An electrically addressable spin qubit in InGaAs

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Project Summary:

This project will build on the early work established by the Cambridge University/National C-K University of Taiwan semiconductor physics groups. It was determined that two 1-dimensional semiconductor channels coupled ballistically to a 2-dimensional region, could be spin selective enough to modulate the spin precession at the few spin-level. This PhD project will build on this device scheme to include enhanced spin-properties that have been engineered through device design or materials selection and optimisation. Gated spin precession through an angle π gives the single qubit NOT-gate and to complement this, a two-qubit CNOT gate will be optimised and the fidelity of this system will be determined. The spin-control in this device scheme is through the spin-orbit coupling via an applied electric field and competing spin decoherence mechanisms will be studied and then minimised in the final device. Non-abelian states in the 1-dimensional part of the device will also be considered and developed in this type of device, where a braiding of these states is a possibility leading to Quantum control.

Project outline, the intended outcomes and possible collaborations:

This work will be carried out in the Nanoelectronics laboratory in the LCN with Professor Sir Michael Pepper and Dr Yilmaz Gul. The outcome will be low temperature electrical measurements on a spin-field effect transistor device where ballistic spin effects are enhanced. There is a strong overlap of this research with the Quantum Foundry in the University of California at Santa Barbara who have provided some of the semiconductor materials through an EPSRC-funded *Quantum for Science* collaboration. Periodic visits are envisaged to Santa Barbara during the course of this PhD. Collaboration with Birmingham and Aston Universities will be established on the theoretical side of the project as well as with UCL theoreticians.