

Compiled by Steve Reucroft and John Swain

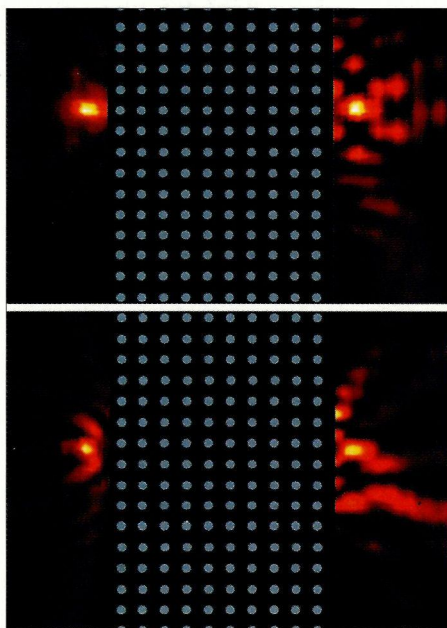
Photonic crystal makes flat lens

Lenses are usually thought of as being made of curved dielectrics, but must this always be the case? Rather surprisingly, the answer is "no", as Srinivas Sridhar and colleagues at Northeastern University in Boston, US, have demonstrated.

The key to creating the flat lens lies with the recent advent of materials – photonic crystals – that effectively have a negative index of refraction. A flat slab of such a substance can have an index of refraction that depends on the angle at which radiation hits it. The slab can then act as a lens, with the amazing property that there is no preferred axis and no restriction in aperture size. As the Northeastern researchers point out, the tricky part in creating the flat lens is in designing a photonic crystal with negative refraction over a wide range of angles – and low absorption.

The two pictures on the right show that they succeeded with a structure composed of cylindrical aluminium rods. In the upper picture an image of a point source of microwaves, at a frequency of 9.3 GHz, is created on the far side of the slab. In the lower picture the source has been moved up by 4 cm and the image has moved correspondingly. This illustrates that the flat lens does not have a single optical axis and limited aperture.

While this lens works only with microwaves – and in fact only for a narrow range of



A flat lens formed from an array of cylindrical aluminium rods creates an image (right) of a microwave source (left). In the lower picture the image has followed the 4 cm upward movement of the source.

frequencies, from 9.0–9.4 GHz – the principle could herald a revolution in optics.

Further reading

P V Parimi *et al.* 2003 *Nature* **426** 404.

New random way to immunize

Whether one worries about limited supplies of vaccines during the flu season, or about what might be needed in the event of a biological attack, it seems a good idea to think about how to optimize the distribution of such protection. Reuven Cohen of Bar-Ilan University in Israel and colleagues have made an amazingly simple suggestion: choose, at random, a sample of the population, ask them to name one acquaintance and then vaccinate those acquaintances.

The idea is that the people who are most likely to spread the disease, due to their large number of associates, have a high probability of being named. This overcomes the problem that those who have many acquaintances tend to be fewer in number and therefore unlikely to be chosen in a random trial. While this is clearly of medical interest, its application in protecting computers from viral attack by distributing suitable patches is also clear.

Further reading

R Cohen *et al.* 2003 *Phys. Rev. Lett.* **91** 247901.

Doppler reversed in radio waves

When does the frequency of a source increase, rather than decrease, as it moves away from you? One place is in Bristol, UK, in a laboratory at BAE Systems, where Nigel Seddon and Trevor Bearpark have demonstrated this remarkable effect with radio waves. The idea is to have waves in a nonlinear medium that can exhibit anomalous dispersion. In this case – which as it turns out has been known since the 1940s – the effect occurs as the incoming waves strike the boundary between a region of anomalous dispersion that is moving away and a region of normal dispersion that has not yet been made anomalous. The backscattered component then comes back shifted not down, but up in frequency. This work offers a whole new way of thinking about how to generate frequencies in traditionally difficult regions of the spectrum.

Further reading

N Seddon and T Bearpark 2003 *Science* **302** 1537.

Quintessence drives inconstant constant

The idea that the fine structure "constant" α might vary with time is an old one, but has been bolstered by observations of distant quasars that suggest α could have been dramatically smaller some 10 billion years ago. On the other hand, terrestrial measurements suggest only a very slow variation (if any!), which seems to be incompatible with the quasar work (*CERN Courier* March 2003 p15).

Now Luis Anchordoqui and Haim Goldberg of Northeastern University, US, have shown that these pictures can be reconciled by linking the variation in α not just to the passage of time, but also to the evolution of the dynamical scalar field known as "quintessence". This has been proposed to

explain the "dark energy" that appears to control the expansion of the universe (*CERN Courier* September 2003 p23). In particular, Anchordoqui and Goldberg have considered the model of Andreas Albrecht and Constantinos Skordis, in which the quintessence field has rapidly slowed in the recent past. They found that they obtained agreement with all the data on α . So it does indeed seem that while most of the things in the universe fly away from each other, protons and electrons – as if to defy the expansion of space – hold ever tighter to each other as α increases.

Further reading

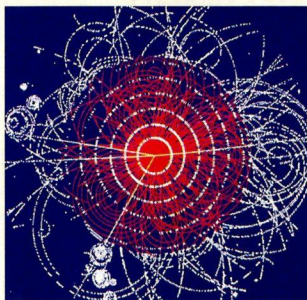
L Anchordoqui and H Goldberg 2003 *Phys. Rev. D* **68** 083513.



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Image shows a simulation by the ATLAS experiment of the
decay of a Higgs boson into four muons (yellow tracks).



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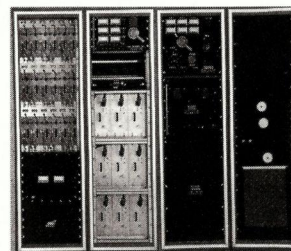
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