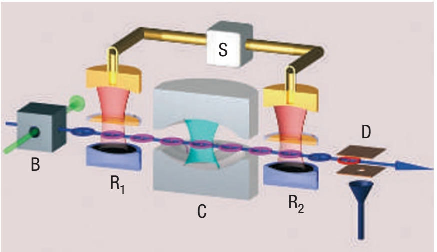
Go ahead, jump



Nature **446,** 297–300 (2007)

Quantum systems fluctuate, randomly jumping between states — as has been demonstrated for trapped massive particles, such as electrons and ions. But to catch photons in the act requires a particularly sophisticated non-demolition approach.

Sébastien Gleyzes and colleagues have devised an interferometric set-up in which they can observe the fluctuation of photon number n between 0 and 1 through thermal fluctuations and relaxation in a niobium-mirror cavity (labelled C above).

Rubidium atoms are prepared in a circular Rydberg state in box B and cross the cavity at a rate of 900 Hz. Inside the Ramsey cavity R_1 (fed by microwave source S), the atoms enter a superposition of two circular states, known as e and g; the cavity C is set at resonance with the e–g transition. As the atoms pass singly through C, the superposed state acquires a phase that is probed by a second Ramsey cavity R_2 and a counter D. The relative phase of the fields in R_1 and R_2 is set so that finding an atom in state g corresponds to the $n = 0$, empty-cavity situation, whereas e means $n = 1$.

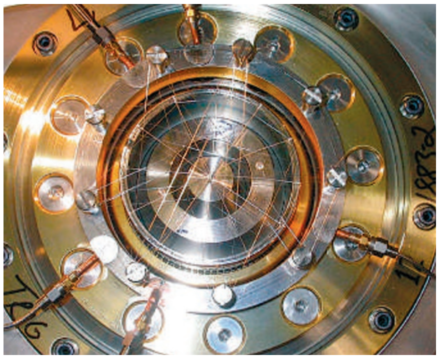
A switch on qubits

Phys. Rev. Lett. **98,** 070501 (2007)

A qubit, the data carrier of future quantum computers, has to lead a double life. It should be able to store information, in isolation from everything around it, but at other times it needs to interact strongly with other qubits, to perform the logic-gate operations required for the processing of information. David Hayes and colleagues propose that the nuclear spin of ultracold neutral atoms could be used to switch back and forth between such isolation and the more social situation.

Neutral atoms, cold enough for their quantum properties emerge, are a candidate system for quantum information processing. The atoms can interact with each other through collisions, a process governed by electronic interactions. Nuclear properties do not come into play directly, but in fermionic nuclei (those with half-integer spins) the Pauli exclusion principle prevents parallel spins getting close to each other, effectively suppressing collisions. In the antiparallel configuration, however, interaction is allowed. So flipping the nuclear spins, using NMR techniques, could provide the desired switch for interaction between the atoms.

A pinch of neutrons



Phys. Plasmas **14,** 022701 *(2007)*
Phys. Plasmas **14,** 022706 *(2007)*

Neutron beams are useful for a range of applications, from non-invasive imaging and characterization of materials to the production of medical isotopes. Unfortunately, generating neutrons of sufficient energy and intensity requires a nuclear reactor or particle accelerator. But now two groups report progress towards generating neutrons from thermonuclear fusion reactions, using a device known as a 'Z-pinch'.

A Z-pinch consists of a mesh of thin metal wires through which a pulsed current of the order of tens of megaamps is passed. This causes the wires to vaporize and implode — or 'pinch' — to form a dense, high-energy plasma. The possibility of producing neutrons from the fusion of deuterium and tritium atoms injected into such a plasma was proposed over 50 years ago. Only now do simulations and experiments suggest that the technology has matured to a stage where useful fluxes could soon be generated.

Focus to polarize

Nature Photon. **1,** 228–231 (2007)

Polarization is a useful property in most contexts in which light is put to practical purpose. In microscopy, it is used to generate contrast and to determine the make-up and orientation of optically active materials; and in telecommunications, it can limit the rate at which information is transmitted down an optical fibre. Conventionally, polarization is controlled using polarizing filters, which are made from bulk optically anisotropic materials. But Klas Lindfors and colleagues demonstrate the surprising result that light can also be polarized by doing nothing more than focusing an otherwise unpolarized beam of light.

They show this by scattering a tightly focused laser beam off a gold nanoparticle suspended in oil. Previous experiments have shown that such scattering provides an effective means of probing the local polarization of an optical field. Their results, which agree with theoretical predictions, suggest that the resulting light varies from zero to almost complete linear polarization over distances of around 100 nm — with important implications for the emerging field of nano-optics.

Numbers watered down

Phys. Rev. Lett. (in the press);
http://arxiv.org/quant-ph/0609174 (2006)

When it comes to computing with spins, all eyes are usually on quantum sorcery. But Michael Mehring and colleagues show that spins can do intriguing things without evoking entanglement. They implement a 'physical' scheme for factorizing numbers on an NMR platform and use plain water as the ensemble of spins.

Their algorithm uses Gauss sums to factorize integers. The story goes that young Carl Friedrich Gauss, when his teacher asked the class to sum up all numbers from 1 to 100, immediately wrote down the correct answer — 5,050 — on his slate: he'd realized that the problem can be handily formulated as $(100+1) + (99+2) + \ldots$, which is simply 50×101. Mehring *et al.* use the periodicity properties of such sums; after irradiating the spins with a series of radiofrequency pulses, the averaged NMR signal is different for numbers that are and numbers that aren't a factor of the integer being factorized. As a first example, 157,573 was correctly factorized, but the method is expected to be expandable to considerably larger numbers.