

Plastic invisibility cloak hides you from people with plastic brains

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Earlier this week there was suddenly news of an exciting new invisibility cloak. In the end, the story was driven by a blathering press release full of typically questionable science buzzwords. Add science by YouTube video, and yes, this looks like shoddy science at its best.

However, the interminably long “technical” video has some value in that it makes it clear what the material does and does not do. It might be best to think of the inventor as creating a kind of clever adaptive camouflage. I can kind of see how it might be useful to people with guns in some circumstances.

Let's play with rulers

I think almost everyone has at one point owned a plastic ruler with an animation on it. By tilting the ruler, the images it contains appear to move. This works because the plastic coating consists of a series of stripes, creating what are called lenticular lenses. By changing angles, the focal stripe of the lens shifts left and right. At one angle you see one image and at a different angle you see a second image. If the

images are similar enough, changing your perspective creates the illusion of a single item moving.

Lenticular lenses produce some really strange effects if the backing is removed. Consider that you are viewing a scene that is behind a sheet of lenticular lenses, getting rid of the images. Light will reach the ruler from an object behind it, hit the lens system, and get refracted. If an object is the right distance from the sheet, there is no angle of light refraction from any lens that will go in your direction—effectively, you cannot see the object.

This is the invisibility that is advertised. The background behind the object, however, does not appear in place of the object; in that sense, this is not invisibility.

Of course, if you move to the left or right, then the object will reappear—the invisibility point depends on your viewing angle. A single object can be hidden by curving the sheet of plastic so that no matter where the viewer is, their angle with respect to the sheet of lenses remains the same. This keeps the invisibility point at a single spatial location.

You are not invisible

The problem is the background. In many demonstrations, the background is kept very bland and symmetrical. This hides the distortion that is induced by the lens sheet. However, once the sheet is curved, nothing can hide the distortion: you may not know *what* is hidden, but you can certainly tell *something* is hidden.

Even worse, for flat sheets, the background isn't just distorted, it also moves just like the animated images in the ruler you had as a kid. So, yes, you have hidden an object, but it is a pantomime invisibility. You'd really have to have a plastic brain to not be suspicious when trees jump up and down as your head moves.

Now, the video goes into excruciating details of variations on the theme of lenticular lenses. If you combine lenses back to back, you can make the sheet thinner, and the background isn't as blurred. Instead, the background jumps about, and, at a certain distance, objects will flip orientation.

You can combine back-to-back lens sheets in pairs, with varying lens spacings and focal lengths. The effects of these mismatched lens systems are really cool: you can magnify the background, demagnify the background, and get repeating images. You can play almost any trick you like with the background while still concealing an object that is relatively close to the sheet.

But every combination does *something* to the background. Unfortunately, there is no combination of lenses that does not reveal itself in fairly obvious ways.

Adaptive camouflage

That said, this work may not be a set of useless tricks. A sheet of this material can act as a kind of adaptive camouflage. The lens system basically presents the viewer with partial images of objects in the background. If the background is close enough (e.g., in a forest, or if you are looking down from a plane), then the lens system will present a patchwork of the background. In a forest, where everything is broken up, the lens system presents a broken up image that could make for very effective concealment. Likewise, looking down on an object in the desert or grassland would also work because the uniform background has few features to be distorted by the lens sheet.

Ultimately, this is a pretty clever set of ideas. Although the inventor does not have a background in optics, he has clearly given a lot of thought to combinations of lenses to optimize performance for military purposes. And given that some military organizations were once convinced that dowsing rods

were a good investment, this work should be a shoe-in and may even provide some benefit.

I'm not sure about operational details, though. Imagine that I wanted to use this on a tank. I'd end up putting an excellent *shiny* plastic material over my tank, and I typically do not want to shine if I am in a tank. An antireflection coating would help, but, as anyone who has looked at glasses knows, antireflection coatings still reflect, and, indeed create rainbow patterns that kind of stand out—viewing angle matters for optics.

Then you get to more practical problems. If a bird does what birds do on my tank, that is probably not going to make it highly visible. I am not sure that the same is true of the plastic material. In fact, I am reasonably sure it is not, since the video showed examples of well-used sheets. In these, the blemishes stood out like the proverbial sore thumb.

It's hard to know how to sum up the plusses and minuses here; I simply don't know if this is better or worse than imperfect standard camouflage.

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