Abstract Submitted
for the DFD15 Meeting of
The American Physical Society

Wave propagation in inhomogeneous media as turbulent mixing in six-dimensional incompressible flow[1] JAAN KALDA, MIHKEL KREE, Institute of Cybernetics, Tallinn University of Technology — Using the approximation of geometrical optics, light propagation in media with fluctuating coefficient of refraction can be described as Hamiltonian dynamics of wave vectors in 6-dimensional phase space where the spatial coordinates are complemented by the respective wave vector components. Hence, according to the Liouville's theorem, the dynamics of the wave front can be described as mixing in an incompressible 6D velocity field. As the wave energy is transferred along the ray trajectories, the energy density fluctuations follow the dilution of the wave front. We use the theory of turbulent mixing to show that the intensity-distribution of speckles (regions of high energy density) follows a power law, and to derive the scaling exponents. If the velocity field were isotropic, these exponents would be determined by the dimensionality of the flow. However, there is a strong anisotropy of the field due to the asymmetry between the spatial and wave vector coordinates. Also, the effective dimensionality of the flow is reduced by one due to the energy (wave frequency) conservation law: any ray trajectory is bound to a five-dimensional manifold within the 6D phase space. Implications of the anisotropy, and of the effective reduction of the dimensionality are studied numerically

[1]The research was supported by the European Union Regional Development Fund (Centre of Excellence TK124: Centre for Nonlinear Studies).

Jaan Kalda
Institute of Cybernetics, Tallinn University of Technology

Date submitted: 31 Jul 2015 Electronic form version 1.4