

Sciencewatch

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Masers come in from the cold

Solid-state masers, the analogues of lasers but working with microwaves instead of light, have been limited in their applications owing to their need for cooling and strong magnetic fields. This is set to change with work by Max Oxborrow of the UK's National Physical Laboratory and colleagues, who have built the first maser that works at room temperature. Operating at around 1.45 GHz, it uses a molecular crystal, p-terphenyl, doped with pentacene.

The pentacene is photoexcited by yellow light; exploiting a spin-selective molecular intersystem-crossing into a



This maser core was developed at the National Physical Laboratory in the UK. (Image credit: Andrew Brookes/NPL.)

triplet state, it then decays via microwave emission. Operating in air and in the normal terrestrial magnetic field, in oscillator mode the maser puts out about 100 million times the power of an atomic hydrogen maser, at a similar frequency. As an amplifier, the new maser can provide gain with a noise-temperature far below room temperature. So far, the device runs only in pulsed mode but it nevertheless represents an amazing breakthrough.

● **Further reading**

M Oxborrow *et al.* 2012 *Nature* **488** 353.

One photon at a time

Photons, as all particle physicists know, can interact with each other via charged particles so that some nonlinearity appears that is not present for the free electromagnetic field. This nonlinearity can be increased in the presence of condensed matter but is usually extremely small at intensities corresponding to one or two photons. Now, Thibault Peyronel of Massachusetts Institute of Technology and colleagues have demonstrated a medium that is so nonlinear that while individual photons can pass through, pairs are strongly absorbed.

The idea is to couple slowly-propagating photons coherently to strongly interacting Rydberg states in a cold, dense atomic gas of rubidium atoms. In addition to being essentially an optical switch controlled by a single photon, the device also constitutes a single-photon source that can operate in the megahertz range. It could lead to high quantum-efficiency photodetectors and quantum-switching devices for quantum computing and communications.

● **Further reading**

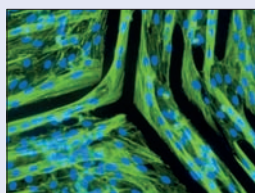
T Peyronel *et al.* 2012 *Nature* **488** 57.

Fractal archeology

Fractal geometry has found a new application, namely figuring out where ancient civilizations built structures that have since disappeared from sight. Arne Ramisch of the Freie Universität in Berlin and colleagues noted that rivers carve out fractal patterns in landscapes and, by using computers, they found an area some 6 km²

Building a jellyfish

The fictional Dr Frankenstein tried to create a living human from bits and pieces. While that seems to be a far-off prospect in real life, Kevin Kit Parker of Harvard University, John Dabiri of Caltech and colleagues have done



Close-up of engineered cardiac muscle used to power the tissue-engineered jellyfish. (Image credit: Janna Nawroth/Caltech.)

something similar at the level of jellyfish.

After characterizing the muscular structure of jellyfish, which make quick contractions and slow recoils to feed and move, the researchers made a mould to represent it. Seeding the mould with heart cells from a rat and coating it with a silicone polymer, they could the peel off a part silicone, part rat heart "medusoid" that, when placed in water through which a current was pulsed, swims like a real jellyfish. Their work opens the door to all sorts of synthetic muscular pumps and "organisms" that could be used to test drugs or even perform robotic tasks.

● **Further reading**

J C Nawroth *et al.* 2012 *Nature Biotech.* **30** 792.

near the Dahshur royal necropolis in Egypt where the fractal pattern had broken down. This was enough to suggest that extensive human activity had taken place there, even

though the signs are difficult to see with the untrained eye. Their work suggests a general approach to finding sites of archeological interest that can be used even when the elements have worn away obviously visible structures.

● **Further reading**

A Ramisch *et al.* 2012 *Quaternary Internat.* **266** 34.

The origin of Indo-European languages

Of all of the world's families of languages, Indo-European is the most global. It comprises more than 400 languages as diverse as English, French, Persian and Hindi, which together are spoken by about 3 billion people. Its origin, however, has remained obscure. Enter Quentin Atkinson of the University of Auckland and colleagues, who decided to apply to languages models originally designed to trace the genetic origins of pathogens. In effect, the idea is that languages might evolve over time in a similar way to the evolution of species.

The results come out clearly in favour of an origin with neolithic farmers in Anatolia (mainly in what is now Turkey) and against the other popular hypothesis that the Indo-European languages came from Bronze Age horse-masters from the Eurasian steppes. Not everyone agrees with the conclusions yet, but it demonstrates a fascinating extension of concepts from biology to linguistics.

● **Further reading**

R Bouckaert *et al.* 2012 *Science* **337** 957.