Light in correlated disordered media

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Disorder has been considered a major drawback in any optical material design since the presence of uncontrolled scattering sources can spoil the intended performance of virtually any design. This fact is particularly evident in photonic crystals because the very existence of a photonic band structure relies on an exact translation invariance. However, disorder is not always as harming as one might expect. In particular, optical structures with correlated disorder can exhibit a rich variety of light transport regimes.

In this contribution, we will discuss some of the results obtained in this field in the last years. Stealth hyperuniform (SHU) structures [1] have been shown to exhibit a well defined and substantially wide photonic gap despite being disordered [2]. Furthermore, this behavior is not exclusive of this particular kind of correlated disorder but appears in wider classes of correlated disordered photonic structures [3].

In the case of two dimensional SHU optical materials, it has been shown that several fundamentally different light transport regimes can emerge and be controlled depending on correlation degree, materials and wavelength [4]. These range from the purest transparency (stealthiness) to isotropic photonic bandgaps passing through regimes of light diffusion and strong Anderson localization. All of them are accessible in a relatively narrow wavelength span.

It is particularly relevant to have designer rules for three dimensional optical materials showing Anderson localization. In this regard, we will discuss the strong numerical evidence found in correlated disordered three dimensional photonic networks [5].

References

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