ANEIRIN JOHN BAKER

7 Egypt Mews, Edinburgh , EH10 4RS
(+44)7463858178 ⋄ ajb17@hw.ac.uk

EDUCATION

Heriot watt University *October 2018 - Present*
PhD - Supervisor *Michael J Hartmann*
Institute of photonics and Quantum Sciences

University of Edinburgh *September 2014 - July 2018*
Mathematical Physics MPhys *Degree Classification 2:1*
School of Physics and Astronomy

Manchester Grammar School *September 2012 - July 2014*
6th Form - Maths - A*, Further Maths - A, Physics - A* , Chemistry - A

RESEARCH EXPERIENCE

PhD October 2018 - Present
Many-Body Operations and Simulations of Lattice Gauge Theories with Superconducting Qubits

Over the past decade Superconducting circuits have becomes one of the strongest contenders for the basic architecture of Quantum Computers, with IBM using them in their IBMqx2 Computer. Quantum Computers operator on gate operations which act on multiple Qubits, currently only two Qubit gates are available on the quantum chips and so any multi Qubit gates must be broken down into a series of two Qubit gates. This increases gate time and decreases the overall fidelity (accuracy) of the multi Qubit gate as each individual gate is not 100% accurate. This project aims to generate three body interaction which will allow for three Qubit gates to be implemented within this architecture.

If Many body interactions can be achieved then this architecture could be used in quantum simulators to simulate Quantum electrodynamics. It may be possible to simulate a simple QED Hamiltonian and then extend this to the full QED Lagrangian. A long term aim would be to incorporate many degrees of freedom into a system to simulate theories such as QCD (Quantum Chromo Dynamics)

Masters Project September 2017 - June 2018
Fourier Accelerated Dynamics in HMC Simulations of Lattice Field Theory

- Aim to find ways to increase the tunneling rate through potential barriers using Fourier Acceleration.
- Proof of concept for a basic lattice field theory simulation that could be extended to larger simulations (E.g. Remanian Hybrid Monte Carlo)
- Experience using more complex Monte Carlo (Hybrid Monte Carlo) algorithms and C++ packages such as FFTW
- Experience dealing with large amount of stastical data and analysing of that data using algorithms such as Bootstrap.

Summer internship - Eric Tittley Summer 2017
Parellization of Astronomy Software Toold

- Aim to compare Nvidias CUDA and OpenMP using implementations of Astronomical software tools.

- Developing and comparing new integration methods for large data sets using symmetry and decay properties of the interactions.
- Experience using both CUDA and OpenMP to develop new C++ implementations of lookup tables.

Summer internship - Jenni Smillie Summer 2016
Comparison of HEJ at 100TeV vs 10Tev

- First experience with large computational models
- Experience using HEJ Particle Physics model in C++ , BOOST libraries and use of the Linux environment

RESEARCH INTERESTS

Currently my interests are concentrated on the applications of superconducting circuits that consist of Transmon Qubits and an RF Squid (or SNAIL). The aim of this research is to create a single shot Toffoli gate. This involves using interactions of the system to create a Toffoli gate. Previous implementations of a Toffoli gate consisted of a series of up to 14 Two-Qubit gates, this implementation would be a vast improvement over the previous attempts. This fast Toffoli gate along with a Hadmard gate form a Universal set which would be able to perform any algorithm to an arbitary degree of accuracy.An extension to this work using the same configuration could potentially be used as a Quantum Simulator, the first aim is to simulate a Badic version of WED with a view to incorperate more Degrees of Freedom to simulate QCD.

As a side project I am interested in speeding up the simulations of this quantum system through the use of GPUs (using PyCuda). Using GPUs could decrease the time taken to simulate the system. I am also interested in producing other high fidelity gates such as a CNOT gate. The CNOT gate was a simpler version of the Toffoli gate which was simulated first. A High fidelity CNOT gate would show further that this setup could be a general quantum gate simulator.Using this the setup could be used to implement quantum algorithms showing that it would be a good candidate for a real quantum computer. This set up could be a good candidate for simulations of many quantum algorithms.

TECHNICAL SKILLS

Programming Languages: C++, Python, Java

Other: Version control - Github, Report writing - Latex

AWARDS

2015/16: Awarded the Physics Astronomy Career Development Internship
2016/17: Awarded the EPSRC Undergraduate Scholarship