Modes and transmission eigenchannels in the photon localization transition

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We will discuss the changing statistics of the speckle pattern of waves transmitted through random media in the Anderson transition from diffusive to localized waves. We will consider the speckle pattern itself, as well as its decomposition into the modes of excitation of the medium and into the transmission eigenchannels. We will explore the manner in which a wide range of complex static and dynamic phenomena can be related via localization parameters which reflect diverse characteristics of the speckle pattern. The statistics of intensity will be given in terms of the statistics of the dimensionless conductance determined by its average value, g. This will be related to the Thouless number determined from the ratio of the width and spacing of modes, which is equal to g.

The linewidth, central frequency, and speckle pattern of modes is found by decomposing the transmitted microwave field speckle pattern into a sum of patterns associated with each of the modes of the medium. The strong correlation between modal speckle patterns leads to destructive interference between modes and explains the delay in the rise of pulsed transmission of diffusive waves from a wave perspective. Beyond the peak in the transmitted pulse, the phasing between modes is randomized by the random spacing between modes and transmission approaches the incoherent sum of modes.

We have measured the field transmission matrix, t, and found the eigenchannels and eigenvalues of the energy flux matrix $tt^{\dagger}$. The maximum transmission eigenvalue is near unity for diffusive waves even in strongly scattering samples. For localized waves, the maximum transmission is nearly equal to the dimensionless conductance, g, which equals the sum of all transmission eigenvalues. The relationship between correlation within the speckle pattern, the modes and eigenchannels of the random medium will be discussed.

Work done in collaboration with Jing Wang, Zhou Shi, and Matthieu Davy