

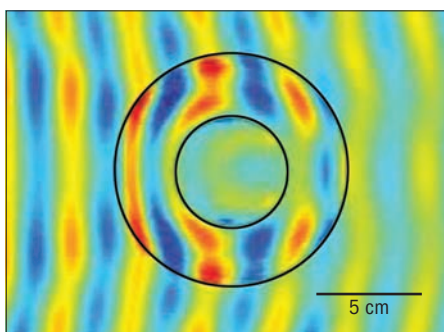
Compiled by Steve Reucroft and John Swain, Northeastern University

Invisibility cloak relies on the magic of metamaterials

The first invisibility cloak has been demonstrated by David Schurig of Duke University and colleagues. This is the first practical realization of a theoretical concept proposed earlier this year by John Pendry from Imperial College London (*CERN Courier* September 2006 p11).

The team created a shield in the form of a "metamaterial" made of 10 concentric fibreglass rings, each printed with a copper pattern. Working in the microwave region, the cloak interacts with electromagnetic waves to give the impression that both the cloak and the object within are nothing more than free space. It reduces both the shadow of the object and the radiation reflected, basically bending the incoming microwaves to make it appear that the shielded object is not there. The effect is rather like when water flows round a smooth rock and no disturbance is visible downstream.

The device tested was some 12 cm across



The invisibility cloak, between the black circles, shields a copper cylinder within.

and provided invisibility in two dimensions. Now the team plans to work towards a 3D device. So far the technique works only in a narrow frequency band in the microwave region, but shorter wavelengths could follow.

Further reading

D Schurig et al. 2006 *Science* **314** 977.

Untidy packing can have its advantages

The optimal packing of spheres in higher dimensions is an open problem with important implications for computing and error-correcting code in communications. It might seem that the best arrangement should involve some sort of regular lattice – think of stacking oranges in the market – and indeed in three dimensions the face-centre cubic lattice provides the densest packing arrangement. This was conjectured by Johannes Kepler some 400 years ago but proved only recently.

When it comes to higher dimensions the case is less clear, and no-one has yet improved on the lower bound on maximal packing density found 100 years ago by Hermann Minkowski for a d-dimensional space. Now, however, Salvatore Torquato and Frank Stillinger at Princeton University have found that sometimes it may be better to vary the local density of packing – that



In higher dimensions untidy packing may be better than the tidy equivalent. (Image copyright Willem Dijkstra/Dreamstime.com.)

is, to pack in a disordered way. They argue that for a high number of dimensions lattice packings are unlikely to be the densest, with disordered packing becoming more important as the number of dimensions increases.

Further reading

S Torquato and F H Stillinger 2006 *Experimental Mathematics* **15** 307.

Transitions reveal new Doppler effect

Everyone is familiar with the Doppler shift that occurs when the observer moves relative to some source of waves, but now a rotational effect has been found.

The idea hinges on the fact that a beam of light can carry orbital angular momentum in addition to the spin angular momentum of the photons. So an oncoming wave with orbital angular momentum could be Doppler-shifted depending on how the observer rotated relative to the beam.

The effects are small, but Sergio Barreiro of the University of Montevideo in Uruguay and colleagues have demonstrated them. They used a sophisticated set-up with an exotic transition in rubidium, a magnetic field, and two light beams with different values of orbital angular momentum.

Further reading

S Barreiro et al. 2006 *Phys. Rev. Lett.* **97** 113601.

Dubna discovers heaviest element yet

Researchers at the Joint Institute for Nuclear Research (JINR) in Dubna have created the first atoms of element 118, the heaviest produced so far, by firing calcium-48 ions into californium-249. They were detected by their alpha-decay to element 116 – also a new discovery – followed by two further alpha-decays to element 112, which broke into two fission fragments of approximately equal mass. Element 118 falls into the same column as the noble gases in the Periodic Table.

The collaboration, including members of the Lawrence Livermore Laboratory, has found only three examples of element 118 in some 2×10^{19} events (the first in 2002 and two more in 2005). However, the odds of a fluke are 1 in 100 000. The three examples had an average lifetime of 1 ms and a total atomic mass of 294.

Further reading

Yu Ts Oganessian et al. 2006 *Phys. Rev. C* **74** 044602.