Anderson Localization of classical waves in one dimensional Levy lattices

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Abstract

The Anderson localization is a fascinating phenomenon in which the interference of multiply scattered waves in disordered media can lead to the localization of all states, which prohibits the wave's propagation and leads to the inhibition of waves transport. In such situations the amplitude of the incident wave decays exponentially. The scale on which this decay takes place is called the localization length l which also describes the spatial spread of the modes of the system. We studied the Anderson localization of classical waves in weakly scattering one-dimensional Levy lattices both analytically and numerically. The disordered medium is composed of layers with alternating refractive indices and with thickness disorder distributed according to the Pareto distribution $\sim 1/x^{\alpha}$. In Levy lattices the variance (or both variance and mean) of a random parameter does not exist which leads to a different functional form for the localization length. In this study an equation for the localization length is obtained and it is found to be in excellent agreement with the numerical calculations throughout the spectrum. The explicit asymptotic equations for the localization lengths for both short and long wavelengths have been deduced. It is shown that the localization length tends to a constant at short wavelengths and it is determined by the layer interface Fresnel coefficient. At the long wavelengths the localization length is proportional to the power of the wavelength λ^{α} for $1<\alpha<2$ and it has a transcendental behaviour $\sim\lambda^2/\ln\lambda$ for $\alpha=2$. For $\alpha>2$, where the variance of the random distribution exists the localization length attains its classical long wavelength asymptotic form $\sim\lambda^2$.

Keywords—*wave propagation in random media, Anderson localization, multiple scattering, Levy flights*

Professional Biographies

Ara A. Asatryan has completed his PhD at the age of 27 from the Armenian Academy of Sciences, Armenia and he did the postdoctoral studies at the University of Sydney. He is currently a lecturer at the University of Technology Sydney. He has published four book chapters, 92 papers in reputed Journals and more than 150 conference abstracts. He is a Senior Member of the Optical Society of America.

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