1155th General Monthly Meeting

Recent Progress in Quantum Electronics: What happens when electronic circuits are small enough that the laws governing their behaviour change from classical to quantum physics?

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Date: Wednesday, 5th September, 2007
Time: 6:30 for 7:00 pm
Venue: Conference Room 1, Darlington Centre, City Road

ABSTRACT

The transistor, a product of fundamental research, is now an integral part of modern life, and has created the "information age". A transistor is simply a "tap for electrons', where current flow through the device's "channel" is switched on or off by applying a voltage to a "gate". In a computer, bits of information are represented by the transistor's on/off state. In order to make ever faster and more powerful computers, more and more transistors have to be packed onto each silicon chip, which has been achieved by continued advances in miniaturization. However the electrons that move inside these transistors are quantum objects, and as we shrink these transistors, eventually the laws that describe their operation will change from the familiar classical physics to the counter-intuitive, and just plain strange, quantum physics. There is thus great interest in understanding the properties of quantum electronic devices, both to predict how current devices will work, and to exploit the power of quantum mechanics to create new types of devices.

Quantum semiconductor devices already form the basis of important devices such as lasers and high frequency transistors (subjects of the 2000 Nobel Prize for Physics), and underpin much fundamental physics research. Quantum effects become particularly apparent when one or more of the device's physical dimensions is comparable to the electron's wavelength. Using a combination of modern crystal growth and lithography techniques it is possible to define the physical size of quantum devices in all three dimensions. This exquisite control allows a range of new quantum phenomena to be examined.

In this talk I will give a gentle introduction to quantum semiconductors and transistors, and illustrate the strange role of quantum mechanics by focussing on a few specific devices from leading research groups worldwide, including a `which-path' detector that can be used to directly test the wave-particle duality of nature, and new `spinelectronics' devices.

BIOGRAPHICAL NOTES

Professor Alex Hamilton's research interests are in the design and fabrication of nanoscale semiconductor devices to study their quantum electronic properties. He has published over 100 research papers, as well as jointly establishing UNSW's degree program in Nanotechnology. Hamilton obtained his degree in Physics from Imperial College, London in 1988, and his PhD in 1993 from the University of Cambridge. His PhD studies were performed at the Cavendish Laboratory, under the supervision of Professor Sir Michael Pepper FRS and Professor Mike Kelly FRS. He continued his research at Cambridge under the auspices of an EPSRC Fellowship, and moved to the University of New South Wales in 1999. In 2000 he was a founding member of the Centre for Quantum Computer Technology where he established the Quantum Measurement group. He now leads a research group in the School of Physics studying fundamental quantum properties of semiconductor nanostructures.

School of Physics, UNSW http://www.phys.unsw.edu.au/QED