Non-destructive detection

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A single photon can be detected without being destroyed, researchers now show.

Most classical optical detectors work by absorption. The energy carried by the light particle transfers to the electron in an absorbing material, for example. This excited electron is measurable, but the photon is lost. Andreas Reiserer and co-workers instead use the quantum-mechanical properties of atoms to create a non-absorbing detector of light.

Their detector is a single rubidium atom trapped in an optical cavity. Reiserer *et al.* prepared the atom in a superposition of two quantum states nearly on resonance with the cavity. A resonant photon incident on the atom–cavity system is reflected away, but leaves its mark on the atom by flipping its quantum state. Further manipulation of the atom leaves it in its upper state if a photon was incident on the system, and its lower state if not.

The system detected 74% of incident photons from an attenuated light source. Of course, the advantage of a non-destructive detector is that this efficiency can be improved by repeating the measurement on the same photon many times. *DG*

Unusual suspect

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The radius of the proton is a fundamental constant, but have we got it right? The standard measurement is based on electron–proton scattering and the spectroscopy of atomic hydrogen. But a 2010 laser-spectroscopy study of muonic hydrogen — in which the electron is replaced by a muon — came up with a considerably different value. The discrepancy has since been confirmed in improved measurements, reported in 2013. Among the several theories proposed to explain this proton-radius anomaly, Roberto Onofrio points to gravity as the chief suspect.

Onofrio has previously suggested that quantum gravity might be manifest in weak interactions at the Fermi scale, if the gravitational and weak forces have equal strength at that scale through the unification of the two forces. From this assumption he has calculated the Lamb shift for muonic hydrogen, from which the experimental proton radius can be derived. The heavier muon has a smaller Bohr radius than the electron, and thus the difference in the measurements of proton radius would be a consequence of the different electron–proton and muon–proton interactions — breaking the expected universality of gravity. *IG*

Is it or isn't it?

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Since the discovery of M101 ULX-1, also known as the 'pinwheel' galaxy (pictured), in Ursa Major, astronomers have pondered the source of the ultraluminous X-rays that emanate from it. As a binary system of a black hole and a star, it is either too bright for its estimated mass, or more massive than previously thought. To resolve this issue, it would help to measure the mass of the star — which is exactly what Jifeng Liu and co-workers have done, using the Gemini telescope.

The black hole could be an elusive 'intermediate mass' black hole. Such objects could coalesce to form supermassive black holes, but none of these intermediate-mass 'seeds' have been found so far. Liu and co-workers started with the companion star, which they confirmed is a massive, highly evolved Wolf–Rayet star that is extremely hot; its brightness suggests that it has roughly 19 solar masses. From there, they arrived at a black-hole mass of some 20–30 solar masses. Thus it is a 'stellar mass' black hole, but not by any means standard. The extreme luminosity remains a puzzle. *MC*

With strings attached

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DNA is the carrier of life's genetic code and the field of DNA nanotechnology — making clever use of artificial nucleic acids — is booming. In particular, the well-defined nucleobase pairing rules, which govern the structure of double-stranded DNA, provide molecular-recognition opportunities that are being increasingly exploited for the self-assembly of nanoparticles.

Evelyn Auyeung and colleagues now report an experiment in which they attached pieces of DNA to gold nanoparticles, and then heated a solution of these DNA-functionalized nanoparticles to slightly above the assembly's melting temperature before allowing it to cool down slowly — a process taking two or three days to complete. What emerged from the solution were micrometre-sized crystals in the form of rhombic dodecahedra (the 12 faces of which are congruent rhombi).

The shape of crystallite for which the surface energy is a minimum is called a Wulff polyhedron, and for a body-centred cubic lattice (the type of lattice formed by the gold nanoparticles) the Wulff polyhedron is expected to be a rhombic dodecahedron — exactly as Auyeung and colleagues saw. For many other systems, the predicted Wulff polyhedron does not actually form — hence these experiments clearly underline the power of DNA as a mediator in the fabrication of high-quality 3D nanoparticle crystals. *BV*

The taus have it

http://go.nature.com/vONGwJ; http://go.nature.com/gC2Rp2

With the Large Hadron Collider now shut down for maintenance, the experimental collaborations at CERN are working to extract every bit of juice from the data collected so far, and in particular to find out more about the Higgs boson that was discovered in the 125-GeV mass region. In recent seminars at CERN, the ATLAS and CMS collaborations presented their latest results on the decay of the Higgs into a pair of particles called tau leptons — results that reveal something interesting about the behaviour of the Higgs.

The discovery of the Higgs exploited its coupling to other bosons — the photon, the *Z*. But tau leptons (heavier relatives of the electron and muon) are fermions. The 4.1-sigma 'evidence' presented by the ATLAS collaboration shows that the Higgs can decay to fermions as well as bosons, and at a rate that is consistent with the expectation in the standard model. The result is confirmed by the CMS collaboration, who report a 4.0-sigma significance for a combined analysis of taus and bottom quarks (also fermions). *AW*

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