Localized modes in random arrays of cylinders

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Abstract: We present a numerical study of wave localization in a random system with resonant scatterers. We show that an increase in the dispersion of scatterer size is detrimental to the initiation of Anderson localization. In contrast, we observe strongly localized modes in successive frequency windows when all scatterers are identical.

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Multiple scattering can lead to wave localization in a random medium as a result of complex interference processes. The observation of Anderson localization of light is still a matter of important investigation, with direct application to lasing action with low threshold in active random media. The use of resonant scatterers is among the approaches proposed to enhancing scattering in optical media and fostering the localization of light.

In this work, we numerically investigate the Anderson localization of classical waves in random arrays of dielectric cylinders, as a function of the distribution of their diameters. For identical cylinders, we observe frequency windows of long-lived modes in the spectrum of the impulse response of the system. Such modes exhibit high quality factors and can be considered as good approximations of localized modes in our finite open systems. When cylinders with different diameters are considered, we observe a decrease of the mode lifetime with broadening of the diameter distribution, until the frequency bands of localized modes disappears. These results confirm the essential role of resonant scattering and show how identical resonant scatterers fosters Anderson localization. We discuss this collective process and links it to the effect of proximity resonances that has been studied in the case of small numbers of resonant scatterers.