research highlights

Family matters

Nature **479,** 372–375 (2011)

Neutron stars arise from the gravitational collapse of massive stars during a supernova event. Most are thought to form via one of two mechanisms, each associated with a different type of supernova: iron-core collapse or electron capture. However, attempts to distinguish the two groups by examining the resulting neutron stars have not yet been successful.

A magnetized neutron star in orbit with a companion can, however, constitute a powerful source of X-rays, and such X-ray pulsars may hold the key to telling apart the two types of neutron star — as Christian Knigge and colleagues now show.

They have examined data for a large, well-characterized class of pulsar, and have identified a bimodality in the distributions of their spin and orbital periods, and of their orbital eccentricities. Shorter periods and lower eccentricity, they say, are likely to be associated with supernovae that were initiated through electron capture by neon and magnesium nuclei in a lower-mass stellar core, rather than those created when a high-mass star's degenerate iron core tips over the Chandrasekhar limit. *AK*

Diamond cavities

Nature Nanotech. http://dx.doi.org/10.1038/nnano.2011.190 (2011)

The leading proposal for a solid-state quantum computer that works at room temperature relies on the electronic, spin and optical characteristics of discrete point defects in diamond. Diamond is a good host for spin-based quantum computing because it has very few nuclear spins of its own, and it is able to host defects — most notably nitrogen–vacancy centres — that barely interact with the surrounding lattice. By creating an array of these defects, it might be possible to encode an ensemble of coupled quantum bits in their spins.

One way of enhancing the coupling between qubits of such an array is to embed them in an optical cavity — most obviously by forming a cavity out of diamond itself. What's needed is a narrow-resonance, high-quality cavity that avoids losses to phonon modes and other non-radiative channels, but this has proved difficult to achieve in diamond.

Janine Riedrich-Möller and colleagues have gone some way to overcoming the difficulties by using focused ion-beam milling to create one- and two-dimensional photonic-crystal cavities in suspended single-crystal diamond membranes. They can then tune the characteristics of the cavities to enhance the zero-phonon photoluminescent emission of silicon–vacancy defects present in the diamond. *EG*

Putting it together

Phys. Rev. D **84,** 101301 (2011)

Sometime after the Big Bang, the Universe is thought to have undergone a period of exponential expansion, known as inflation — and thus quantum fluctuations in the early Universe were amplified to seed its present structure. Cosmological data support inflation, but it's proving harder to reconcile with the well-developed and well-tested standard model of particle physics. A particular problem is matching the 'inflaton' — the hypothetical scalar field that would drive inflation — to a scalar field that sits comfortably with particle physics as we know it.

Rouzbeh Allahverdi and colleagues have developed what they consider to be a general prescription for constructing the right kind of potentials for the job. Importantly, the potentials have a desirable quality of 'flatness', have vacuum expectation values that fall below the Planck scale, and can be embedded, without too much fine-tuning, in a version of the standard model that is extended to include supersymmetry. Supersymmetry links integer-spin and half-integer-spin particles, such that every known particle of the standard model is partnered by a 'superparticle'. Evidence of supersymmetry could be found at the Large Hadron Collider. *AW*

Let it flow

Phys. Rev. Lett. (in the press)

It's simple, really: the basic principle of writing with ink is the delivery of a liquid from a reservoir to an absorbent surface, and then the spreading of that liquid as the source moves across the porous substrate. To study the hydrodynamics in more detail, however, Jungchul Kim and colleagues have used a 'minimal pen' made of a capillary tube, brought close to a highly hydrophilic micropillar array, which served as their model of paper.

The basic hydrodynamics of the writing process is governed by the capillary force that makes the ink flow and by the viscous force exerted by the substrate. Considering the balance of the two forces, Kim *et al.* have succeeded in reproducing both the dynamics of the blot that is created before the pen starts moving, and the frontal shape and final width of the line produced by their simple pen. *AT*

Dots work together

Phys. Rev. Lett. **107,** 196802 (2011)

When a beam of light hits a thin metal film, some of it is absorbed and the rest is reflected. However, pierce the same film with a regular array of holes and, even if the hole size is smaller than the wavelength of the light, more light is transmitted than would be expected. Researchers have now shown that an effect similar to this so-called extraordinary optical transmission might also be seen with electrons.

In the analogy put forward by L. S. Petrosyan and colleagues, the optical apertures are replaced by quantum dots — nanostructures that can support discrete and localized electron states by virtue of their small size. The researchers considered a device in which this quantum-dot array is sandwiched between two electrical leads and calculated that the device's conductance per quantum dot in the array is significantly enhanced over the single-quantum-dot case. They attribute this to the fact that some of the quantum-dot electron states become delocalized because of coherent coupling to the leads. *DG*

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