Interplay between Quasi-normal Modes and Transmission Eigenchannels in Random Media

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It should be possible in principle to provide a full description of wave propagation in disordered systems in terms of either quasi-normal modes, which are solutions of the wave equation, or transmission eigenchannels, which are the singular vectors of the transmission matrix. The close connection between these approaches is indicated in the equality for diffusive waves of the Thouless number, δ, which gives the average degree of spectral overlap of modes, and the average of the transmittance, g, known as the dimensionless conductance, $\delta = g$. Each of these approaches can explain properties ordinarily associated with the other. We will show that the spectrum of transmission eigenchannels yields the density of states (DOS), which is the count of the modes of the medium. The DOS can be determined from the central frequencies and linewidths of each of the modes, which are obtained from the decomposition of field spectra into its modal components. It can also be found from the sum of the derivatives of the phases of the transmission eigenchannels. We will also show that the modal makeup of transmission eigenchannels can explain the broad range of transmission eigenvalues and their spectral correlation. This leads to an approach for maximally and selectively exciting modes within a medium.