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RELATIONSHIP BETWEEN BROADBAND SPECTRUM OF CROSS-CORRELATION REFLECTOMETRY OF PLASMA DENSITY FLUCTUATIONS AND NONLOCALITY OF TURBULENCE IN TOKAMAKS *)

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The nonlocality of hydrodynamic turbulence of gases and liquids was first discovered by Richardson [1]: his empirical law (Richardson t^3 law) for the mean square of the mutual separation of a pair of particles in a liquid or gaseous medium, $r^2 \sim t^3$, differs significantly from that for ordinary Brownian diffusion, $r^2 \sim t$. A key step in the development of the theory of nonlocality of various processes in physics and other sciences based on the concept of Lévy flights [2] and Lévy walks, which generalize Lévy flights to the case of taking into account the finite velocity of carriers (see review [3]), was the idea of Shlesinger and colleagues [4] on the possibility of describing the nonlocality of turbulence using a linear integro-differential equation with a kernel slowly decreasing with distance. In [5, 6] an approach close in spirit to [4] was proposed. The basis was a formalism of the Biberman-Holstein equation type for excitation transfer by photons in gases and plasmas [7], generalized to take into account the finiteness of the excitation carrier velocity. This kind of formalism was already used in [8] to describe non-stationary heat transfer in magnetized plasmas by electron Bernstein waves in a generalization of the formalism of the equation of stationary heat transfer by such waves, integral over spatial variables, in [9]. In [5, 6] it was shown that plasma density fluctuations observed in the T-10 tokamak using cross-correlation reflectometry of EM waves [10, 11] can have a turbulent origin: the decay rate in the Lévy distribution for the probability of the free path of density fluctuations across a strong magnetic field (i.e. along tokamak plasma minor radius) in the T-10 tokamak, found by solving the inverse problem from the spectral and radial dependence of the measured cross-correlation function, turned out to be close to its analogue in the empirical Richardson law.

In the present work, in developing the approach of [5, 6], an analytical relationship was obtained between the shape of the "wings" of the cross-correlation reflectometry spectra (the so-called broadband spectra of scattering and cross-correlation) and the distant flights of fluctuations, i.e. the "tail" of the distribution function of density fluctuations along their free path.

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