

Reconfigurable silicon nanoantennas controlled by vectorial light field

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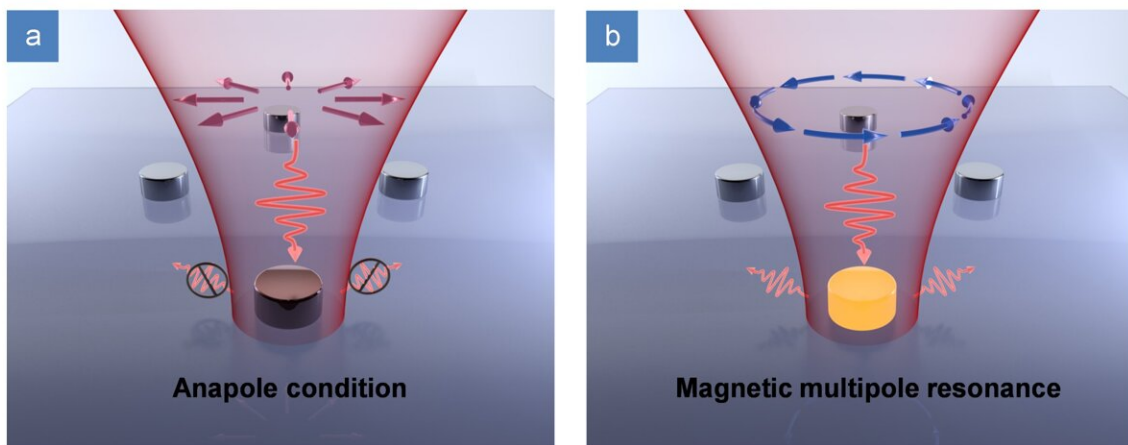


Fig. 1. Schematic of a reconfigurable optical antenna which supports the radiationless anapole condition hidden in a magnetic resonance at the same frequency. Tightly focused RP (a) or AP (b) beam is used to selectively realize the nonscattering and resonant scattering scenarios of the optical antenna.

A new publication from *Opto-Electronic Advances* considers reconfigurable silicon nano antennas controlled by vectorial light field.

According to Mie's theory, high-index dielectric particles can be induced with intense electric and magnetic multipole resonance under visible range. The interference between electric and magnetic multipole in particles will bring many novel optical properties, such as the

enhancement of electromagnetic field, the change of scattering direction and so on. Thereinto, since silicon is the most commonly used material for [semiconductor devices](#) with high [refractive index](#), the use of micro-nano silicon structures as all-dielectric optical nano-antennas provides a high-quality platform for optical field modulation and interaction between light and matter at the nanoscale.

All-dielectric optical nanostructures excited by a specific optical field will exhibit a novel electromagnetic mode, anapole mode. This mode induced by [destructive interference](#) between [electric dipole](#) and toroidal dipolar can realize a radiationless mode in which far-field scattering is completely disappears.

Optical scattering of a nanoparticle under the excitation of a plane wave is usually determined by its predominant electromagnetic multipole moment. Such a predominant multipole moment can even decide the electric or magnetic nature of the scattering in all-dielectric photonics. It is generally perceived that sophisticated manipulation of electromagnetic multipolar moments of all orders to realize superposition of vanished moment strengths at the same wavelength are necessary to achieve the anapole condition.

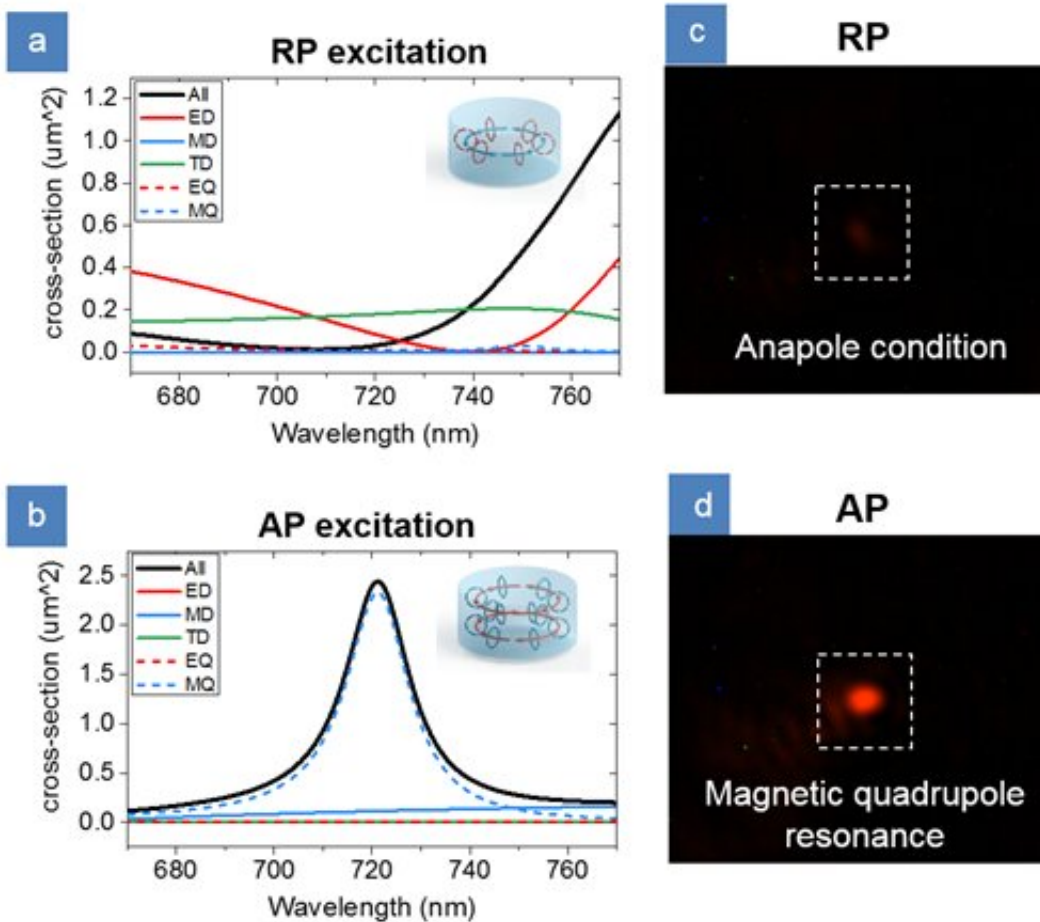


Fig. 2. Cartesian electromagnetic multipolar decomposition results for the scattering power of a Si nanodisk under the excitation of a tightly focused RP beam (a) and a tightly focused AP beam (b), respectively. And the experimental images under the anapole condition excited by a focused RP (c) and the MQ resonance condition excited by a focused AP (d). Credit: Compuscript Ltd

In sharp contrast, Professor Li Xiangping's research group discovered that sophisticated tailoring of [electromagnetic](#) multipolar moments in nanoparticles is unnecessary for the excitation of the anapole condition. This article reports the theoretical and experimental demonstration of radiationless optical anapole hidden in a resonant state of a Si nanoparticle utilizing tightly focused radially polarized beam.

Furthermore, the results demonstrate the possibility for the realization of high contrast reconfigurable optical scattering, ranging between the radiationless anapole condition and the magnetic multipolar resonance by switching structured polarization beams to azimuthal polarized beam.

The demonstrated mechanism resembles a new and unparalleled way to tailor the [optical properties](#) of meta-structures, which might initial a subfield of reconfigurable meta-optics where the tunable functionality of meta-structures are enabled by the unique combination of structured light and structured Mie resonances. The authors anticipate that this discovery could pave the way for the advanced manipulation of optical signal in nanophotonics.

More information: Yudong Lu et al, Cylindrical vector beams reveal radiationless anapole condition in a resonant state, *Opto-Electronic Advances* (2022). [DOI: 10.29026/oea.2022.210014](https://doi.org/10.29026/oea.2022.210014)

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