Study in Topological States in Optical Lattice

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***Abstract*—The light diffraction in waveguide arrays has proven to be an important simulator for the condensed matter and topological physics. Here, we proposed and demonstrated the topologically non-trivial phases and photonic topological edge states (TES) within such a 1D coupled optical system. Our studies deepen the understanding of light propagation in waveguide arrays and may open new avenues for optical simulation and photonic design.**

Keywords—topological edge state; waveguide array

I. Introduction

The concept of topological physics have been successfully extended to optical domain and launched the topic of topological photonics [1]. The observation of the photonic topological edge states (TES) that gives rise to robustness against scattering from defects prompted the search for photonic TES in different systems[2-5], including coupled optical waveguide systems [4,5]. In this work [6], we investigate the coupling effects and topological phase in an Su-Schriffer-Heeger (SSH) modeled optical waveguide array [7], and demonstrate the nontrivial topological edge state.

II. Results

Here, we investigated the topological phase based on SSH model. By varying the on-site potential and hopping amplitude, we discover the topological phase diagram. The region where topologically nontrivial phase and the edge state exist is found, which has weight on the boundary. The topological protection property of the edge state is also verified.

To confirm these theoretical results based on coupled-mode theory (CMT) calculations, we simulated the TES using straight plasmonics waveguide arrays. It is well demonstrated that the TES is immune to the structural disorder and nanofabrication errors. Furthermore, due to the convenience in modulating the coupling coefficient in the plasmonic waveguide array, it is possible to construct positive, negative and even zero couplings in such a waveguide array, so that any input state would be perfectly transferred to the output, and more interesting effects such as optical revival can be achieved.

III. Conclusion

In conclusion, we have investigated the coupling effects and topological phase based on optical SSH model. It is found that topologically nontrivial phase and TES can be supported in the 1D optical systems. The TES we have found could be useful for routing light waves and deepen the basic understanding of optical simulation of topological physics.

Acknowledgment

This work is supported by National Key R&D Program of China (No. 2017YFA0303700, 2016YFA0202103), the National Natural Science Foundation of China (Nos. 11674167, 11621091, and 11322439), the Dengfeng Project B of Nanjing University, and the PAPD of Jiangsu Higher Education Institutions.

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