Markovian Properties of Transfer of Fluctuations in Solar Wind Turbulence

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ABSTRACT

In recent years, investigations of dynamical properties of irregular fluid flows have attracted the attention of the scientific community. The studies are expected to shed some light on processes controlling dynamics of the flows and eventually help us to understand better the fundamental physical mechanisms leading to turbulence. Analysis of turbulent flows is also interesting for practical purposes, because statistical properties of the irregular flows determine many physical processes (e.g., diffusion) in such media. Solar wind is an example of astrophysical plasma in a turbulent state. Large amount of data available from in-situ measurements of the solar wind plasma parameters makes the medium an excellent laboratory for analysis of plasma turbulence at high Reynolds numbers.

We present results of statistical analysis of solar wind turbulence using an approach based on the theory of Markov processes. We show that the Chapman-Kolmogorov equation is approximately satisfied for the turbulent cascade, which justifies the application of the statistical approach to the description of the turbulent flow. We have also evaluated the first two Kramers-Moyal coefficients from experimental data. We show that the solution of the resulting Fokker-Planck equation fits well the experimental probability distributions. Our results show that the Markov processes approach can be applied to the description and modeling of the intermittent turbulent cascade in the solar wind. We argue that this approach can also be useful in experimental studies of the question of locality of transfer mechanisms in the turbulent cascade in the solar wind.