'Antimagnet' renders magnets invisible

Magnetic cloak could bring medical benefits — and security risks.

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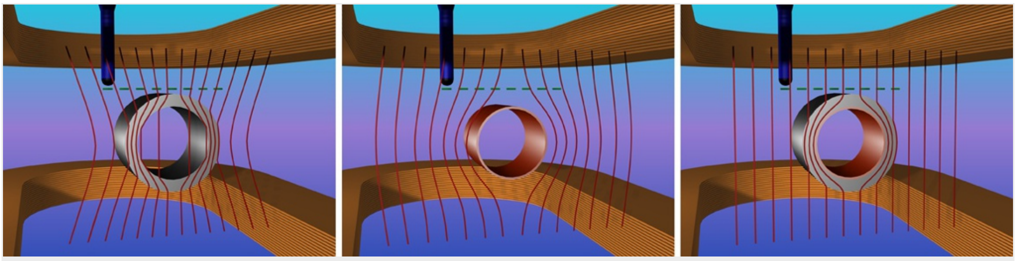

Image courtesy of J. Prat-Camps, C. Navau & A. Sanchez

A superconductor can cloak a magnet's field, but its own magnetic effects must be offset by a ferromagnetic coating for it to avoid detection (right panel).

Physicists have already unveiled invisibility cloaks that can hide objects from light, sound, seismic and even water waves. Now researchers report a cloak that can hide objects from static magnetic fields. This 'antimagnet' could have medical applications, but might also subvert airport security.

Writing in *Science*[1], a team of theorists led by Alvaro Sanchez at the Autonomous University of Barcelona in Spain, together with experimentalists at the Slovak Academy of Sciences in Bratislava, describe a magnetic cloak made with inexpensive, readily available materials.

The cloak's interior is lined with turns of tape made from a high-temperature superconductor. Superconductors repel magnetic fields, so any magnetic field enclosed within a superconductor would be undetectable from outside. But the superconductor itself would still perturb an external magnetic field, so the researchers coated its external side with an ordinary ferromagnet — the material that kitchen fridge magnets are made of. The superconductor tries to repel external field lines, whereas the ferromagnet tries to draw them in — together, the two layers cancel each other out.

To test the antimagnet, the Slovak group cooled the cloak with liquid nitrogen to activate the superconductor, and placed it in a static, uniform magnetic field with a strength of 40 millitesla. Using a measuring device called a Hall probe to map the magnetic field, the researchers found that the field lines did not enter the cloak, even through from the outside they appeared to pass straight through. They say that theirs is an 'exact' cloak — one for which the cloaking could, in principle, be made perfect using currently available materials.

Wildly variable

The theory behind invisibility cloaks was put forward independently in 2006 by physicists John Pendry and colleagues from Imperial College London and Ulf Leonhardt of the University of St Andrews, UK[2, 3]. Their idea was that materials with well-tuned electromagnetic properties could guide light around an object so that the light's overall path remained unperturbed: from a distance, both the object and cloak would appear invisible. But for this to work with visible light, the electric permittivity and magnetic permeability — which describe a material's response to electric and magnetic fields — of the material used would probably need to vary wildly throughout the cloak. So scientists have turned their attention to simpler forms of cloaking that are easier to implement.

In 2008, Pendry and others demonstrated the beginnings of a cloak for static magnetic fields[4], the simplicity of which resided in the need to vary only the cloak's magnetic permeability, and not its electric permittivity.

That design still had one complex aspect: the permeability had to be anisotropic, taking different values in different directions. But Sanchez and colleagues' cloak is simpler still. Its permeability is isotropic — that is, it has the same value in all directions.

Pendry calls the new work "seminal" in the progress of cloaking technology. "Although the final result shows a less-than-perfect cloak, it is convincingly demonstrated that the raw concept works and there is no doubt that further improvement of manufacture would considerably improve the quality," he says.

Sanchez points out that the magnetic cloak is straightforward to make: it requires only off-the-shelf materials and costs in the region of €1,000 (US$1,300) — very little in research terms. He believes the cloak could have uses in medicine, protecting delicate pacemakers from the strong magnetic fields of magnetic resonance imaging machines. But he admits there could also be unsavoury applications — the technology could, for example, be used to hide metallic weapons from security portals. "I would prefer to consider it the other way — that our ideas can help to design safer security procedures," Sanchez says.

Richard Tomsett, a border-security adviser who works for London-based consultancy firm Dextera Global, points out that there are other technologies used in airport security, such as X-ray machines and sniffer dogs, that the cloak may not fool. But he thinks security officials will still keep abreast of technological developments. "While the cloak may present another operational challenge for security organizations, they will actively respond by working with technology manufacturers and scientists to combat the potential threat," he says.

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References

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