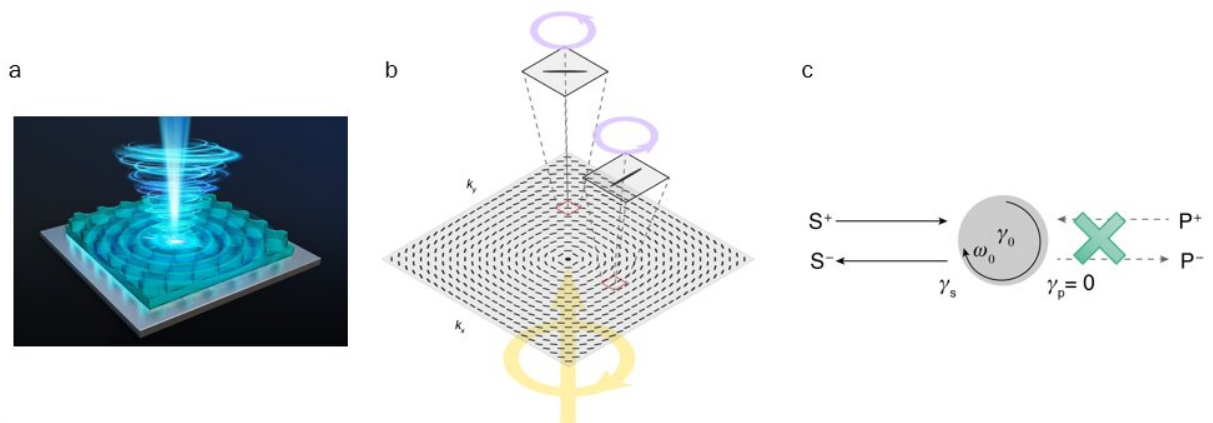


# High efficiency vortex beam generation without alignment center

January 4 2023



(a) The schematic diagram of reflection-type vortex beam generator; (b) Principle of using the polarization singularity in the momentum space to generate vortex beam; (c) The diagram of temporal coupled-mode theory. Credit: ©Science China Press; *National Science Review* (2022). DOI: 10.1093/nsr/nwac234

The PBG group of Department of physics, Fudan University, recently proposed a method using a reflective photonic crystal slab to generate vortex with high conversion efficiency and without an alignment center.

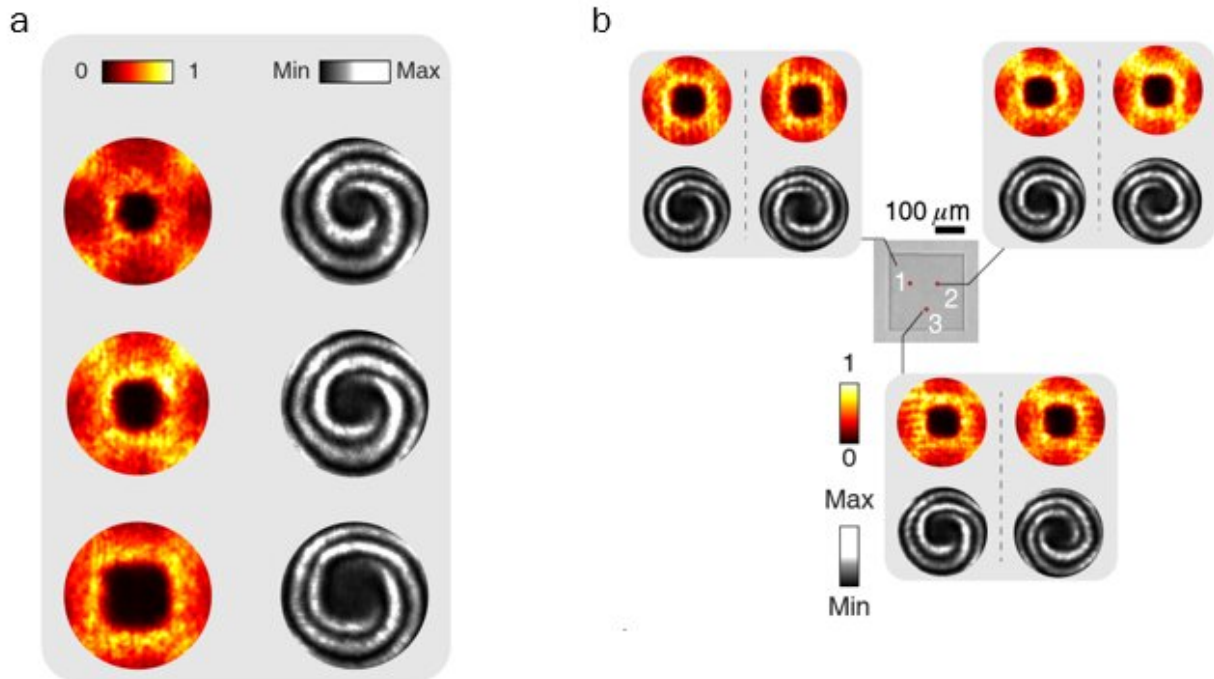
Researchers utilize the polarization [singularity](#) located at the at- $\Gamma$  bound state in the continuum in the momentum space to generate the [vortex](#) beam. Since the singularity exists in the momentum space, the working

region of the photonic crystal slab doesn't rely on the incident position of the beam.

To push the conversion efficiency of the [generator](#), researchers firstly introduced a perfect mirror to block the transmission channels in nonlocal vortex beam generation systems, which will then only transfer the incident energy to the reflection channel. They found that VB generation using single resonances and a perfect mirror in a reflection-type system can achieve 100% cross-polarized conversion efficiency.

Unfortunately, when the practical applications at visible and near-infrared wavelengths are considered, the absorption of the metal mirror will inevitably cause a loss that will reduce the conversion efficiency of such a vortex beam generator greatly. In this work, they gave a general picture based on temporal coupled mode theory to improve the VB generation efficiency of reflection-type generators with intrinsic absorption. In their theory, the conversion efficiency was determined by the ratio of the radiative loss to the intrinsic absorption.

Based on this picture, mode selection and structure design are employed to increase this ratio efficiently. In both simulations and experiments, they observed the maximum on-resonance [conversion](#) efficiency of up to 86% in their designed reflection-type vortex beam generators. They also experimentally observed the vortex [beam](#) profiles generated at different wavelengths and in different working regions.



(a) Beam profiles and interference fringes at different working wavelength; (b) Vortex beam generation with different incident position. Credit: ©Science China Press; *National Science Review* (2022). DOI: 10.1093/nsr/nwac234

**More information:** Tongyu Li et al, High-efficiency nonlocal reflection-type vortex beam generation based on bound states in the continuum, *National Science Review* (2022). [DOI: 10.1093/nsr/nwac234](https://doi.org/10.1093/nsr/nwac234)

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