Transmission and localization length through 1D periodic system with disorder

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Abstract

The study of disordered photonic crystals has experienced an increasing interest in recent years because of their potential applications, notably to build new transducers. More recently, Anderson localization in disordered graphene system has been reported [1] and interesting phenomena have been revealed, as the Anderson insulators behvior of graphene nanoribbons [2], the localization of Dirac quasi particule in relation with the Klein paradox [3] or the suppression of Anderson localization in graphene sheet [4]. We report the study of the localization length and of the transmission through 1D periodic systems with delta potentials perturbed with both positional and compositional disorders. The use of the Coherent Potential Approximation (CPA) allows to identify, in addition to the localization length, the whole structure of the Bloch-Floquet mode in this perturbed but periodic-on-average system. This allows to calculate a transmission coefficient that accounts for the internal reflexion inherent to the propagation in finite size system, beyond the usual prediction $T = \exp(-x/L)$, with L the localization length. Comparison of our predictions with previous works [5] and with direct numerical calculations are reported (Fig. 1 and 2).

References

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Figures

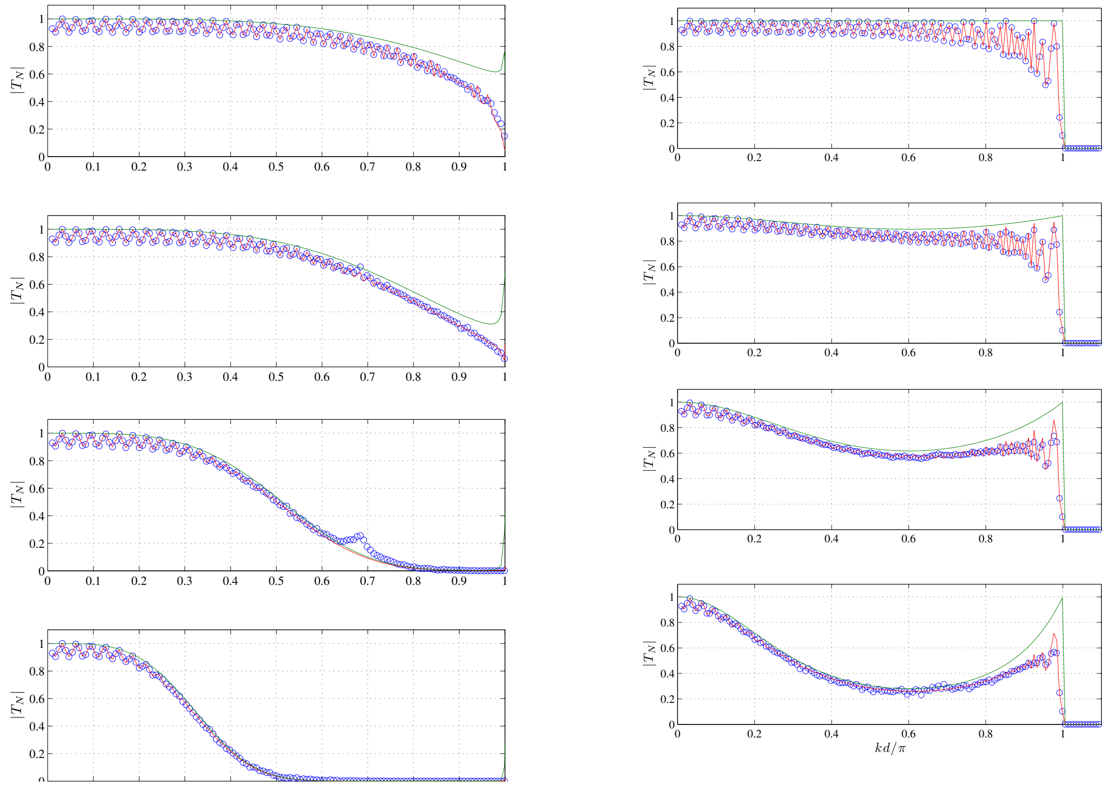

Fig. 1: Transmission as a function of the frequency through a 1D periodic system in the presence of disorder. The system is a wave propagating through periodic delta potentials with perturbation in the position (positional disorder) and in the potential height (compositional disorder). Blue symbols: direct numerical calculations, ref curves: our CPA prediciton for the transmission, Green curves: usual prediction transmission based on the localization length *T*= exp*(-x/L).*

Left: Effect of the increasing positional disorder.

Right: Effect of the increasing compositional disorder.

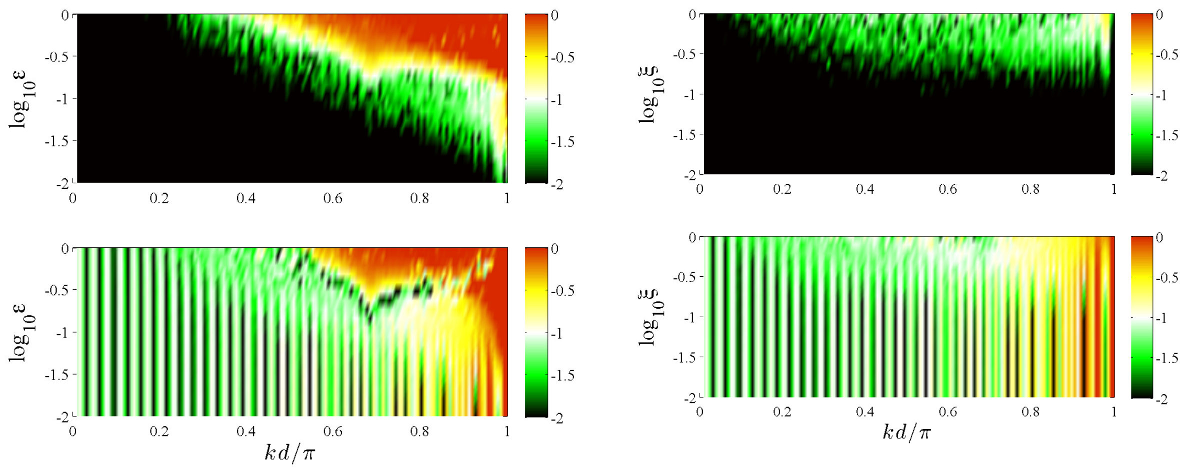

Fig. 2: 2D representation of the error (in log10 scale) between the prediction transmission value and the reference value (calculated numerically), as a function of the amount of disorder (vertical, in log10 scale) and as a function of the frequency (horizontal).

Left: for positional disorder.

Right: for compositional disorder.