Semi-empirical method of characterization of disorder-induced resonances in random media

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Although strong localization of waves in one-dimensional random media has been well studied theoretically, most of the analytical results were obtained for lossless systems and for values averaged over ensembles of random realizations. Obviously, this does not specify the frequency spectrum and the intensity distribution within a particular sample, yet such data are essential for possible applications.

In this talk, we present our results of the investigation of localized states (modes or resonances) in one-dimensional (1D) open, disordered systems. To understand the nature of the resonances in such systems and to describe them quantitatively, the problem is mapped onto a quantum-mechanical problem of tunneling and resonant transmission through an effective two-humped, regular, complex-valued potential. Based on this mapping, an algorithm has been developed for determining internal parameters of random realizations via external measurements. The algorithm enables the localization length and the absorption rate, as well as the frequencies, widths, positions, and intensities of resonances in a given sample to be retrieved from the measurements of the frequency dependences of the reflectance and transmittance. Using these results, one can also solve an inverse problem, namely, to find for each resonance the position and the size of the effective cavity, and the absorption rate of the medium, by using the total length of the sample and localization length as the fitting parameters, and the transmission and reflection coefficient as the input data. The analytical results deduced from the quantum-mechanical analogy are in close agreement with the results of numerical simulations and direct measurements in single-mode microwave waveguides filled with random scatterers. In such waveguides, the interaction of Anderson localized states has been also studied by varying the internal structure of the sample. As the frequencies of two states come close, they are transformed into multiply peaked quasi-extended modes. Level repulsion is observed experimentally and explained within a model of coupled resonators. The spectral and spatial evolution of the coupled modes is described in terms of the coupling coefficient and Q factors of resonators. Those results make grounds to believe that random systems may serve as resonant elements in optical and microwave circuits