



## WHAT TO DO WITH A WORMHOLE

- **OPTICAL CABLES:** the wormhole could act as a perfect optical fibre that is invisible from the outside — but only at a single wavelength, the one the tube is designed to carry.
- **OPTICAL COMPUTERS:** data-processing elements for conducting logical operations on light signals could be placed inside the wormhole, so that all one would see of the computer is input and output sockets.
- **THREE-DIMENSIONAL (3D) VIDEO DISPLAYS:** each 3D pixel (voxel) of a cube-shaped space could be wired up with a separate wormhole, so that light fed in at the other end would appear in the voxel, creating a 3D image with invisible wiring.
- **MAGNETIC MONOPOLES:** the existence of magnetic particles that have only a 'north' or a 'south' pole has been long debated by physicists. But an artificial monopole could be made by conducting the magnetic field lines of just one pole of a magnet into a wormhole, so that the other end would act like a monopole.
- **MAGNETIC RESONANCE IMAGING (MRI):** a wormhole could transport the particles used for MRI, such as magnetic nanoparticles, to the imaged area without disturbing the applied magnetic field, which would allow high-quality images to be obtained.

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Like space-time wormholes, electromagnetic wormholes connect remote regions of space.

have to be much smaller.

Greenleaf and his colleagues say that such a shield can be regarded as 'blowing up a point': expanding an infinitely small — and thus invisible — point in space while 'moulding' the way light interacts with it so as to sustain the invisibility. Their wormholes, in contrast, are like 'blowing up a line' — in essence, rather like making a tubular shield. They have worked out a prescription for the properties a metamaterial tube would need to have in order for light from outside to bend around it while light inside bounces along the channel as if along an optical fibre. In this way, light entering one end of the wormhole would be visible at the other end — albeit with some odd distortions. If the wormhole is very short, it acts rather like a fisheye lens, they say.

The researchers believe that it should be possible to make such devices with the same

microwave metamaterials as those used by Smith's team. But Leonhardt cautions that this remains "very far in the future". Making a 3D invisibility shield is already a big challenge, he says, and a wormhole would be harder still.

Smith is optimistic, however. "A version of these wormholes at microwave frequencies could definitely be feasible, although over a very narrow frequency range," he says. "I'm hoping to demonstrate lots of interesting optical structures using metamaterials in the near future, and we may add this one to the list." ■

**Philip Ball**

1. Greenleaf, A., Kurylev, Y., Lassas, M. & Uhlmann, G. *Phys. Rev. Lett.* **99**, 183901 (2007).
2. Schurig, D. *et al. Science* **314**, 977-980 (2006).
3. Leonhardt, U. *Science* **312**, 1777-1780 (2006).
4. Pendry, J. B., Schurig, D. & Smith, D. R. *Science* **312**, 1780-1782 (2006).

## ON THE RECORD

**“This is not one pig flying in orbit — this is a herd of pigs with gold trotters, platinum tails and diamond eyes.”**

Gwyneth Dunwoody, chair of Britain's Transport Select Committee, chooses a striking metaphor to promote Europe's planned Galileo global-positioning system.

## SCORECARD



**Japanese wetland**  
Engineers are

painstakingly adding bends to the Kushiro River in Hokkaido to reverse the shrinking of the surrounding wetlands that has occurred since the waterway was straightened in the 1980s.



**Wet building**

The Massachusetts Institute of Technology is suing architect Frank Gehry over its Stata Center, which it claims is leaking and growing mouldy.

NAIC/ARECIBO OBSERVATORY/NSF



## 3 GOOD REASONS...

Why the Arecibo Observatory in Puerto Rico (pictured above) should not be shut down after 2011:

**1** It's the world's largest radio telescope — 20 times more sensitive than any other instrument for keeping tabs on near-Earth asteroids.

**2** It might save scientists from embarrassment — this week they accidentally identified the European satellite Rosetta as an 'incoming asteroid'.

**3** NASA seems to have the money to bail out the observatory, which needs to find US\$4 million per year after 2011 — coincidentally the same amount that NASA spent on parties this year.

Sources: BBC, planetary.org, CBS News, New York Times, Associated Press

SIDELINES