Synopsis: Superconductor optics

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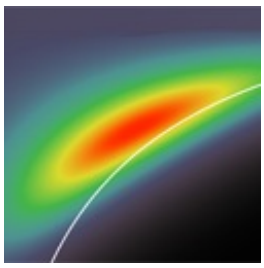
In the domain of unusual optical properties, layered superconductors could be viable materials with a negative index of refraction.

V. Golick *et al.*, Phys. Rev. Lett. (2010)



Materials with a negative index of refraction bend and guide a beam of light in unconventional ways—an effect that could be exploited to make perfect lenses. The search for candidate negative-index materials has identified multilayers of high-temperature superconductors as a possibility. Because these materials are anisotropic, the sign of the electrical permittivity (or, more specifically, elements of the permittivity tensor) can change over a certain frequency range, which opens the possibility for negative-index refraction.

Writing in *Physical Review Letters*, Vladislav Golick and colleagues at Kharkov University in the Ukraine, in collaboration with scientists in the Ukraine, Russia, Japan, and the US, calculate dispersion curves for so-called “surface Josephson-plasma waves” in layered superconductors. They find a branch of these waves above the Josephson plasma frequency, displaying abnormal surface mode behavior. They also identify a window of THz frequencies (above the plasma frequency) where the permittivities switch signs to produce negative-index refraction. At higher frequencies, their model predicts that light incident through a high-index, transparent medium would be completely refracted (no reflection) inside the layered superconductor.

When the superconductor-layer width is below the free path of the surface waves, the refracted waves could be emitted from the edge of the superconductor in the form of a highly collimated beam. With a magnetic field applied parallel to the layers, it should be possible to modulate this channeling effect to make fast switching shutters and mirrors for guiding light. –*Saad E. Hebboul*