Prof. V. I. Tatrskii and strong scintillation theory

Mikhail Charnotskii
Independent researcher
Erie, CO, USA

After reviewing the history of interaction and collaboration with Prof. Tatarskii in Moscow and Boulder spanning from 1970s to 2000s, we concentrate on one of his major achievements: theory of strong scintillation of wave propagating in randomly inhomogeneous medium (SST). Fundamentals of the SST have been formulated in a very transparent form in the 1977 paper in collaboration with V. I. Klyatskin and V. U. Zavorotny. This development vastly increased the reach of theoretical description of propagation processes, which previously was limited to the various versions of perturbation approach.

Original, 1977, theory was presented for a simplest case of scintillation index of plane wave. In the following four decades V. I. Tatarskii's ideas have been extended for a variety of propagation problems. It appeared that, in conjunction with the classical perturbation results, SST provides complete sets of asymptotic solution for the propagation problems.

SST uses parabolic equations for the fourth and higher-order coherence functions of propagating paraxial waves. In many cases, the Feynman path-integral solution of parabolic equations id used as a starting point for the SST expansion. Prof. V. I. Tatrskii was also a leading figure in application of both of these methods to the wave propagation in random medium. We review the fundamentals of the SST and present several classic and more recent results that use the SST for

- bounded beam waves with various focusing conditions,
- scintillation averaging by a finite receiving aperture
- scintillations on the ground-to-space beam propagation
- statistics of random PSF in imaging through turbulence
- statistics of the phase fluctuations under "deep turbulence" conditions
- fluctuations of the "OAM–in-the-bucket" for propagation through turbulence

Unfortunately, SST has a steep learning curve, which probably explains a modest number of publications that are taking advantage of it. Author encourages younger researches in the wave propagation field to carry on Prof. Tatarskii's work.