Highlights

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Statistical moments of quantum-walk dynamics reveal topological quantum transitions

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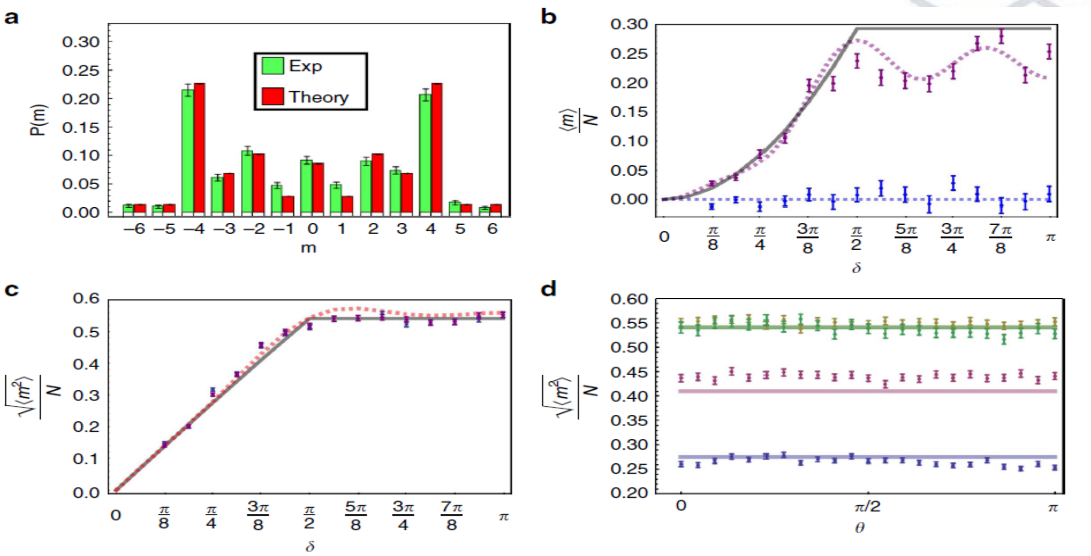
Many phenomena in solid-state physics can be understood in terms of their topological properties. Recently, controlled protocols of quantum walk (QW) are proving to be effective simulators of such phenomena. Here we report the realization of a photonic QW showing both the trivial and the non-trivial topologies associated with chiral symmetry in onedimensional (1D) periodic systems. We find that the probability distribution moments of the walker position after many steps can be used as direct indicators of the topological quantum transition: while varying a control parameter that defines the system phase, these moments exhibit a slope discontinuity at the transition point. Numerical simulations strongly support the conjecture that these features are general of 1D topological systems. Extending this approach to higher dimensions, different topological classes, and other typologies of quantum phases may offer general instruments for investigating and experimentally detecting quantum transitions in such complex systems.



Theoretical predictions and experimental results. (a) Example of a probability distribution for the walker: measured (green,left) and expected (red, right) probability distributions. (b,c) Measured values of statistical moments (dotted lines) for two different initial states. The continuous lines are theoretical asymptotic predictions. (d) Comparison between measured values of $\sqrt{M_2}/N$ (dotted points) and theoretical predictions (continuous lines) by varying the initial polarization for three values of the optical retardation.