Quantum Walks in Photonic Lattices

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Photonic lattices in the form of arrays of optical waveguides with nearest-neighbour evanescent coupling offer a rich playground for the study of linear and nonlinear effect in periodic media. Such lattices have been used by my group and others for more than a decade to study some of the most basic phenomena of wave propagation in periodic and quasi-periodic structures, from Bloch Oscillations to Anderson Localization. While most work with such lattices have studied wave propagation using coherent laser light, we have shown that they could also serve as an excellent decoherence-free platform for the study of quantum dynamics, and in particular of quantum walks [1]. Random quantum walk is the process describing the motion of a quantum particle that hops randomly, yet coherently, from site to site on a lattice. We have extended this concept to more complex random walks of several particles [2-4], and have shown that such walks by indistinguishable particles lead to new and surprising effects on the quantum correlations of the copropagating walkers in periodic lattices. Even more surprises are found when the quantum walkers move in a disordered lattice where the particles are also constrained via Anderson localization [5-7]. I will present recent experiments on such systems, and review the effects of interactions on such correlations [8].

References

[1] H. Perets *et al.* Phys. Rev. Lett. **100** 170506 (2008)
[2] Y. Bromberg, Y. Lahini, R. Morandotti and Y. Silberberg, Phys. Rev. Lett. **102**, 253904 (2009)
[3] Y. Bromberg, Y. Lahini, Y. Silberberg, Phys. Rev. Lett. **105** 263604 (2010)
[4] A. Peruzzo *et al.* Science **329** 1500-1503 (2010)
[5] Y. Lahini *et al.* Phys. Rev. Lett. **100** 013906 (2008)
[6] M. Segev, Y. Silberberg and D.N. Christodoulides Nature Photonics **7** 197 (2013)
[7] Y. Lahini, Y. Bromberg, D.N. Christodoulides and Y. Silberberg, Phys. Rev. Lett. **105**, 163905 (2010).
[8] Y. Lahini *et al.* Phys. Rev. A **86** 011603 (2012)