Bang-bang: a step closer to quantum supercomputers

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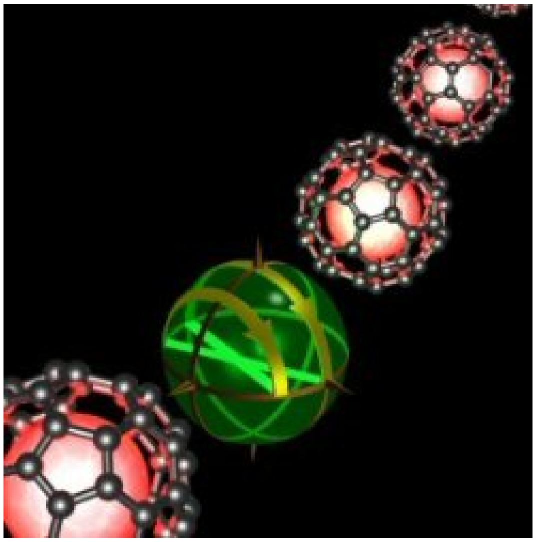

Image: A representation of the buckyball cages, with arrows showing how their rotation can be knocked back and forth.

Oxford scientists have come a step closer to quantum ‘supercomputers’ by creating a new technique called ‘bang-bang’ to hold quantum information.

The method, which the researchers report today in *Nature Physics*, costs £7 million pounds per gram, but fortunately the nanoscale of the information-holding molecules they have created – just ten atoms across – keeps the cost down.

The idea behind quantum computing is based on quantum mechanics, which allow an entity, such as an atom, to exist in multiple states simultaneously. Quantum computing is seen as the holy grail of computing because each individual piece of information, or ‘bit’, would exist in more than one state at once, making processing billions of times faster and thus dramatically widening the scope of what computers can do.

There’s just one problem: no-one knows how to build a quantum computer yet. The biggest hurdle is that the quantum state is only maintained as long as the quantum entity does not interact with anything. Once it is detected, or interacts in any way with the environment around it, the quantum bit (qubit) collapses into one state or another and loses the vital quality of existing in more than one state at once. The challenge is how to isolate quantum information from its surroundings.

The team, from the Materials Science Department, had a plan to ‘cage’ the qubit in a buckyball (a Buckminster fullerene particle), a molecule which has a cage structure reminiscent of a football. This isolates the qubit to some extent, but not quite enough.

The next step the researchers took was to apply the so-called ‘bang-bang’ method: the qubit is repeatedly hit with a strong pulse of microwaves which reverses the way in which it interacts with the environment. Dr John Morton, one of the authors on the paper, said: ‘The loss of information is like a child at a party game running with a blindfold on. We keep regularly turning the child around. If we do this quickly enough, the information remains intact (i.e. the child never gets very far).’

Dr Simon Benjamin, another of the authors, said: ‘The experiment was a complete success. We were able to show a very high level of decoupling of the nuclear spin from its environment, freezing the information exactly as planned. It's likely that strategies like this will form a quintessential element in any future quantum computer.'

Source: University of Oxford

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