Contribution of Anderson Localization to the Beyond-the-Horizon Propagation of Microwaves in the Troposphere

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As the propagation of microwave radiation above the sea surface is concerned, the most adequate and efficient electrodynamic model of the atmosphere is a random medium with fluctuating refractive index. The spatial spectrum of the fluctuations can be separated into two statistically independent regions, whose effects can be treated separately and, to some extent, independently. One of these two is related to the small-scale atmospheric turbulence, and has been comprehensively studied by V. I. Tatarskii within the Markov process approximation. The other region, characterized by much larger length scale, is usually strongly anisotropic, which makes it possible to neglect variations in the horizontal plane and to describe it approximately as a random function of a single vertical coordinate.

In this talk, I will first briefly introduce the Anderson localization phenomenon, which dominates the wave propagation in one-dimensional (1D) random media. It will be shown that in the localized regime, the statistical properties of the spectrum of the transmission coefficient of statistically homogeneous random media are similar to those of a conventional microwave resonator. While typically (i.e., at the most of frequencies) the transmission through a long enough 1D random realization is exponentially small, there exist a discrete set of resonances, at which the transmission is large, sometimes close to unity, depending on the location of the effective resonant cavity inside the sample. In 3D randomly stratified media, the one-dimensional (in the vertical direction) Anderson localization leads to formation of disorder-induced fluctuational waveguides, along which the radiation propagates with anomalously small attenuation. The estimations show that, for example, in tropical zones at anticyclone conditions, this mechanism can contribute significantly to the far-beyond-the-horizon microwave propagation along the ocean surface. Although no thorough radiophysical measurements aimed at observing the fluctuation waveguide have yet been carried out, some indirect evidences in favor of this phenomenon do exist, for example, frequently observed correlation of the over-the-horizon field intensity with the dispersion of the refraction index fluctuations near the surface.