

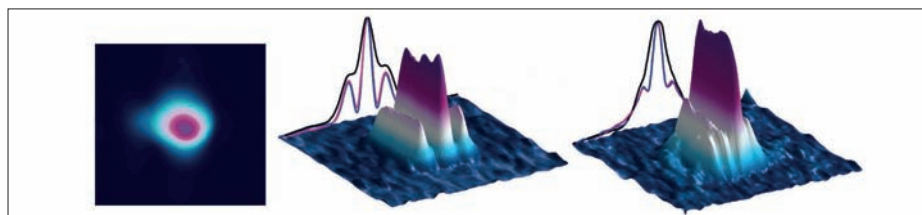
Sciencewatch

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An X-ray laser for the table top

Tenio Popmintchev and colleagues at JILA in Boulder have reported the first table-top X-ray laser. The team drives pressurized helium gas with an infrared laser, producing a strong electric field that pulls electrons off the helium and energizes them. The electrons release this extra energy as radiation (at shorter wavelengths) when they smash back into the helium atoms – in close analogy with how standard Röntgen X-ray tubes work, but in this case coherently.

The technique involves high-harmonic generation where frequency upconversions of more than a factor of 5000 greatly exceed typical high factors of around 100. The result is a bright continuum in which the photons produced have energies that range from extreme UV to 1.6 keV. They also come in



The X-ray beam profile generated in helium, left, and diffraction patterns formed by illuminating two 5- μm slits, separated by 10 μm , with X-rays generated in neon, centre, and helium, right, spanning 7.7–43 Å and 14–43 Å, respectively.

brief pulses – around 2.5×10^{-18} s is possible. This is shorter than from traditional sources but the intensity is also lower. The system consumes only about 1 W and provides some 10^5 photons per shot. Nevertheless, the simplicity and low cost make this an

attractive alternative to synchrotrons or free-electron lasers for applications in time-resolved nanoscale chemistry.

● Further reading

T Popmintchev *et al.* 2012 *Science* **336** 1287.

The shape of stalactites

Anyone who has seen a stalactite or stalagmite will have noticed the presence of crenulations, or ripples along the surface. Carlo Camporeale and Luca Ridolfi of the Politecnico di Torino now have an explanation of where they come from. The researchers have shown that coupling the fluid dynamics of falling films of liquid with the geochemistry that governs how minerals precipitate onto these structures, or how water dissolves them, produces universal shapes that match well with observations down to the wavelengths of the crenulations. In addition to its intrinsic interest, the work makes it possible to determine past film-flow rates from measurements on stalactites, which can be used for palaeoclimate analyses.

● Further reading

C Camporeale and L Ridolfi 2012 *Phys. Rev. Lett.* **108** 238501.

Gamma-ray optics

The difference between the index of refraction of a material and 1 can be written as the sum of real and imaginary parts, describing refraction and absorption. While making measurements of the refractive index of silicon in the region 0.18–2 MeV using gamma rays from an in-pile target at the neutron high-flux reactor at Institut Laue-Langevin in Grenoble, D Habs of Ludwig Maximilians University in Munich

Quantum information stored for 3 minutes

Two recent results put nuclear spins as front-runners to store quantum information. M Steger of Simon Fraser University and colleagues stored spins on an ensemble of dilute ^{31}P nuclei in ultrapure ^{28}Si using a combination of hyperfine-resolved optical transitions, Auger photoionization and nuclear magnetic resonance and were able to store quantum information for 180 s. The ultrapure silicon acts as an effective “vacuum” for the data, insulating it from decoherence.

In work published in the same issue of *Science*, P C Maurer of Harvard University and colleagues stored qubits on a single ^{13}C nuclear spin near a nitrogen-vacancy colour centre in isotopically pure diamond. This gave coherence lifetimes of more than 1 s at room temperature and the team suggests it could be extended to 1.5 days. Long-lived quantum information could revolutionize information security by providing intrinsically unforgeable and non-copyable forms of data.

● Further reading

M Steger *et al.* 2012 *Science* **336** 1280.
P C Maurer *et al.* *ibid.* 1283.

and colleagues have found that the real part changes sign at around 0.7 MeV and is much larger than expected. The result can be understood in terms of Delbrück scattering

and virtual-pair creation in the large nuclear electric field. Extrapolation to atoms of higher Z , such as gold, suggests that the real part could be as large as 10^{-5} – big enough to open a new field of gamma-ray optics based on refraction.

● Further reading

D Habs *et al.* 2012 *Phys. Rev. Lett.* **108** 184802.

Majorana quasiparticles

Majorana fermions – should they exist – would be their own antiparticles, much as the photon is. While the jury is still out on whether or not neutrinos are Majorana particles, V Mourik of the Kavli Institute of Nanoscience at Delft University of Technology in the Netherlands and colleagues report on making them in the laboratory as quasiparticles. The team used a wire made of InSb, a semiconductor with a large spin-orbit coupling, coated with superconducting NbTiN and placed in a magnetic field along its axis. The number of electrons in the wire was controlled by capacitatively coupled gates and for certain electron densities the magnetic field and spin-orbit coupling produced a novel superconducting state with Majorana bound states at its ends. This may be exotic condensed matter, but arrays of such wires could form the basis of a quantum computer.

● Further reading

V Mourik *et al.* 2012 *Science* **336** 1003.