Fractal phase of quasimodes in three-dimensional ensembles of point scatterers

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Abstract

Experimental observation of Anderson localization of electromagnetic waves in three dimensions has been elusive despite decades of research efforts. More recently, a deeper understanding of the fundamental issues in this task has been established, in which near-field coupling between scatterers in optically dense media would open new transport channels and eventually suppress the renormalization of diffusion towards localization. In this work, we contribute to this picture by providing evidence of a phase of fractal states, which are expected to exist only at the Anderson transition, but instead could be found in a finite range of disorder strengths. Coupled-dipole simulations within the scalar approximation indicate an intermediate phase between the diffusive and localized regimes, akin to the putative non-ergodic extended phase in certain many-body systems and random-matrix models. Although localization is never reached when polarization effects are taken into account, deviations from standard signatures of the diffusive regime are found and a fractal phase holds for a significant range of densities. These results may be linked to recent observations of subdiffusion of light in spite of the absence of the Anderson transition.

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