PhD Studentship Opportunity

The London Centre for Nanotechnology (LCN) at UCL is looking to appoint a PhD student to work on developing a simulation framework for the performance of cryogenic electronic circuits in quantum devices, especially quantum-dot-based spin qubits. The student would be based in UCL and would work closely with researchers at Quantum Motion Ltd at its London and Oxford offices.

Scientific Background

As quantum processors grow in complexity, attention is moving to the scalability of the entire quantum computing system, including the classical support hardware. For spins in semiconductor quantum dots such as in silicon or germanium, there has been rapid recent progress showing high-fidelity control and that qubits can be manufactured in a similar fashion to field-effect transistors. This creates an opportunity to leverage the know-how of the complementary metal–oxide–semiconductor (CMOS) industry to address the scaling challenge by integrating quantum processing units with conventional analogue and digital electronics. For classical circuits, advanced simulation tools exist that can predict the performance of complex electronic circuits before manufacture; however, a corresponding tool for hybrid quantum-classical circuits is largely lacking.

Work programme

In this project, the student will work on creating a simulation framework for quantum-dot based devices at high frequencies that can be integrated with industry-standard circuit simulators. The simulation pipeline will be divided into several milestones; most crucially: (i) developing a theoretical description of a quantum dot qubit incorporating the relevant semiconductor physics; (ii) a Lindblad-based formalism to calculate the time-dependent properties of the driven quantum dot system subject to a time-dependent voltage input and including relaxation and dephasing effects, extracting Hamiltonians for the spin systems either from experiments or quantum simulations; (iii) translating the time-dependent charge occupation probabilities into measurable signals (using appropriate models of the readout process) that can be incorporated into classical simulations.

Supervision

The project will be co-supervised by Prof. Andrew Fisher (UCL) and Prof. Simon Benjamin (Oxford, also co-founder and Chief Scientist of Quantum Motion Ltd). Additional key individuals providing guidance at will be Dr Fernando Gonzalez-Zalba, Lead Quantum Engineer and UKRI Future Leaders Fellow at QM and an expert in quantum-dot equivalent circuits, and Prof. John Morton, co-founder and Chief Technologist at QM and Professor at UCL, an expert in spin resonance and silicon qubit characterization. The student will work closely with the Device Modelling team at Quantum Motion Ltd, where Prof. Fisher is a consultant.

About the institutions

The LCN is an internationally leading nanotechnology and nanoscience research centre located in Bloomsbury in central London. As well as a research department of UCL, it is

also a joint cross-London research centre partnering with Imperial College London and King's College London. This studentship will be based in the LCN's Bloomsbury building, and the student will be registered for their PhD at UCL, where the Quantum Science and Technology Institute (UCLQ) forms an umbrella for a vibrant science and engineering ecosystem ranging from fundamental quantum information theory to device engineering.

Quantum Motion Ltd is a joint UCL-Oxford start-up and is one of the leading companies worldwide in the development of quantum dot-based qubits for quantum computation. Following a successful investment round in 2023 it was recently among the companies selected to supply prototype systems to the UK National Quantum Computing Centre.

Funding
The studentship is co-funded by the Engineering and Physical Sciences Research Council (through the Quantum Computing and Simulation Hub) and Quantum Motion Ltd. The studentship covers fees (at home UK student level) and stipend at the standard UKRI/UCL rate plus an enhancement of £2,400 per year, for a period of 3.5 years.

What we are looking for
We are looking for students with a strong background in quantum mechanics and/or semiconductor physics, reflected in a strong undergraduate degree in physics, electrical engineering or similar subjects. However, strong quantitative problem-solving and communication skills are more important than exactly what you have already studied. Coding experience (ideally in Python) would be an advantage. Above all, we are looking for students who will thrive at the interface between an interdisciplinary academic research centre and a quantum computing start-up.

UCL recruits for studentship opportunities on merit, but we are particularly keen to attract applications from groups who are currently under-represented among our postgraduate research student cohort in physical sciences and engineering.

Dates and application process
The student will need to be available to start the studentship from 1 September 2024 and must qualify as a home student under UKRI rules in order to be eligible for funding. Applications will close at 5.00pm BST on Friday 19 July. To apply please send a single PDF containing:

- A CV;
- A transcript of your undergraduate studies;
- A personal statement (maximum 1 page of A4, 11pt) outlining what interests you about this research opportunity and what skills and/or experience you would bring to it;
- The names of two referees familiar with your academic work.

The submission portal will ask you questions about your sex/gender, sexual orientation and ethnicity; these will play no part in our selection but will be used to monitor our processes. Please ask your referees to write to lcn-administrator@ucl.ac.uk by the same deadline.

For shortlisted candidates, the selection process will include an academic interview at UCL and an interview with Quantum Motion Ltd.

For further information please contact andrew.fisher@ucl.ac.uk