulence intermittency. **3.** We find that the level contours of magnetic field and velocity self-correlations become isotropic for short intervals from about 10hours to 1hour. This result is not consistent with the prediction by the "critical balance cascade theory" about more pronounced elongation at smaller scales than at larger scales. **4.** We show the break frequency (f_b) appeared at the high frequency end of the inertial rangy normalized, respectively, by the frequencies corresponding to ion inertial length (f_di), ion gyroradius (f_ρi), and cyclotron resonance scale (f_ri) as a function of β which values spread from 0.005 to 20, which nearly covers the full β range of the observed solar wind turbulence. It is found that f_b /f_di (f_b/f_ρi) generally decreases (increases) with β, while f_b /f_ri is nearly a constant which value is near to unit. Our result favors the idea that the cyclotron resonance is an important mechanism for energy dissipation at the spectral break.

These new results initiate some new thoughts on the energy cascade mechanism of the solar wind turbulence. We suggest a new scenario for the solar wind: the HD cascading mechanism controls the inertial cascading, an intermittency-associated sub-range of the inertial domain forms adjacent to the dissipation range, and ion-cyclotron damping controls the dissipation mechanism.

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