

武汉物数所理论交叉学术交流系列报告

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Manipulating photons in the synthetic dimension

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磁共振楼12楼1217报告厅



报告人简介:

周正威, 分别于1996年、2001年在中国科学技术大学物理获得本科和博士学位, 后留校任教, 目前是中国科学技术大学光学与光学工程系 执行主任、教授。中国物理学会量子光学专业委员会秘书长, 《中国科学——信息科学》编委。研究兴趣主要集中在: 量子模拟、量子调控、多体纠缠和量子相变等问题。迄今为止发表SCI论文97篇, 包括《Nature Photonics》(1), 《Nature Communications》(2), 《Physical Review Letters》(5), 《Physical Review A、B》(45), 《New Journal of Physics》(4), 被SCI引用900多次, H-index为17。

Abstract:

Quantum simulation is one of the most important research fields in quantum information science, which not only allows the study of the existed physical systems, but also new physical modes with new phenomena. Currently, there are various experimental platforms used for quantum simulation, such as ultra-cold neutral atom, trapped ion, integrated optical system et al.

Orbital angular momentum of light is a fundamental optical degree of freedom. It is characterized by unlimited number of available angular momentum states, and has proved invaluable in diverse recent studies ranging from quantum information to optical communication.

In this talk, we will introduce fully new applications of photon's orbital angular momentum in quantum simulation of topological physics. The basic idea is to design a degenerate cavity supporting photonic modes carrying different orbital angular momentum (i.e. the Laguerre-Gaussian modes), whose resonance frequencies are the same. By coupling photons in different orbital angular momentum states, a single degenerate cavity is equivalent to a 1D coupled-cavity array. Consequently, 1D coupled degenerate cavity array can be used to simulate 2D physics. We proposed some schemes to realize arbitrary Abelian gauge field, SU(2) non-Abelian gauge field, to detect topological invariants such as edge state and Chern number, and to observe topological quantum phase transition. In contrast to other 2D proposals, this 1D structure greatly reduces the complexity of the simulator, and feasible scale of simulation is also increased[1].

Furthermore, we also investigate 1D topological models by using single degenerate cavity. By designing the boundary of such kind of synthetic dimension, we may observe the dynamics of edge modes which will exhibit topological phase transition of models[2]. By manipulating the synthetic dimension in the degenerate cavity, some significant all-optical devices can be constructed[3].

References:

- [1] Xi-Wang Luo, Xingxiang Zhou, Chuan-Feng Li, Jin-Shi Xu, Guang-Can Guo & Zheng-Wei Zhou, Quantum simulation of 2D topological physics in a 1D array of optical cavities, Nature Communications 6,7704 (2015).
- [2] Xiang-Fa Zhou, Xi-Wang Luo, Su Wang, Guang-Can Guo, Xingxiang Zhou, & Zheng-Wei Zhou, Dynamical manipulation of topological edge modes and Floquet topological insulator in a single degenerate optical cavity, Phys. Rev. Lett. 118, 083603 (2017).
- [3] Xi-Wang Luo, Xingxiang Zhou, Chuan-Feng Li, Jin-Shi Xu, Guang-Can Guo & Zheng-Wei Zhou, Synthetic-lattice enabled all-optical devices based on orbital angular momentum of light, Nature Communications 6,7704 (2015)..

主办单位:武汉物数所理论与交叉研究部