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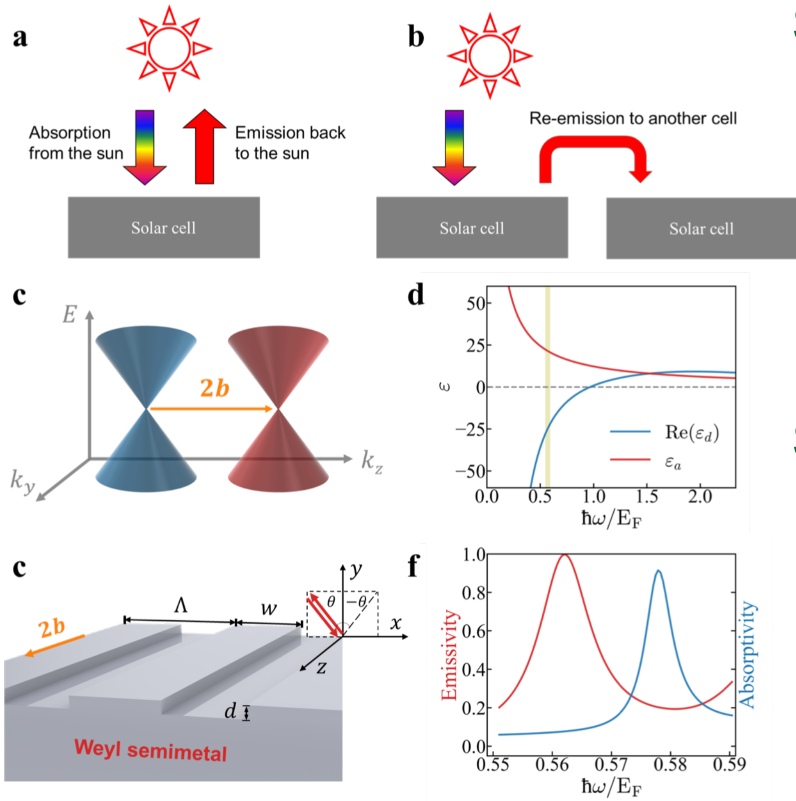
Nonreciprocal Thermal Radiation in Weyl Semimetals



(a) Solar cell in the reciprocal regime. (b) Solar cell with nonreciprocal emission ability that bends the back emission. (c) Electronic band structure of a magnetic Weyl semimetal. (d) The permittivity tensor components of the Weyl semimetal. (e) Schematic of a Weyl-semimetal photonic crystal. (f) Emissivity and absorptivity spectrum in θ = 80° direction.

Work was performed at Stanford and Harvard

Scientific Achievement

As an important first step to improve the efficiency of solar cells to their thermodynamic limit, we demonstrate strongly nonreciprocal thermal emitters based on magnetic Weyl semimetals that do not require any external magnetic field needed in conventional designs.

Significance and Impact

Our work puts forth topological quantum materials as a solution to the long-standing materials challenge in constructing nonreciprocal components in photonics and energy applications.

Research Details

- Modeled the optical properties from Kubo-Greenwood formalism with random phase approximation.
- Archived high performance by critically coupling to nonreciprocal surface plasmon polaritons.

Zhao, B.*, Guo, C.*, Garcia, C., Narang, P., and Fan, S., 2020, "Axion-Field-Enabled Nonreciprocal Thermal Radiation in Weyl Semimetals," Nano Letters, Vol. 20, pp. 1923-1927 (2020).