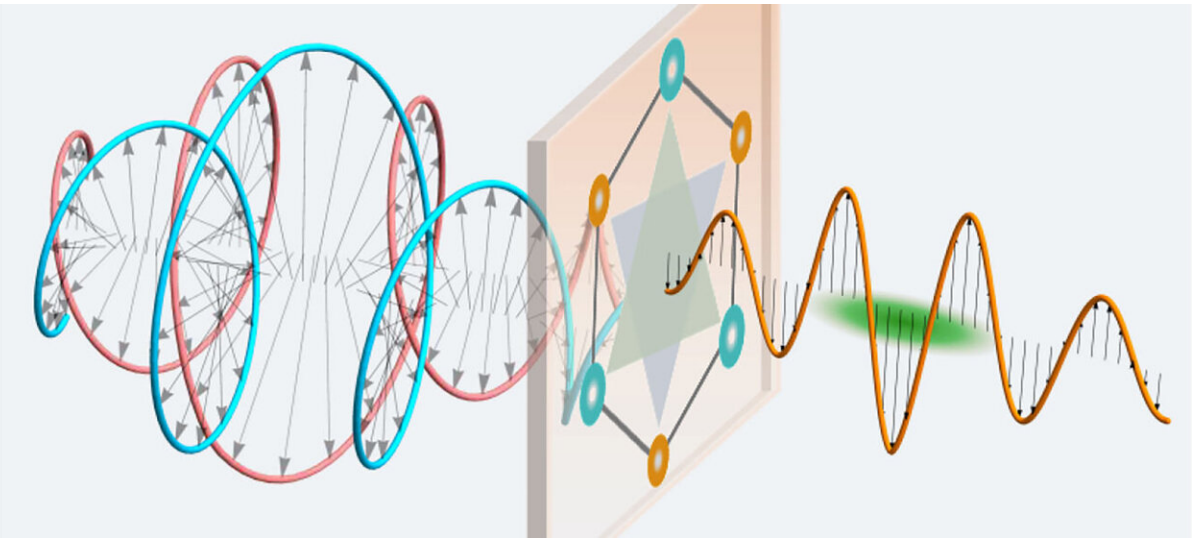
The handedness of light holds the key to better optical control

July 18 2022



A schematic of perfect nonlinear modulation using chiral light beams. Credit: Yi Zhang / Aalto University

Researchers at Aalto University's School of Electrical Engineering have developed a new approach to control the properties of a light beam. By using the handedness of the light beam, the technique achieves significantly enhanced performance together with a more compact footprint.

"Handedness or chirality is everywhere, from electrons to molecules, from our hands to spiral galaxies. Light also has handedness. Our

modulation method uses the handedness of light by selecting certain polarizations via the crystal structure of the material in the device. It's a fundamentally different approach from previous methods," says Yi Zhang, the postdoctoral researcher who led the study.

Optical modulators are used to manipulate the properties of a beam of light, such as its intensity, phase, or polarization. Switching between states (for example, between adjustable and zero intensity) is a cornerstone of optical technologies, such as fiber optic communications, laser-based displays, and optical computing.

Current optical modulators mainly use electrical or acoustic effects to modulate light's properties indirectly. "These two traditional optical modulator technologies can control the properties of light at nanosecond speeds . Our all-optical modulator, which uses a coherent optical process, can work at femtosecond speeds, or about a million times faster," Zhang notes.

Zhang believes the technology will be easy to transfer from lab to application, where it offers possible improvements in a wide range of fields, from fiber optics to display technologies. "The principle we used to modulate the light more quickly and efficiently is quite clear, and I believe it could be applied very soon," Zhang says.

Professor Zhipei Sun, the group leader, says that "this new method holds great promise for advanced nonlinear optical devices, computing, and quantum technologies. It also provides extra choices of materials for current devices, which is beneficial for companies that produce optical modulators."

The study was published in the journal *Light: Science & Applications*.

More information: Yi Zhang et al, Coherent modulation of chiral

nonlinear optics with crystal symmetry, *Light: Science & Applications* (2022). DOI: 10.1038/s41377-022-00915-4