What is 'quantum'?

Nature **461,** 1101–1104 (2009)

Quantum theory, despite its success over the past century, still lacks the clear axiomatic foundation that characterizes, for example, the theory of relativity. But help might come from work by Marcin Pawłowski and colleagues, in which they introduce the principle of 'information causality'. In the future this might acquire the status of a basic principle on which quantum mechanics as a whole is based.

Quantum mechanics has several distinguishing features, among them non-locality: measurements made by two spatially separated observers can show stronger correlations than allowed classically. This property can be tested experimentally, but there is a broad class of other, non-physical theories that respect the no-signalling principle (which means that information cannot be transmitted faster than light) and also behave in a 'typically quantum' manner — and these allow for even stronger correlations than those provided by quantum mechanics.

But the principle of information causality, which prescribes how much information one party can gain when receiving classical bits from another, can distinguish quantum mechanics from these other no-signalling theories. As Pawłowski *et al.* show, their model is respected by classical and quantum physics, but not by theories with stronger-than-quantum correlations.

Graphene sees the light

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The maximum speed of charge carriers in graphene is just a few hundred times less than the speed of light. It is perhaps for this reason that a great deal of research into the practical use of graphene is focused on the development of high-speed electronic devices, such as the diodes and transistors that would be needed to build graphene-based computer chips. But electronics is not the only thing that graphene might be good for: Fengian Xia and colleagues show how it could also be used to make photodetectors capable of achieving unprecedented operating frequencies.

Conventional photodiodes require large external bias voltages to ensure that photoinduced electron–hole pairs generated within them are separated before they have a chance to recombine. Xia *et al* show that, in graphene, the high speed of its charge carriers means that these pairs can be efficiently separated by much lower voltages — indeed, they find that even the internal fields that arise at the interface between graphene and a metal electrode are sufficient. They demonstrate the operation of photodetecting graphene transistors up to frequencies of 40 GHz. By optimizing the structure of their devices to minimize extrinsic speed-limiting factors, they believe operating frequencies in excess of 500 GHz could be reached.

Catch the wave

Science **326,** 272–275 (2009)

One of the hallmarks of superconductivity is the flow of an electric current without dissipation. But since the 1960s, theories have predicted that normal metal rings should be able to sustain persistent currents as well. In basic terms, to an electron travelling in a one-dimensional ring in the presence of a magnetic field, each circular orbit is equivalent to one period within a periodic potential (M. Büttiker *et al. Phys. Lett. A* **96,** 365–367; 1983). The current has a wavevector k determined by the magnetic flux Φ through the ring. Unfortunately, in a micrometre-sized ring below 1 K, these are 1 nA currents: only now have Ania C. Bleszynski–Jayich and co-workers made an unambiguous measurement of such persistent currents.

Bleszynski–Jayich *et al.* mounted their aluminium rings on a microcantilever and applied a magnetic field strong enough to eliminate any superconductivity in the aluminium. By means of the change in the resonant frequency of the cantilever, they detected a current with a periodicity determined by $\Phi = h/e$. Several orders of magnitude more sensitive than SQUID-based detectors, these micromechanical detectors could be used to study many-body effects.

Jet pack

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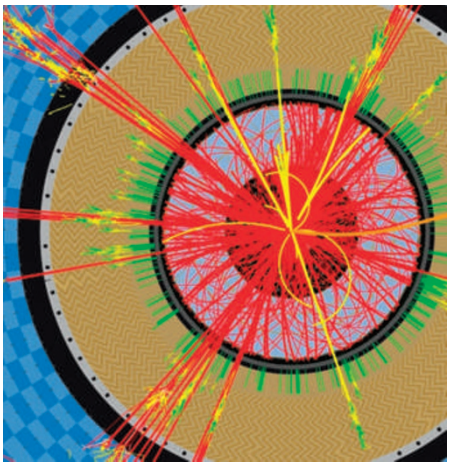

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Supersymmetry could be one of the first discoveries at the Large Hadron Collider (LHC). The gluino, the fermionic superpartner of the bosonic gluon, is just one member of the supersymmetric family of particles that could be created in the proton–proton collisions. But the gluino signature in the LHC's huge detectors might be blurred, due to so-called initial-state radiation: Johan Alwall and colleagues, however, suggest a fix.

A pair of gluinos created in a collision could create a pattern of 'jets' in a detector: each gluino decays into a pair of quarks and another superparticle, a neutralino; each quark then forms a jet of particles, streaming out from the collision point, but the neutralino escapes undetected.

But gluons radiated from the incoming protons — initial-state radiation — could also create jets in the body of the detector: how do you know, in the typical mess of tracks, that you've picked out the jets that actually came from the gluino of interest? Alwall *et al.* have devised an algorithm to do the job, using an existing 'transverse mass' variable that takes into account the transverse momentum seen, and missing, in the event.

Harmonic blinking

Phys. Rev. B **80,** 161407(R) (2009)

Rough metallic surfaces can enhance electromagnetic fields. An application of this is in surface-enhanced Raman scattering, which is used to boost the fluorescence from single molecules and nanoparticles. Sometimes this radiation intermittently switches on and off. Now, Nicholas Borys and co-workers have also seen such temporal fluctuations in second-harmonic radiation.

In their experiment, incident infrared light (with a wavelength of 1,070 nm) is scattered by a silver nanoparticle sitting on a silver film. Nonlinear optical processes generate radiation at the second harmonic, a wavelength of approximately 535 nm, which is enhanced by the rough surface.

Blinking has been observed in the light emitted from a number of different nanoscale sources and can be understood because such emission involves transitions between real electronic states. But blinking of nonlinear scattering was not expected. At this stage the underlying mechanism is not completely understood; however, Borys *et al.* suggest that it may be charging that alters the optical properties of the nanoscale particles.