

Manipulation of higher-order Poincaré sphere beams beyond the diffraction limit using single-layer metasurface

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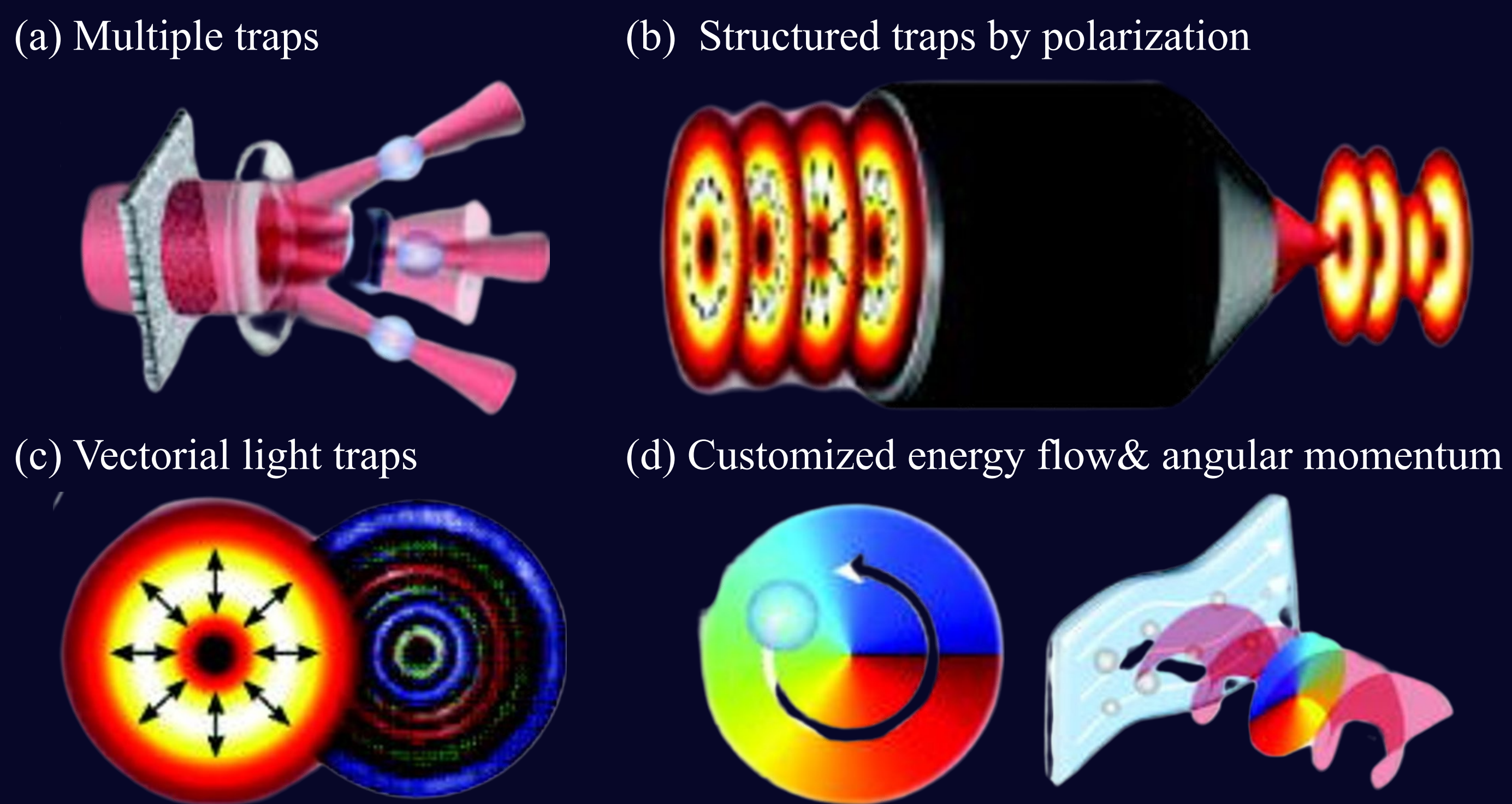
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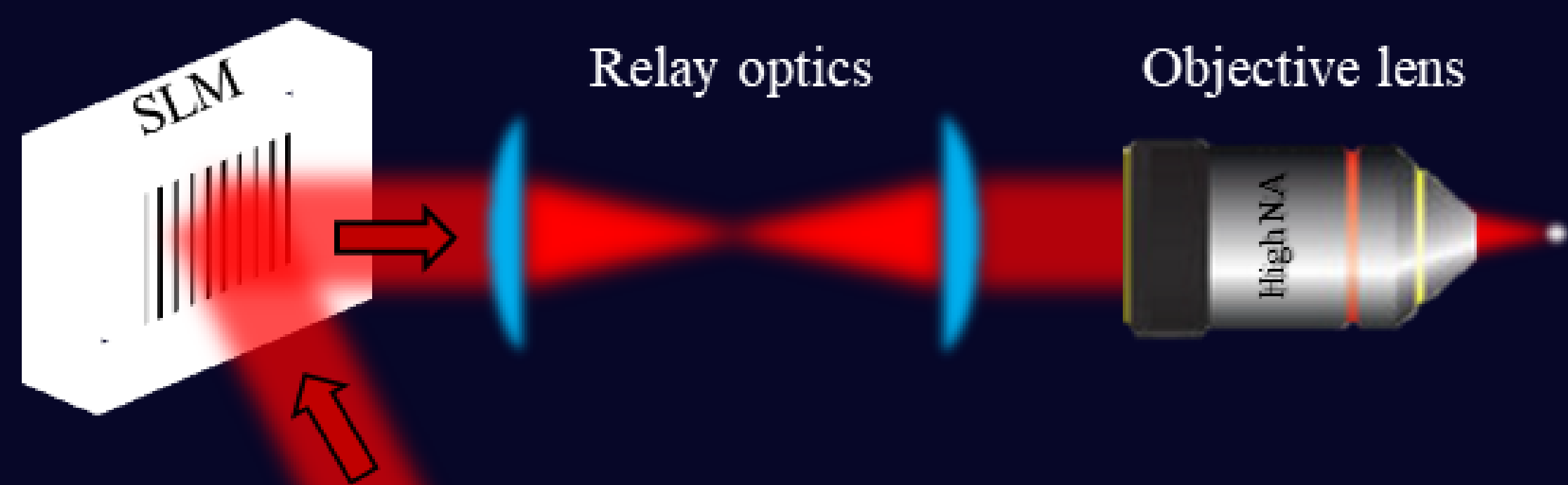
Abstract: Control and generation of arbitrary higher-order Poincaré sphere (HOPS) beams have attracted intensive interest because of the potential of extreme optical manipulation using HOPS beams. Here, we experimentally demonstrate the control of focused HOPS beams with multi-foci of 22% smaller than the diffraction limit via a single-layer metasurface.

Challenges in structured optical manipulation



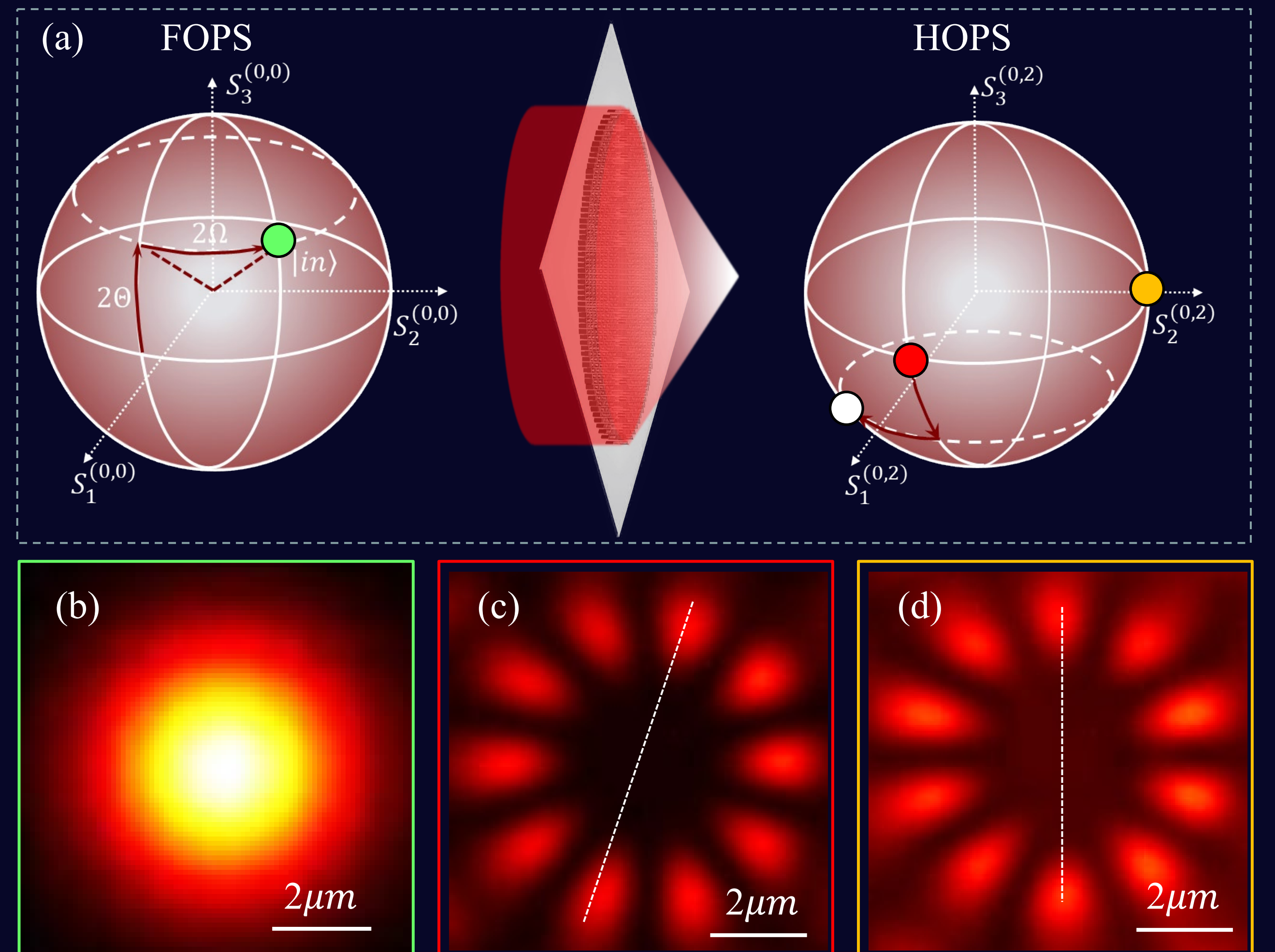
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Classical optical configuration for structured optical trapping



Bulky, Low efficiency, Difficulty in alignment

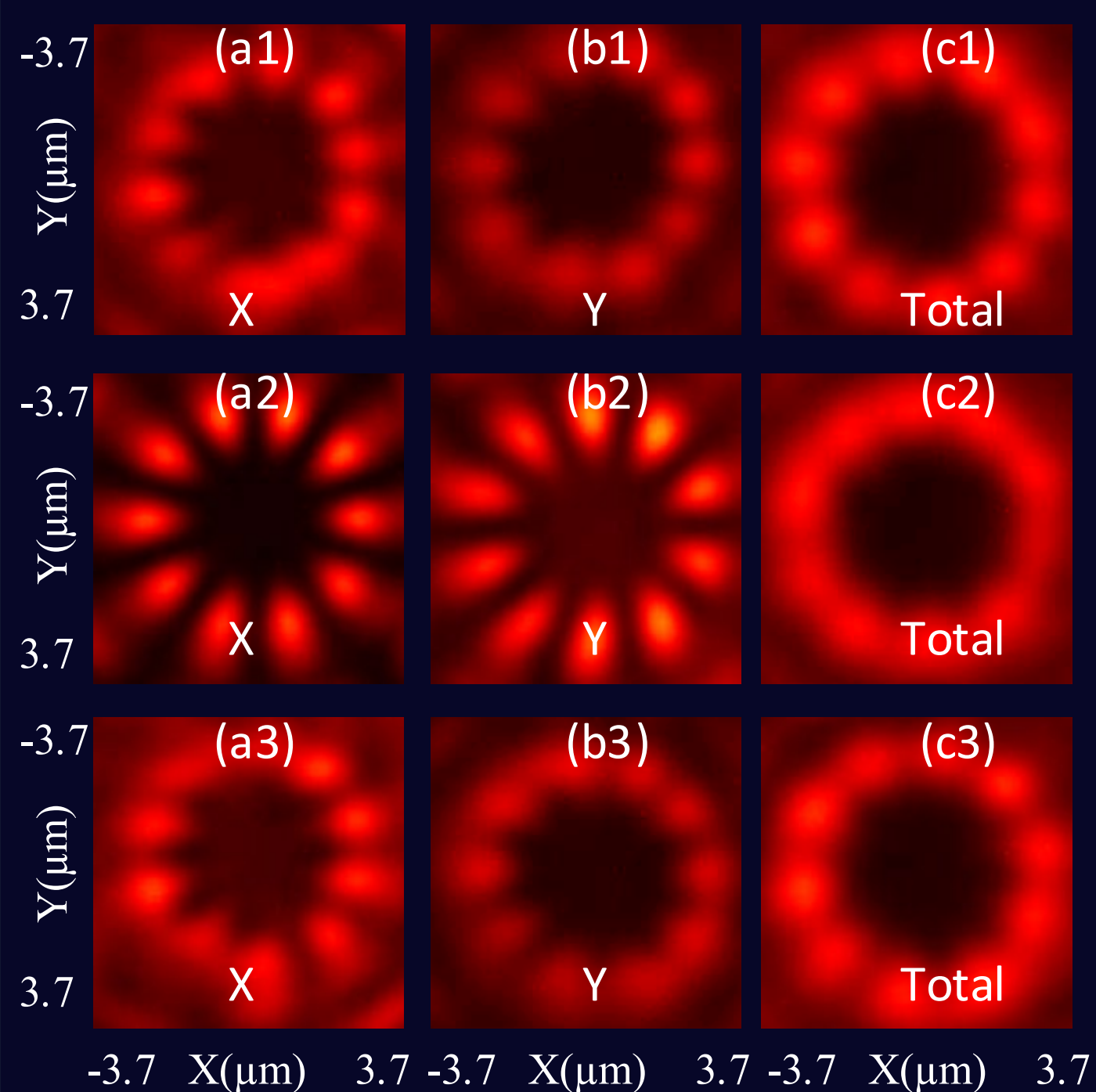
Generation and tightly-focusing of HOPS beams via single-layer dielectric metasurface



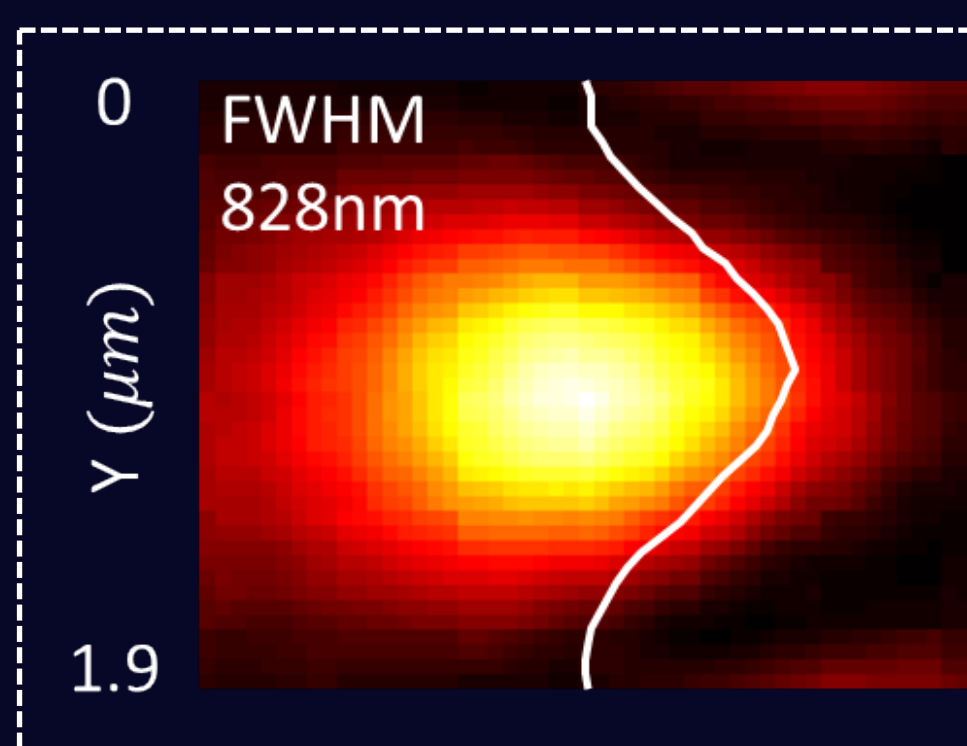
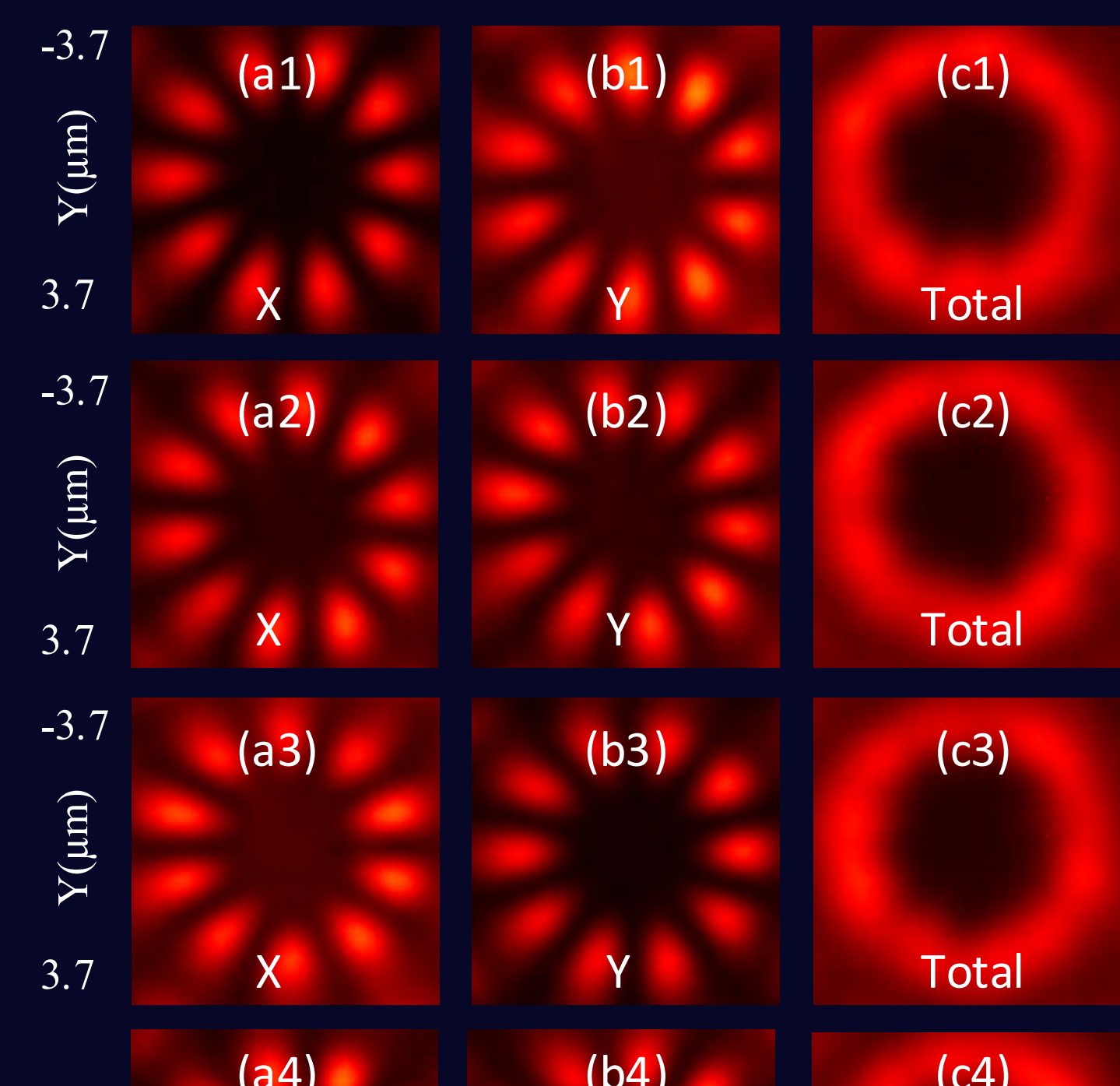
Controlled generation and tightly-focusing (0.89 NA) of arbitrary HOPS beams; Highly compact and high efficiency (30%)

Manipulation of the focal field

Manipulate the 2θ

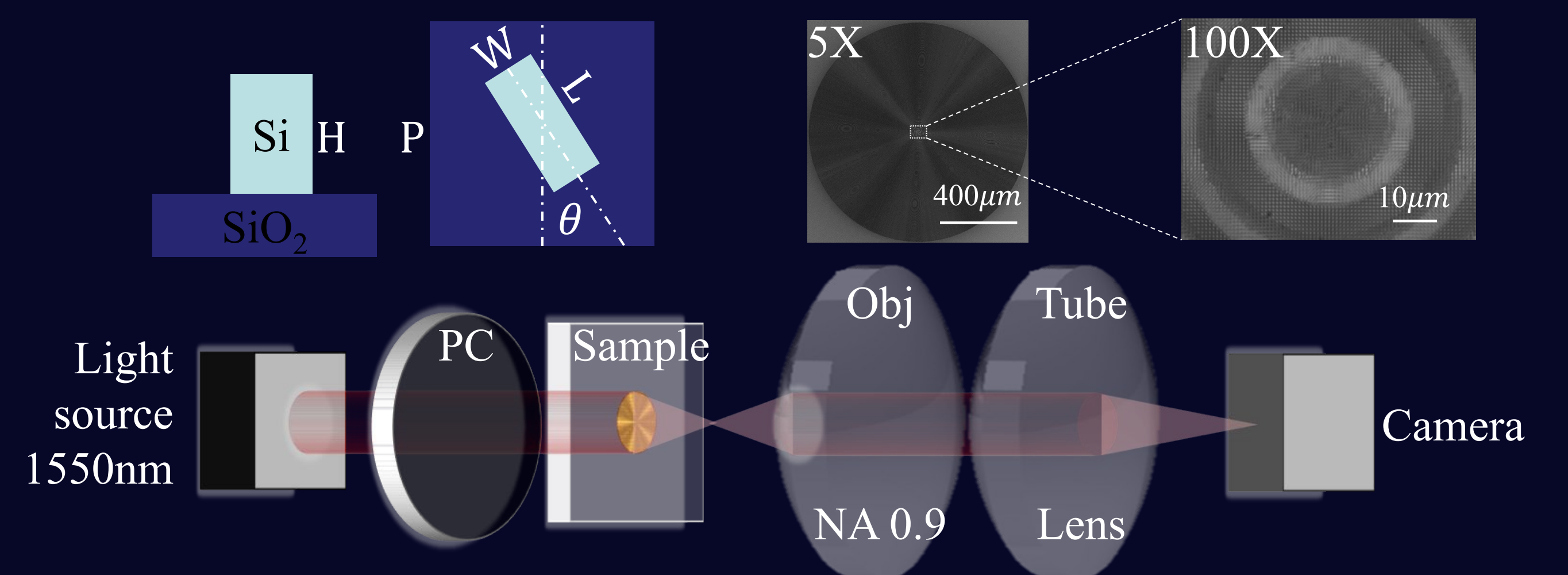


Manipulate the 2Ω



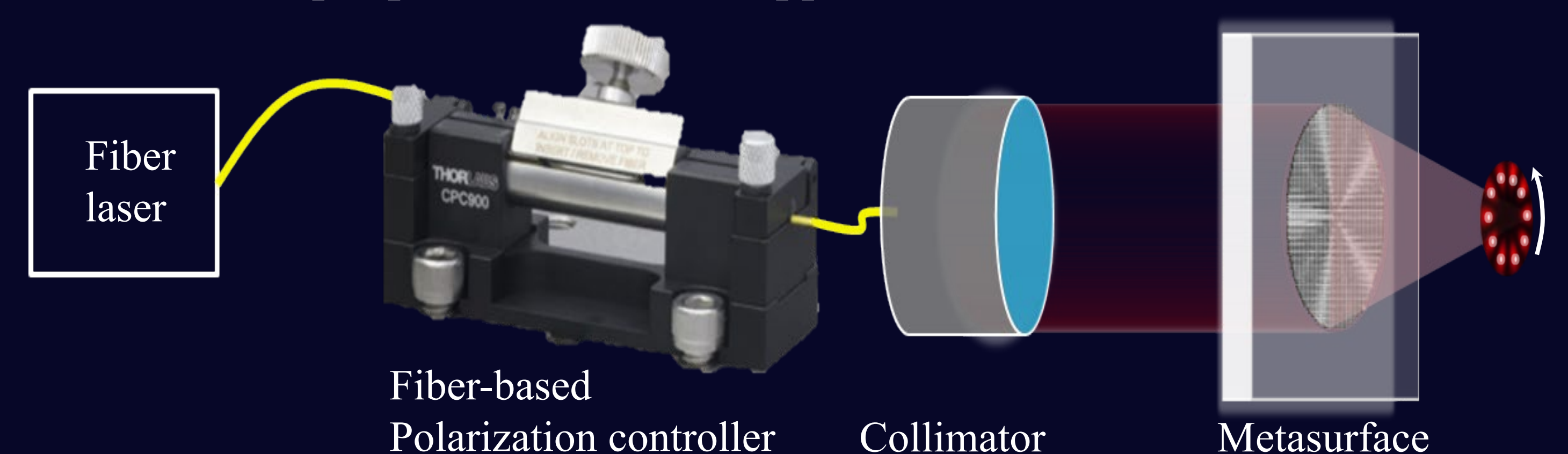
Outgoing lights position (2θ , 2Ω) on a HOPS can be manipulated; Each lobe has a FWHM of 828nm.

Design and characterization of metasurface



Compact structured optical manipulation

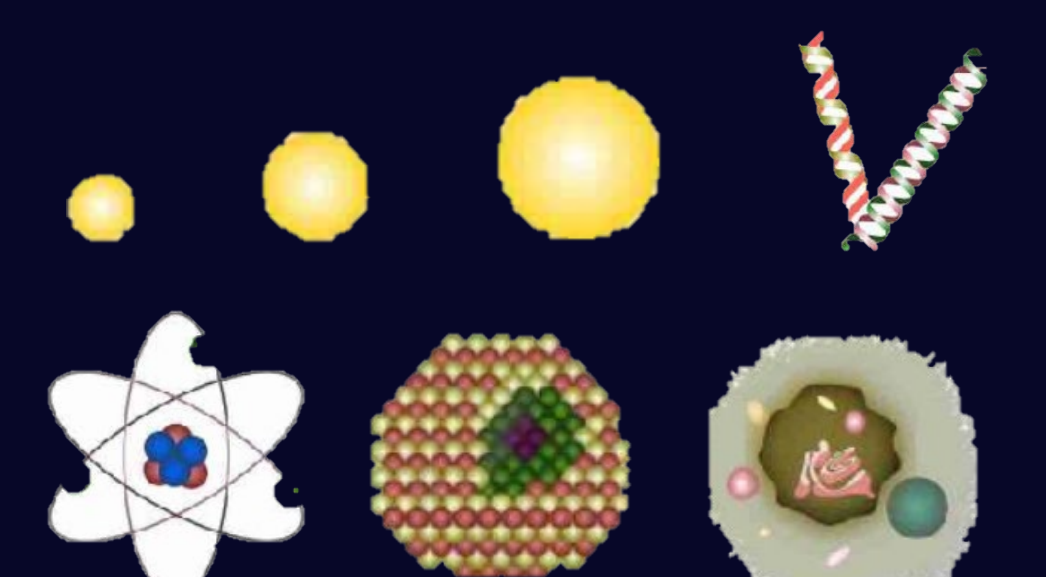
Multiple particles can be trapped and rotated at one time



Summary

- Single-layer dielectric metasurface is designed and fabricated.
- Arbitrary 5th-order HOPS beams are generated, manipulated, and tightly-focused.
- Multiple lobes with a FWHM beyond diffraction limitation are obtained and rotated.
- A compact system is proposed for simultaneously trapping and rotating multiple particles.

Applications



<https://doi.org/10.1364/AOP.394888>