Challenges in Study of Solar Wind Turbulence

He Jiansen (何建森)
jshept@pku.edu.cn
School of Earth and Space Sciences, Peking University, 100871, Beijing, China

Solar wind turbulence, which is a natural plasma turbulence that can be both in situ explored and remote-sensing observed, provides us an ideal object to understand the underlying physical processes of plasma turbulence development, cascading, and dissipation. In the past 60 years, thanks to the ground-based and space-born observations, we have learned that: (a) The solar wind is emanating from the solar atmosphere into the heliosphere with the accompanied turbulent fluctuations acting as one of the main drivers. (b) The solar wind abundant with stronger Alfvenic turbulence flows faster and becomes hotter than that free of Alfvenic turbulence. Recent main progresses regarding to the solar wind turbulence are reviewed briefly but not fully in this talk: (1) Three types of MHD waves in the solar wind source region, the possible key elements of turbulence, have been identified from the advanced (spectroscopic) imaging observations and simulated in numerical modeling. (2) The wave-modes and corresponding wave-particle interactions have been diagnosed to be responsible for the turbulence dissipation at ion kinetic scale. (3) The solar wind turbulence has been revealed to be anisotropic in both spectral density and spectral scaling. Although a series of successes have been achieved to reveal the puzzle of solar wind turbulence, some key challenges still remain and need to be addressed in the future. For example: (I) How is the turbulence observed in the source region evolved into and connected with its counterpart in the interplanetary space? (II) What kind of physical mechanism is taking place when going down to the electron kinetic scale? (III) What is the nature and role of intermittency in the solar wind turbulence? These challenges confronting the community become part of the major objectives for the future space mission dedicated to the solar and heliospheric exploration.