CHERWELL - SIMON LECTURE

Semiconductor Nanostructures- The Engineering of Physics

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Friday 28th May

4.30 p.m.

Martin Wood Lecture Theatre,
Clarendon Laboratory, Parks Road, Oxford

The combination of advanced semiconductor growth and electron beam lithography which has been developed for the semiconductor industry has also stimulated a considerable research effort in basic properties of semiconductor nanostructures. In this lecture advanced semiconductor growth technology will be described and it will be shown how this technology, which was developed for high frequency transistors, has allowed the fabrication of new types of structure for investigating the quantum aspects of electron transport. In these structures the widths of the samples are considerably less than 10^{-5} cms which can result in the effective dimensionality becoming less than three.

It will be demonstrated that when an electron gas becomes one-dimensional the conductance at low temperatures takes values determined by the fundamental quantum of resistance h/e^2, where e is the electron charge and h is Planck's constant. Understanding this transport behaviour has led to remarkable demonstrations of the quantisation at room temperature in a variety of systems such as stretched wires and even closure of a simple relay switch where the resistance is determined by one, two, three... atoms in contact.

Prospects for practical devices and systems based on quantum effects will be presented. It will also be shown that the use of semiconductor nanostructures allows the fabrication of a quantum pump through which single electrons can be transported giving a current $I=ef$, where e is the electron charge and f is the frequency. At present this pump gives an accurate measurement of e to nearly 1 part in 10^5, the pumping mechanism and prospects for improving accuracy by the three orders of magnitude necessary for recognition as a standard will be discussed.