Transformed detectors

Opt. Express **20,** 2110–2115 (2012)

Optical computing involves encoding data into the physical properties of light beams or even individual photons. Orbital angular momentum is a particularly appealing degree of freedom for this task because, unlike polarization, it can take on a wide range of values — but conventional detectors are not sensitive to this property. Martin Lavery and colleagues have now shown how transforming the optical beam offers an indirect method for detecting its orbital angular momentum.

Diffraction-based detection methods can test whether a photon has a specific orbital angular momentum — which is not that useful if you don't know what value to check. Lavery *et al.* instead demonstrate a technique that uses refractive optical elements. Their set-up transforms an incoming angular momentum state into a complementary transverse momentum state. The output beam is then focused by a lens onto a camera — a specific spot on the camera corresponds to a particular initial orbital angular momentum. Thus, the method checks all possible values simultaneously.

The transmission efficiency of the combined refractive elements is 85% — high enough for use at low light levels. Indeed, the team have also demonstrated that the technique works for single photons by replacing the conventional camera with a sensitive CCD (charge-coupled device) camera. *DG*

Roll up!

Soft Matter (in the press)

Limblessness is no barrier to locomotion. Indeed, living systems that have remarkably simple topologies find little difficulty in converting chemical energy directly into mechanical energy. However, our best efforts to design machines with comparable efficiency are often far from simple.

Dipabali Hore and colleagues have succeeded in this respect by devising a novel means of inciting elastomeric microcylinders to roll up an inclined plane. The idea centres around an asymmetric swelling cycle induced by the application of an organic solvent. The solvent accumulates preferentially on the downhill side of the cylinder, causing it to swell differentially and creating a torque that sets the cylinder in motion — rolling up the hill.

The authors found that increasing the plane's inclination could actually increase the velocity of the cylinder, and developed a scaling relation that describes the dependence of this velocity on the material properties of both solvent and cylinder. That the cylinder was even able to bear the weight of cargo on its ascent raises the possibility of applying differential swelling to transport design on the microscale. *AK*

Pep talk

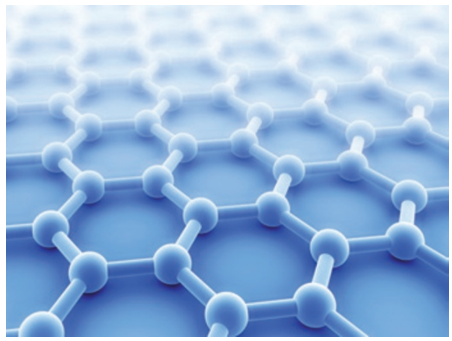
Phys. Rev. Lett. **108,** 051302 (2012)

A star the size of the Sun is predominantly powered by the proton–proton (*pp*) fusion reaction, which releases a substantial flux of neutrinos. Borexino — a 278-ton liquid-scintillator detector of electron neutrinos, located at Italy's Gran Sasso laboratory —has now achieved sufficient sensitivity in a particular energy range for Gianpaolo Bellini *et al.* to claim the first detection of electron neutrinos from the so-called *pep* reaction of the *pp* chain.

The fusion of two protons and an electron (*pep*) to produce deuterium is a rare but possible step in the elaborate *pp* chain that produces light elements such as lithium and beryllium in the Sun. The *pep* reaction also releases an electron neutrino of a specific energy (1.44 MeV). The challenge to detect the relatively small flux of these neutrinos has been met in large part by the efforts of Bellini *et al.* to suppress the main background around that energy: beta emission from carbon-11 atoms, which are produced from carbon-12 nuclei in Borexino's organic scintillator through interactions with cosmic muons. The authors have also managed to put the tightest constraint yet on the neutrino flux from the carbon–nitrogen–oxygen cycle for fusion in stars. *AW*

Between the sheets

Science http://doi.org/hqc (2012)



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It is often suggested that the superlative electrical characteristics of graphene could, in theory, enable the development of computer circuits that significantly outperform today's silicon chips. In reality, no one has yet demonstrated any graphene device that is capable of controlling the flow of current through an electrical circuit as effectively as a conventional silicon field-effect transistor can. This is because electrical currents move through graphene with such ease that it is difficult to turn them off, and limits the room-temperature on/off ratio of graphene devices to less than ten.

Liam Britnell and colleagues suggest that this situation could be improved by controlling the flow of current between different graphene sheets rather than between different regions of a single sheet. They have demonstrated this approach using a device that consists of two layers of graphene separated from each other by a nanometre-thick layer of either hexagonal boron nitride or molybdenum disulphide, all deposited on top of an isolated silicon substrate (which acts like the gate of a conventional field-effect transistor). By varying the voltage on this gate, the authors show that they can switch the current between the sheets by a factor of up to 10,000. *EG*

Tolerable errors

Nature **482,** 489–494 (2012)

Error correction enables computing machines constructed from fault-prone components to perform calculations with arbitrary precision. This works also, at least in principle, for quantum computers, and several codes for quantum error correction have been devised over the years.

For most of these codes, however, the demands on hardware are dauntingly, if not prohibitively, high. Therefore, the experiment performed by Xing-Can Yao and colleagues is particularly welcome: they have implemented an approach that works at relatively modest error rates and requires only nearest-neighbour interactions between particles, which makes application more feasible.

The method, known as topological error correction, exploits the topology of so-called cluster states. Yao *et al.* inscribe such a cluster state on eight photons. When one of the qubits is disturbed, the faulty 'component' can be located and the error corrected. And when the error affects all qubits simultaneously, the effective error rate can also be lowered, underlining the promise of the approach. *AT*

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