Generation of Longitudinally Varying Vector Vortex Beams Using Dielectric Metasurfaces

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Abstract: We numerically demonstrate the generation of vector vortex beams using dielectric metasurfaces, where the beams' topological features evolve longitudinally during propagation. This distinctive characteristic, along with the ability to control it, could enable new applications in remote sensing for topological light.

Vector vortex beams are light beams that possess topological features in their phase and polarization distributions in space. These unique properties have attracted significant research interest, not only for their fundamental physics but also for their potential applications in communications and remote sensing. Meanwhile, metasurfaces enable precise control over light propagation, facilitating functionalities such as narrow-band wavelength filtering, focusing, beam deflection, beam expansion, and the generation of vector vortex beams [1-4]. Due to their compact form factor and compatibility with established semiconductor nanofabrication techniques, silicon-based dielectric metasurfaces are particularly well suited for generating such topologically structured light beams.

In this talk, we present our recent work on generating vector vortex beams whose topological features evolve longitudinally during propagation. We argue that this type of evolution is often overlooked in topological light research, particularly for monochromatic light in the paraxial regime. Using numerical simulations, we demonstrate the generation of such beams using silicon metasurfaces. We also demonstrate the analytical methods for controlling their topological features along the propagation direction. Our findings could contribute to the development of topological light-based remote sensing techniques.

References

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