Silicon photonic crystals key to optical cloaking

June 25 2008

In computer simulations, the researchers have demonstrated an approximate cloaking effect created by concentric rings of silicon photonic crystals. The mathematical proof brings scientists a step closer to a practical solution for optical cloaking.

"This is much more than a theoretical exercise," said Harley Johnson, a Cannon Faculty Scholar and professor of mechanical science and engineering at Illinois. "An optical cloaking device is almost within reach."

In October 2006, an invisibility cloak operating in the microwave region of the electromagnetic spectrum was reported by researchers at Duke University, Imperial College in London, and Sensor Metrix in San Diego. In their experimental demonstration, microwave cloaking was achieved through a thin coating containing an array of tiny metallic structures called ring resonators.

To perform the same feat at much smaller wavelengths in the visible portion of the spectrum, however, would require ring resonators smaller than can be made with current technology, Johnson said. In addition, because metallic particles would absorb some of the incident light, the cloaking effect would be incomplete. Faintly outlined in the shape of the container, some of the background objects would appear dimmer than the rest.

To avoid these problems, postdoctoral research associate Dong Xiao came up with the idea of using a coating of concentric rings of silicon photonic crystals. The width and spacing of the rings can be tailored for specific wavelengths of light.

"When light of the correct wavelength strikes the coating, the light bends around the container and continues on its way, like water flowing around a rock," Xiao said. "An observer sees what is behind the container, as though it isn't there. Both the container and its contents are invisible."

Currently simulated in two dimensions, the cloaking concept could be extended to three dimensions, Xiao said, by replacing the concentric rings with spherical shells of silicon, separated by air or some other dielectric.

The researchers' optical cloaking technique is not perfect, however. "The wave fronts are slightly perturbed as they pass around the container," said Johnson, who also is affiliated with the university's Beckman Institute and the Frederick Seitz Materials Research Laboratory. "Because the wave fronts don't match exactly, we refer to the technique as 'approximate' cloaking."

Source: University of Illinois at Urbana-Champaign

Citation: Silicon photonic crystals key to optical cloaking (2008, June 25) retrieved 17 April 2024 from https://phys.org/news/2008-06-silicon-photonic-crystals-key-optical.html