Anderson transitions in Euclidean random matrix models

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Multiple scattering of waves by random ensembles of resonant point scatterers can be conveniently described by a random matrix model in which elements of random matrices describe propagation of the wave between the scatterers. Such matrices belong to the family of Euclidean matrices defined as matrices with elements depending on the positions of pairs of points in a Euclidean space. The Euclidean random matrix model of wave scattering is virtually exact in some particular cases (e.g., light scattering by immobile atoms) and is expected to contain the essential ingredients of the problem in more complex situations (scattering by extended objects or continuous random media). We use this model to study Anderson transitions for sound, light, and elastic waves in three-dimensional (3D) random media. Eigenmodes of the wave equation become exponentially localized in space at the critical point of Anderson transition taking place at a sufficiently large density of scatterers. This leads to a breakdown of wave transport (a metal-insulator transition for electrons in disordered solids). We compute the critical parameters of the localization transition (the mobility edge and the critical exponent) for sound and elastic waves and show that light can exhibit Anderson localization only when a strong external magnetic field is applied to the random system. We also discuss the relation of our theoretical results to recent optical and acoustic experiments and propose an experiment in which Anderson localization of light in 3D could be clearly demonstrated.