The impact of its environment on a quantum computer

April 14 2005

Scientists have discovered how the performance of a quantum computer can be affected by its surrounding environment. The study, published in the latest issue of the journal *Science*, will help engineers to better understand how to integrate quantum components into a standard office computer - moving us one step closer to a future of quantum computing.

The collaborative team from the London Centre for Nanotechnology, University College London (UCL), the Paul Scherrer Institute/ETH in Switzerland and the Universities of Chicago and Copenhagen, have shown how its environment can radically alter the behaviour of a quantum computer, an effect which is not present for conventional computers of the type that exist now on our desktops.

Professor Gabriel Aeppli of UCL's Dept of Physics and the Director of the London Centre for Nanotechnology says: "One of the most important questions in natural sciences is whether quantum mechanics is relevant to everyday experience. The famous puzzle of whether Schroedinger's cat is dead or alive is the most graphic representation of this question, traditionally considered an academic point of no real practical import.

"However, the recent demand for secure communications and ultra-high speed computation has made the answer highly relevant to future technology where quantum 'qubits' replace the classical binary bits 0 and 1 on which current digital electronics and communications rely.

"To engineer quantum computers it is necessary for the qubits to be

stable in realistic settings, such as the integrated circuit packages in a typical office computer. Physicists refer to such settings as the 'environment', or more picturesquely, the 'bath', and the challenge is to control and minimize the interactions of the qubits with the bath.

"Quantum engineering will require careful attention to the 'baths' in which the new devices will be immersed, in the same way that we worry about turbulent air conditions when we design aircraft." Baths by their very nature can be difficult to define and therefore the systematic study of interactions between qubits and baths is in its infancy. The new work shows how a well-specified bath affects the qubits in a crystal which behaves as a very primitive quantum computer. For example, the bath will change how the qubits will move in response to stimuli such as radio waves. The work also suggests that the effect can be controlled by radio waves themselves and by the temperature of the bath.

Source: University College London