One-way optical transparency at telecommunications wavelengths

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Ultra-low symmetry combined with strong spin-orbit coupling gives rise to many unique properties in many materials, including nonreciprocal directional dichroism, often called "one-way transparency" or an "optical diode effect". Here, a material is highly transmitting for light in the +*k* direction but nearly opaque for light in the -*k* direction.

Because of the need to break time-reversal symmetry, switching the direction of an external magnetic field can also induce one-way transparency. *Ni_3TeO_6 is a perfect platform for exploring these effects because this magnet is both chiral and polar, thus supporting nonreciprocity in a number of different measurement geometries, shown in Figs. (a-c).*

In this work, MagLab users investigated nonreciprocal directional dichroism in Ni_3TeO_6 using optical spectroscopy, high-magnetic-field techniques, and first-principles electronic structure methods. In addition to uncovering the Ni toroidal moment (***T = P x M***) and broad band optical effects, *these measurements revealed that nonreciprocity persists across the entire range of telecommunications wavelengths (see Fig.d).* As such, in addition to considering applications in high-efficiency optical diodes and rectifiers and high-fidelity holograms, these findings open the door to photonics applications – particularly in the area of secure fiber optic telecommunications.

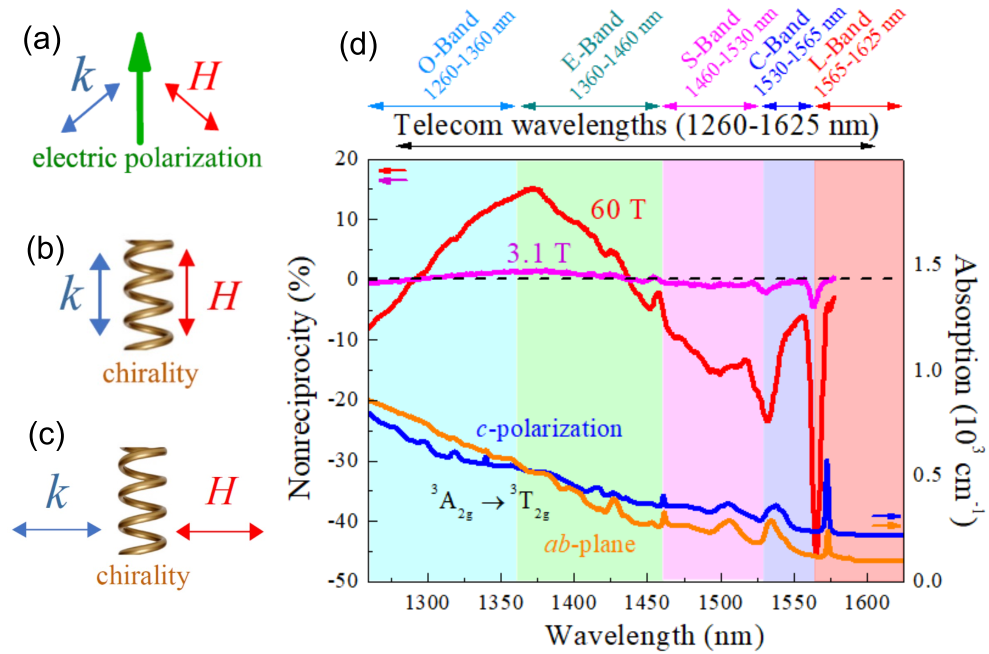

Figure: Three different measurement configurations for which one can realize nonreciprocity in Ni_3TeO_6: **(a)** toroidal; **(b)** magnetochiral; and **(c)** transverse magnetochiral. **(d)** Nonreciprocity at 60 teslas in the toroidal configuration (red line) spans the entire range of telecommunications wavelengths, reaching levels of nearly 50% at some wavelengths. The signal at 1550nm is important for photonics applications and is tunable depending upon the measurement geometry.

Facilities and instrumentation used: 65 T pulsed magnets at the Pulsed Field Facility

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