Studies of Synthetic Dimensions: From Classical Light to Quantum Regime

L Yuan[1]

[1]*School of Physics and Astronomy, Shanghai Jiao Tong University, Shanghai, China*
Contact Email: yuanluqi@sjtu.edu.cn

Synthetic dimensions in photonics have been under rapid development and attract great interests in the past few years. Here I will discuss the opportunity of constructing the synthetic frequency dimension in dynamically modulated ring resonator systems, where the connectivity of the artificial lattice structure can be designed in a synthetic space including the frequency dimension. Hence interesting physics, such as the effective magnetic flux for photons, the flatband physics, the photon blockade effect, and the topological non-equilibrium dynamics, can be studied with synthetic dimensions. Moreover, recent experimental achievements also provide a unique method to observe novel optical phenomena in the synthetic frequency dimension. In addition, I will talk about our recent work on seeking the possibility of creating arbitrary synthetic dimensions via multi-photon dynamics on a one-dimensional lattice, where the one-dimensional lattice hosting N indistinguishable photons can be mapped to a single photon on an N-dimensional lattice with high symmetry. Our newly proposed theoretical framework hence provides a novel perspective to explore the multi-photon dynamics on lattices with photon-photon interactions and opens up a future avenue in the fields of multi-photon manipulation in quantum engineering.