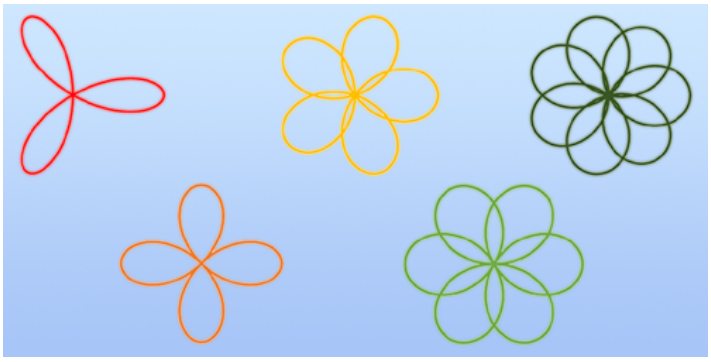
Photovoltaic Effect Goes Symmetric

A flower-petal pattern of light could induce electrical currents in a wider array of crystalline materials.

By **Rachel Berkowitz**

Most photovoltaic devices used to power homes, offices, rural infrastructure, and satellites generate electricity at the junction between two differently doped semiconductors. But certain undoped materials—those whose crystal structures are nonsymmetric about a central axis—can also generate light-induced currents via a phenomenon called the bulk photovoltaic effect. Yuya Ikeda and his colleagues at the University of Tokyo now demonstrate that appropriately polarized light can induce photocurrents in a bulk material that lacks these symmetry requirements [**1**]. Their simulations could broaden the field of bulk photovoltaics to crystalline materials of any symmetry group, potentially leading to more-efficient power conversion devices.

In a noncentrosymmetric material under illumination, the asymmetric crystal structure generates a photocurrent by imparting a net motion to electrons excited into the conduction band. Ikeda and his colleagues propose a way to achieve a similar effect in a centrosymmetric material by imposing an asymmetry on the light instead. They envisage superimposing two different-frequency beams, circularly polarized in opposite directions, such that the combined electric fields draw a rotating flower-like pattern. Such "bicircular light" has recently been used to control magnetic symmetries and topology in crystalline materials.



Credit: Y. Ikeda *et al.* [**1**]; adapted by APS

Ikeda and his colleagues studied how the electric field of bicircular light pulses impacted the electron dynamics in a one-dimensional model for polyacetylene and for a three-dimensional Dirac semimetal. In both cases, they found that irradiation could introduce electrical polarity to these centrosymmetric systems. The phase of the two frequency lights controlled the direction of the polarity, and hence, the photocurrent.

The researchers say that the controllability of bicircular light paves the way for novel optoelectronic functionality. They propose that the effect could most likely be observed in Dirac semimetals.

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REFERENCES

1. Y. Ikeda *et al.*, "Photocurrent induced by a bicircular light drive in centrosymmetric systems," **Phys. Rev. Lett. 131, 096301 (2023).**