Giant optical anisotropy and high refractive index in van der Waals materials

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Anisotropic materials play a pivotal role in contemporary nanophotonics applications, such as polaritonic physics [1], subdiffractional guiding [2], and strong light-matter coupling [3]. However, anisotropic materials have static optical axes, which prevent their complete manipulation of light in anisotropic devices. Here, we found that natural van der Waals crystals rhenium disulfide and diselenide demonstrate wavelength-dispersive optical axes owing to noncollinear excitons. It results in unusual far-field and near-field responses with the opportunity to control light propagation with even a slight wavelength shift. Moreover, we developed a technology for engineering systems with wavelength-dispersive optical axes via carbon and transition metal dichalcogenide nanotubes. It allows us to design almost any rotation of optical axes. Thus, the discovered phenomenon of wavelength-dispersive optical axes offers a novel route for light manipulation without nanostructuring.

References

[1] Ermolaev, G. A. et al. Giant optical anisotropy in transition metal dichalcogenides for next-generation photonics. Nature Communications 12, 854 (2021).
[2] Ermolaev, G. et al. Giant and tunable excitonic optical anisotropy in single-crystal halide perovskites. Nano Letters 23, 2570-2577 (2023).
[3] Ermolaev, G. et al. Topological phase singularities in atomically thin high-refractive-index materials. Nature Communications 13, 2049 (2022).

Figures

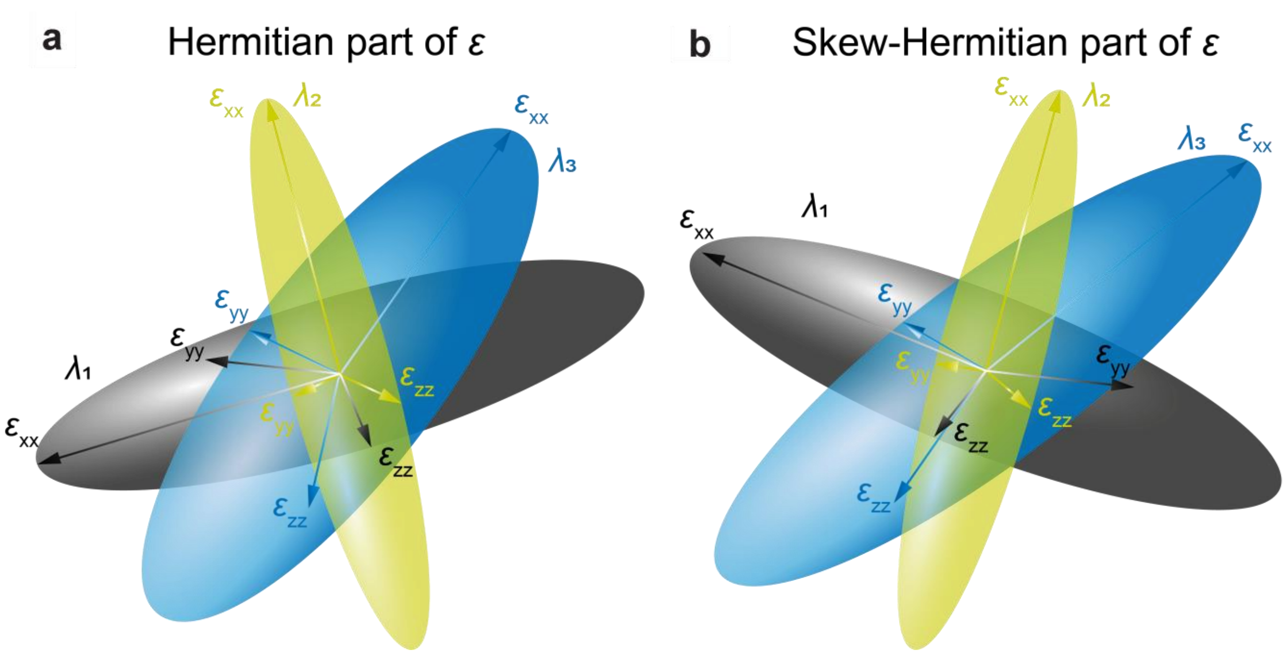

Figure 1: Schematic illustration of principal optical axes rotation arising from giant optical anisotropy in van der Waals materials.