



## The Centre for Nanoscience and Nanotechnology Seminar Series



**TOPIC:** The Rise of Quantum Machines: Nanotechnology and the Challenge of Quantum Computation.

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### **ABSTRACT:**

In the well-known books *The Feynman Lectures in Physics*, Nobel Prize winner Richard Feynman says if there was one principle he could pass on to future generations after some sort of world-wide catastrophe it would be the idea that “matter is made from atoms”. With the rise of nanotechnology in the late 20th Century machines were developed that exploited fewer and fewer atoms in their smallest working components and in doing so worked faster, cheaper and more efficiently than ever before. This gave birth to the world wide web, personal computers, mobile phones, fibre optic communication systems, solar panels and ultra-high density data storage chips.

With the dawn of the 21st Century we are beginning to see machines made from even smaller numbers of atoms, say from 30 to 1000 atoms. We are even beginning to challenge nature where DNA molecules store bits of information in as few as 50 atoms. In fact some of the small features in present generations of computer chips rely on thin semiconductor layers only a few atoms thick. But with such tiny machines, new possibilities arise because of the strong influence of quantum mechanics. This immensely successful and counterintuitive theory had one of its most important foundations laid down by the revolutionary ideas of Albert Einstein 99 years ago with the idea of the light quantum already exploited in 20th Century technology. But 21st Century nanotechnology will push the theory even further.

Commencing in the past decade, quantum mechanics has undergone a profound reappraisal as the technological possibilities of abstract quantum mechanical concepts of superposition (an object being in two places at the same time) and entanglement (two objects being interlinked despite being separated by a large distance) have been recognized. In part, this reappraisal has been driven by the potential of a radical new type of quantum processor that exploits quantum rules for processing information. Recognized as one of the main challenges for 21st nanotechnology, the construction of a quantum computer in silicon has been the main focus of the ARC Centre of Excellence for Quantum Computer Technology in which the University of Melbourne plays a key role. This lecture will review some of the key concepts of quantum mechanics and describe the progress towards the construction of a quantum computer device that uses single atoms to store and process information.