

Edited by Archana Sharma

Woven for nanoelectronics



Nanotube networks – this scanning electron microscope picture shows carbon nanotubes draped across silicon pillars. The spacing between pillars is 500 nm.

Japanese researchers have investigated a new technique through which the self-interconnection of nanostructures could lead to nanoscale logic circuits. Carbon nanotubes are self-assembled nanoscale structures with excellent mechanical, electrical and chemical properties, and are useful for a variety of applications. Semiconducting carbon nanotubes can act as a field-effect transistor or a single electron transistor for nanoelectronics. Metallic carbon nanotubes exhibit ballistic conductivity (electrons travel through without losing energy) at room temperature. This, coupled with the mechanical strength of carbon nanotubes, as well as their shape and size, makes

them ideal for wiring nanoscale devices.

Employing the chemical vapour deposition technique, the Japanese team has grown nanotube networks on arrays of 100 nm high silicon pillars, confirming an earlier observation using 10 μm pillars. This self-directed growth is a remarkable feature of carbon nanotubes; however, the growth mechanism is not yet fully understood. Further investigation is needed before carbon nanotubes find their way onto our desktops.

Further reading

Y Homma *et al.* 2002 *Appl. Phys. Lett.* **81** 2261–2263.

New technique for non-invasive EEG

UK researchers have reported how advances in the amplification, electronic processing and real-time display of electroencephalogram (EEG) signals can provide a new way of monitoring brain activity. Traditional EEG monitoring is invasive, at the minimum requiring shaving of the patient's hair and abrasion of the skin. This can be avoided by using superconducting quantum interference device (SQUID) magnetometers to detect the magnetic component of the fields generated by the flow of currents in the brain. The resulting magnetoencephalograms can be gathered non-invasively, but the technique has its own drawbacks, not least the cryogenic operation of the SQUIDs.

The new EEG sensors use electric displace-

ment, rather than real charge, current. This means that they do not need real electrical contact with the body, and can produce EEGs non-invasively. The UK team has demonstrated their effectiveness by measuring activity in the region of the occipital lobe, with the sensors being in contact with the hair only, and with no preparation of the scalp. The result shows the well-known phenomenon of alpha-blocking – an alpha-rhythm signal is present when the patient's eyes are closed, but is blocked when the eyes are open.

Further reading

C J Harland *et al.* 2002 *Appl. Phys. Lett.* **81** 3284–3286.

Persuading bosons to behave as fermions

Physicists from Germany and Austria have proposed ways of persuading bosons to act as fermions. The Pauli exclusion governs the behaviour of fermions – many electrons in the same box, for example, must differ from each other in some way. They must occupy a different place, or have a different value of a quantum property such as spin. Bosons (such as photons and the hydrogen atom) have no such restrictions – a limitless number of them can be in the identical quantum state.

Persuading fermions to behave as bosons is nothing new. Superconductivity and superfluidity are examples of phenomena where fermions behave like bosons. By pairing up, as they do in superconductors, fermions possess the same key properties as bosons, and so they act just like bosons.

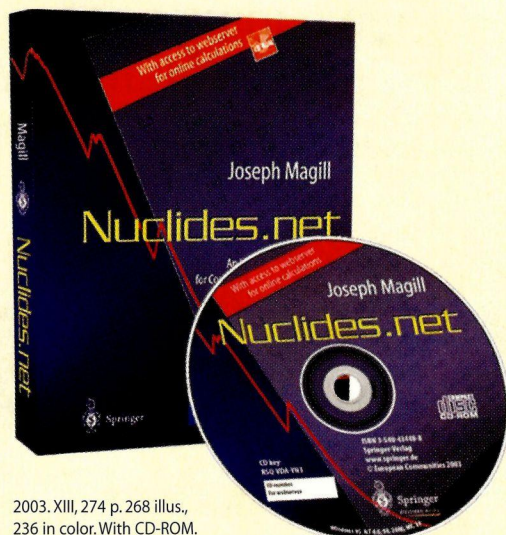
Making bosons behave like fermions, however, is a feat so far unaccomplished. Now, researchers from the Max Planck Institute for Quantum Optics have put forward proposals for doing just this. One way, they suggest, would be to rotate a Bose–Einstein condensate (BEC). In the ground state, a BEC has several different low-energy levels due to different possible values of angular momentum in the atoms. Cancelling the energy gained by angular momentum, and rotating the BEC at just the right rate, causes these levels to become equal to one another in energy. The atoms would then be forced to minimize their repulsion with one another by assuming slightly different values of angular momentum, hence behaving like fermions. Lasers or mechanical devices can be used to rotate a BEC. The caveat is the currently obtainable rotation speeds, requiring researchers to create a BEC with only a handful of atoms instead of the typical 10 000 or so. If this turns out to be unfeasible, the researchers have another proposal: rotate an optical lattice, a light-based web of atom traps containing five atoms in each trap. This is experimentally possible and could produce a stronger signal than that from a single BEC.

Further reading

<http://arXiv.org/abs/cond-mat/0207040>.

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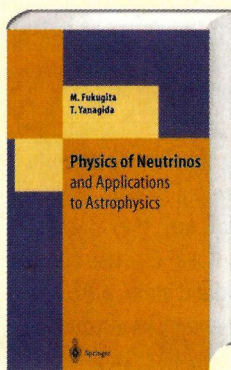
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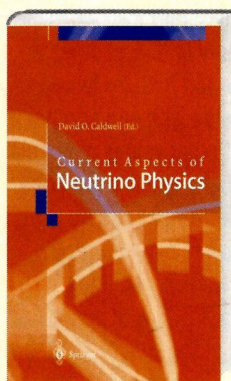
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