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Engineers devise invisibility shield

Philip Ball

Electron effects could stop objects from scattering light.

The idea of a cloak of invisibility that hides objects from view has long been confined to the more improbable reaches of science fiction. But electronic engineers have now come up with a way to make one.

Spot the spaceship.

Andrea Alù and Nader Engheta of the University of Pennsylvania in Philadelphia say that a 'plasmonic cover' could render objects "nearly invisible to an observer". Their idea remains just a proposal at this stage, but it doesn't obviously violate any laws of physics.

"The concept is an interesting one, with several important potential applications," says John Pendry, a physicist at Imperial College in London, UK. "It could find uses in stealth technology and camouflage."

Cloak of many colours

Types of invisibility shielding have been developed before, but these mostly use the chameleon principle: a screen is coloured to match its background, so that the screened object is camouflaged.

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>
> John Pendry
> Physicist, Imperial College, UK

For example, inventor Ray Alden in North Carolina has proposed a system of light detectors and emitters that project a replica of the scene appearing behind an object from its front surface. Researchers at the University of Tokyo are working on a camouflage fabric that uses a similar principle, in which the background scene is projected on to light-reflecting beads in the material.

But the invisibility shield proposed by Alù and Engheta in a preprint on arXiv[1] is more ambitious than this. It is a self-contained structure that would reduce visibility from all viewing angles. In that sense it would be more like the shielding used by the Romulans in the *Star Trek* episode "Balance of Terror" in 1966, which hid their spaceships at the push of a button.

Scatter-brained

The key to the concept is to reduce light scattering. We see objects because light bounces off them; if this scattering of light could be prevented (and if the objects didn't absorb any light) they would become invisible. Alù and Engheta's plasmonic screen suppresses scattering by resonating in tune with the illuminating light.

Plasmons are waves of electron density, caused when the electrons on the surface of a metallic material move in rhythm. The researchers say that a shell of plasmonic material will scatter light negligibly if the light's frequency is close to the resonant frequency of the plasmons. The scattering from the shell effectively cancels out the scattering from the object.

For visible-light shielding, says Engheta, nature has already provided suitable plasmonic materials: silver and gold. To reduce the scattering of longer-wavelength radiation such as microwaves, one could make the shield from a 'metamaterial': a large-scale structure with unusual electromagnetic properties, typically constructed from arrays of wire loops and coils.

Alù and Engheta's calculations show that spherical or cylindrical objects coated with such plasmonic shields do indeed produce very little light scattering. It is as though, when lit by light of the right wavelength, the objects become extremely small, so small that they cannot be seen.

Size matters

Pendry warns, however, that the concept as it stands is "no magic cloak", because it would have to be delicately tuned to suit each different object it hides. Perhaps even more of a drawback, he points out, is the fact that a particular shield only works for one specific wavelength of light.

An object might be made invisible in red light, say, but not in multiwavelength daylight.

And crucially, the effect only works when the wavelength of the light being scattered is roughly the same size as the object. So shielding from visible light would be possible only for microscopic objects; larger ones could be hidden only to long-wavelength radiation such as microwaves. This means that the technology could not be used to hide people or vehicles from human vision.

But that need not undermine other potential uses, Engheta says. For example, the effect could be useful for making antiglare materials.

Another possible use for plasmonic screening is microscopy, he adds. Light microscopes could surpass their usual resolution limits by using tiny probes to measure the light field very close to the object being imaged. Such probes could be made 'invisible' so that they don't disturb the imaging signal.

And of course the shielding would work fine for concealing large objects such as spaceships from sensors or telescopes that used long-wavelength radiation instead of visible light.

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References

1. Alù A. & Engheta N. *Preprint*, http://arxiv.org/abs/cond-mat/0502336 (2005).

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