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Nanoelectronics, and Quantum Computing

The work of the Hitachi Cambridge Laboratory, and elsewhere

Dr David Williams

Head of the Hitachi Cambridge Laboratory

7.30 p.m., Monday 3rd March 2008

The Wolfson Lecture Theatre, Churchill College, Storey's Way, Cambridge

Dr Williams writes:

Nanoelectronics and Quantum Computing

A number of new ways of manipulating information, generically known as quantum information processing, have been postulated in the last 15-20 years. Several have been demonstrated experimentally, but there remains a large gap between principle and practice, particularly in quantum computation. The success of solid-state electronics and optoelectronics in classical information processing leads many to the conclusion that condensed matter systems will provide the best way of bridging this gap. I will describe some of our approaches to making solid-state structures for quantum information processing, including nanoscale silicon and III-V semiconductor devices. I will show recent experimental results, and discuss the various mechanisms which help and hinder the development of this field. There has been substantial progress in the last year, and I will give our view of the routes to making usable structures.

The Hitachi Cambridge Laboratory

The Hitachi Cambridge Laboratory (HCL) was established in 1989, with the aim of using nanostructure physics to create new concepts of advanced electronic and optoelectronic devices. At that time, quantum effects were becoming important in the behavior of conventional electronic devices, and HCL was given the remit of approaching the development of new devices from a quantum mechanical starting point.

One of the main research fields has been single-electronics, with notable successes being the development of the first single-electron memory and the first single-electron logic devices. This led both to the PLEDM memory technology and to many aspects of the present research areas:

- **Nanospintronics** offers opportunities for a new generation of devices combining standard microelectronics with spin-dependent effects. Hitachi is one of the largest manufacturers of hard disc devices for information storage, and HCL is part of a global collaboration within Hitachi, aimed at developing new spintronic devices for future hard disc and memory applications
- **Quantum Information Processing (QIP)** is a new information science based on the principles of quantum mechanics, and includes quantum computing and quantum cryptography. HCL is actively developing the new science into a new information

technology, investigating a wide range of approaches to making devices which can be used to build solid-state quantum computers and quantum cryptography systems

- With the Hitachi Professor of Electron Device Physics, Henning Sirringhaus, HCL has begun research into **organic electronic devices**.

About the Speaker:

Dr David Williams received BA and PhD degrees in physics from Cambridge University in 1984 and 1987 respectively, and held a SERC fellowship from 1987-1989 in the Microelectronics Research Laboratory of the Cavendish. He was a founding member in 1989 of the Hitachi Laboratory. His research interests have included three-dimensional silicon circuit structures, novel silicon memory devices, mesoscopic quantum electron transport, advanced electron microscopy, coherent electron-phonon interactions and semiconductor-superconductor hybrids. His current projects cover quantum information processing and nanospintronics.

Coffee will be available, as usual, in the foyer outside the lecture theatre, from ~7pm onwards

Best Regards

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