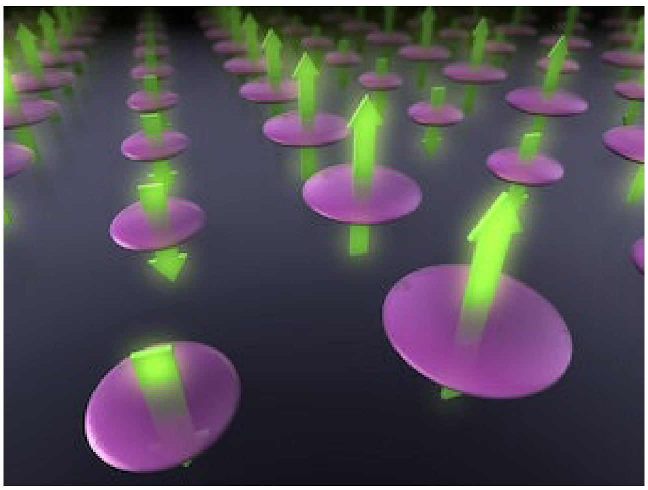
Application of non-Bravais lattices to light control technology

August 31 2022



First BIC state from magnetic (green arrows) dipoles. Credit: Kyoto University

A novel light-manipulating technology has been developed by an international team, including Kyoto University, that can be applied to lasers, sensors, and nonlinear optics.

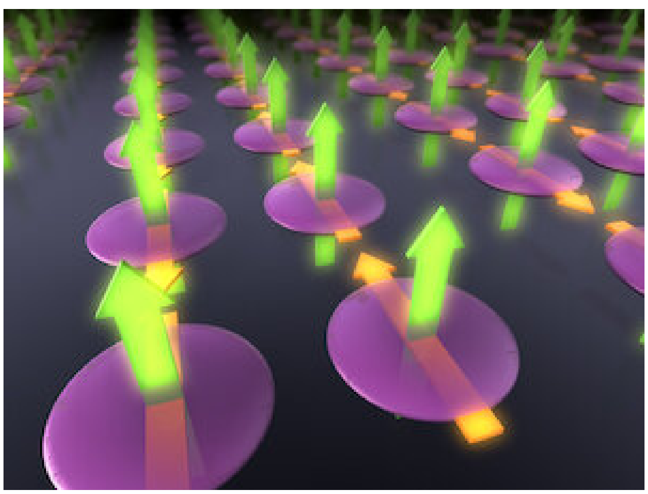
The technique tightly confines near-infrared light within a nanodisk periodic structure. By breaking the symmetry of the periodic square lattice of silicon nanodisks, the team has demonstrated experimentally and computationally their ability to systematically control bound states in the continuum, or BICs.

These light distribution states result from global cancelation of light escaping by destructive interference of scattering waves from silicon nanodisks.

"In this study, starting from a periodic square lattice of a silicon nanodisk—a Bravais lattice—three types of non-Bravais lattices were made by varying the position of a second lattice point in the unit lattice and the size of the disk," explains lead author Shunsuke Murai.

In Bravais lattices, used in crystallography to help us understand and classify crystal structures, all the lattice points were equivalent, meaning all those points could be superimposed by the unit cell.

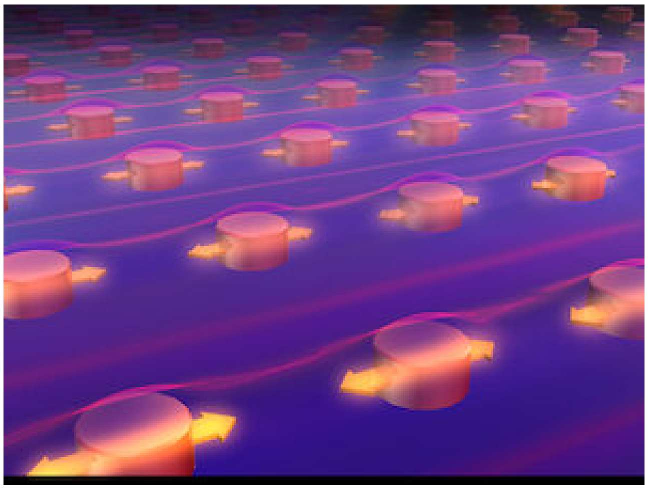
Non-Bravais lattices were created by introducing a second non-equivalent lattice point. These samples were produced using electron-beam lithography and dry etching.



Second BIC state from magnetic (green arrows) and electric (yellow) dipoles excited in Si nanodisks. Credit: Kyoto University

"We applied phototonic, or photosensitive, non-Bravais lattices consisting of silicon nanodisks to control near-infrared light," the author adds.

However, by selecting the appropriate period of these lattices and the material of the nanodisks, not limited to silicon, BIC control may be possible over a wide frequency range from UV to millimeter waves.



Surface lattice resonance, where the dipoles (represented as arrows) in nanodisks are coupled via in-plane diffraction (waves between the disks oscillating perpendicular to the arrows). Credit: Kyoto University

Murai concludes, "The robustness of BIC control over the imperfections in fabricating these lattices was a bonus and an encouraging surprise, given that manufacturing flaws are inevitable."

The study appears in *Laser & Photonics Reviews*.

More information: Shunsuke Murai et al, Engineering Bound States in the Continuum at Telecom Wavelengths with Non-Bravais Lattices, *Laser & Photonics Reviews* (2022). DOI: 10.1002/lpor.202100661

Provided by Kyoto University