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Measurement of the Probability Distribution of Optical Transmittance on the Crossover to Anderson localization

ZHOU SHI, JING WANG, AZRIEL GENACK, Department of Physics, Queens College of the City University of New York — We report measurements of spectra of the field transmission matrix t for microwave radiation propagating through waveguide filled with randomly positioned dielectric scattering spheres in the Anderson localization transition. Diagonalizing the matrix product $tt^\dagger$ gives the transmission eigenvalues τ_n, which yields the optical transmittance, $T = \sum_{a,b=1}^{N} |t_{ba}|^2 = \sum_{n=1}^{N} \tau_n$. The ensemble average of the transmittance is equal to the dimensionless conductance, $g =< T >$. We show the probability distribution of transmittance $P(T)$ changes from Gaussian to log-normal as the value of g decreases. The distribution $P(T)$ is analyzed in terms of the underlying transmission eigenvalues τ_n. For random samples with $g \sim$3.9, we found $P(T)$ follows a Gaussian distribution. For $g \sim$0.37, we observe a highly asymmetric distribution for –ln$T$.The sharp drop for high values of T is attributed to the restriction that $\tau_n <$1 and the repulsion between transmission eigenvalues even for localized samples. For $g \sim$0.04, the distribution of transmittance is nearly log-normal. The variance of -ln$T$, σ^2, scales linearly with <-ln$T$ > as predicted by single parameter scaling even for weakly localized waves.

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