Recent Press Releases

The honeycomb computer

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Quantum computers will harness the laws of quantum mechanics to conduct calculations many times faster than conventional computers. The problem is that no one is sure how to make one. Tom Hodgson of the University of York will describe a design for a quantum computer that could be relatively robust and easy to manufacture on Thursday 12 April at the Condensed Matter and Materials Physics conference, organised by the Institute of Physics.

The design consists of lots of tiny blobs of semi conducting material lodged inside a kind of ceramic sponge and is the result of the international collaboration between the Dept of Physics of the University of York (T.E. Hodgson and Dr. I.D'Amico) and the Dept. of Physics (Prof. M.F. Bertino) and Chemistry (Prof. N. Leventis) of the University of Missouri-Rolla.

Quantum computers will achieve their tremendous power by exploiting the strange fact that in the quantum world objects can exist in several different states at the same time. Objects subject to these rules are generally very small indeed – individual atoms, or in this case, small pieces of material called quantum dots, just a few nanometres (millionths of a millimetre) wide, which can behave rather like ‘artificial atoms’.

Information can be encoded in the states of objects like this, just as it is imprinted into the magnetic states of the material inside today’s computer hard drives. But because the quantum objects – the quantum ‘bits’ or qubits of such a computer – can exist in a ‘superposition’ of many different states at once, this means that the encoded information can be processed in many different ways at the same time. In effect, the quantum computer operates somewhat like many conventional computers running in parallel.

Some researchers are investigating designs for quantum computers in which the qubits are individual atoms trapped by electrical or magnetic fields. These require rather sophisticated microelectronic structures to act as the traps, and the atoms aren’t easy to manipulate in the ways that are needed to conducting a computation. Others think quantum computers might encode the information in the quantum states of ‘light particles’ (photons). But so far, no one has made a quantum computer with more than a handful of qubits – which doesn’t offer much computing power at all, compared with the billions of bits in conventional desktop computers.

The design proposed is rather more down-to-earth. Quantum dots made from semiconductors are now routinely made for many different applications in science and technology, ranging from information processing to biomedicine. But making them all the same size (so that they all have the same behaviour), and arranging them into the kind of orderly arrays that would be needed if they are to serve as the qubit components of a quantum computer, isn’t easy. Hodgson and colleagues say that quantum dots could be made inside a kind of microscopic honeycomb of titania, the material used as the pigment of white paint. Such synthetic porous materials, with regular arrays of identical pores just a few nanometres wide, have been known since the early 1990s.

To make a qubit array, the researchers propose using electrochemistry to create stacks of semiconductor ‘plugs’ in the pores. Information can be read in and out of the qubits by shining laser pulses on them. The area lit by the laser would be much larger than the size of each pore – and so, because each stack of qubits is identical, many copies of the same information would be created. This is actually an important advantage, because quantum computation is known to be inevitably error-prone – it makes many mistakes. But with many copies, these errors can be corrected by averaging them out. The researchers point out that the experimental techniques required to create structures of this type already exist.

Notes to editors:

1. The poster, *Quantum computation using quantum dots in mesoporous materials,* will be on display from Thursday 12 April 2007 at 09:00 hours.

2. For more information and interviews or to attend the conference, please contact Helen MacBain, press officer, Institute of Physics, Tel: +44(0) 7946 321 473, +44(0)20 7470 4815 or E-mail: helen.macbain@iop.org.

3. The Insititute of Physics conference, *Condensed matter and material physics,* will be held on 12 - 13 April 2007 at the University of Leicester. The full programme for the conference can be found here.

4. The Institute of Physics is a scientific membership organisation devoted to increasing the understanding and application of physics. It has an extensive worldwide membership (currently over 35,000) and is a leading communicator of physics with all audiences from specialists through

government to the general public. Its publishing company, IOP Publishing, is a world leader in scientific publishing and the electronic dissemination of physics.

^ To the top ^

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