Poster 1 Bakunin

Percolation effects and coherent structures in turbulent flows

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Essential deviation of transport processes in turbulent fluids and plasma from classical behaviour leads to a necessity of search of new approaches and scaling laws. This paper deals with the relationship between the scalings based upon fractal and upon percolation concepts of turbulence. Renormalization methods of quasi-linear equations in anisotropic mediums are considered. The anisotropy of medium is thought to be due to the presence of a strong magnetic field. It is shown that the Corrsin conjecture about diffusive nature of decorrelations appears to be the basis for such renormalization. The problem of relation between the Lagrangeian correlation function and the Euler one is considered in anisotropic medium. Effectiveness of Corsin's randomization to describe the transport of particles for the model with zonal flow is demonstrated. The common character of correlation approximation for the models of Corrsin's, Taylor-McNamara's is is discussed. The Dreizin-Dykhne model [1], the Kadomtsev-Pogutse method [2], and double diffusion [3] are investigated in detail. The analysis is made of "returns" effects role and memory effects [3-4]. The relation between the description methods of transport in systems with convective cells and percolation method is considered.

The description methods of the strong longitudinal correlation effects are analyzed [5]. The fractional differential equation describing transverse transport in a model with strong longitudinal correlations is obtained. Using the Euler correlation function in the power form $C(x) \sim x^{-a}$ allow us to obtain the relationship between the Hurst factor H and the correlation exponent a. Obtained expression $H=1-a/4$ points out more slowly rate of correlation decay for superdiffusive regimes. This result is in agreement with an analogous scaling law for isotropic medium [4].

The power form of the correlation function allows us to use methods of the percolation theory [5-6]. However, in the frame of monoscale percolation there is not opportunity to describe complex anisotropic effects. There is another way to investigate correlation effects and hierarchy of scales in the frame of multiscale percolation [4]. In that approach drift effects play main role, this differs strongly from the Kolmogorov approach for the description of scale hierarchy. The influence of correlation effects on the limit of applicability of multiscale graded percolation is considered. In that theory the correlation function of the velocity scales as l^{-a}. On the other hand, fractal theory leads to the scaling $l \sim t^{H}$, where H is the Hurst factor. A close examination of fractal and percolation concepts allow us to obtain not only the value of exponent , but also the relationship between H and a. This result is in agreement with the scaling law from quasi-linear approach $H=1-a/4$.

Correlation effects for the Manhattan grid model (generalized Dreizin-Dykhne model) for $H=2/3$ are investigated. Generalization of double diffusion on isotropic case for $H=2/5$ is considered. These models allow us to interpret the superdiffusion behaviour in self-organized criticality and subdiffusion one in transport barriers.

References

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