SUMMARY FOR THE PROJECT

By Team F4

Introduction:

This research started when Bruce Kane published a seminal 1998 paper in Nature. Kane, then a senior research associate at UNSW, hit upon a new architecture that could make a silicon-based quantum computer a reality - triggering Australia's race to build a quantum computer.

About Flip-Flop qubits:

In the earlier models, the atoms were to be placed very close to each other for the purpose of quantum computation, but the backdrop of it is the requirement of the atoms to build a large quantum computer. In this approach the backdrop is overcome with the usage of flip-flop qubit.

To operate this qubit, you need to pull the electron a little bit away from the nucleus, using the electrodes at the top. By doing so, you also create an electric dipole. These electric dipoles interact with each other over fairly large distances, a good fraction of a micron, or 1,000 nano metres. This means we can now place the single-atom qubits much further apart than previously thought possible. So, there is plenty of space to intersperse the key classical components such as interconnects, control electrodes and readout devices, while retaining the precise atom-like nature of the quantum bit.

Building a quantum computer has been called the 'space race of the 21st century' – a difficult and ambitious challenge with the potential to deliver revolutionary tools for tackling otherwise impossible calculations, with a plethora of useful applications in healthcare, defence, finance, chemistry and materials development, software debugging, aerospace and transport. Its speed and power lie in the fact that quantum systems can host multiple 'superpositions' of different initial states, and in the spooky 'entanglement' that only occurs at the quantum level the fundamental particles.

Building Silicon Based Quantum Computers:

A quantum computer maintains a sequence of qubits. A single qubit can represent a one, a zero, or any quantum superposition of those two qubit states. Building a quantum computer requires coupling of a large array of qubits which are to be individually controlled. The distance between the qubits is crucial because if the qubits are too close, or too far apart then the entanglement of the qubits does not take place. In the proposed model, a silicon chip is covered with a layer of insulating silicon oxide, on top of which rests a pattern of metallic electrodes that operate at temperatures near absolute zero and in the presence of a very strong magnetic field. At the core is a phosphorus atom, from which Morello's team has previously built two functional qubits using an electron and the nucleus of the atom. In this approach, a qubit '0' state is defined when the spin of the electron is down and the nucleus spin is up, while the ‘1’ state is when the electron spin is up, and the nuclear spin is down. To operate this qubit, you need to pull the electron a little bit away from the nucleus, using the electrodes at the top. By doing so, you also create an electric dipole.” These electric dipoles interact with each other over fairly large distances, a good fraction of a micron, or 1,000 nanometres. This means we can now place the single-atom qubits much further apart. So there is plenty of space to intersperse the key classical components such as interconnects, control electrodes and readout devices, while retaining the precise atom-like nature of the quantum bit. Thus, with this approach the distance between the qubits which was supposed to be very less has been overcome with the electric dipole-dipole interactions.