Quantum computing

Computing using 2-level quantum systems, “qubits”.

Leverages superposition of states, exponential-size space, and entanglement.

There are a number of things they may/can do better than the “classical” computers today:

- Simulate quantum systems
- Search large, unstructured spaces
- Factor large numbers
- Solve optimization problems
- Perform linear algebra operations / machine learning tasks

Quantum computing

QC is an emerging technology.

The theory is solid; we now face an engineering challenge.

We will likely have large-scale machines in our lifetime, so now is the time to learn.

Quantum computing at TRIUMF

My job here:

- Training everyone who is interested in QC theory
- Teaching you how to use the current-generation machines
- Finding interesting problems at the intersection of QC and HEP / nuclear physics, and working together to solve them

Lecture series

Logistics: May 9, 10, 13, 14 from 12-1:30pm in the auditorium.

Topics:

- Math behind qubit systems
- Small quantum protocols and major quantum algorithms
- Gate-model computing vs. quantum annealing
- Overview of current generation hardware
- Demonstrations and exercises in Python using IBM/D-Wave libraries
- Highlights of successful and recent HEP applications

HEP applications?

Lots, and new ones every week!

In the lectures...

- Simulating neutrino oscillations
- Finding ground states of small molecules
- Classifying Higgs decay background vs. signal
- Particle track recognition

HEP applications!

Current ideas for applications at TRIUMF:

- Simulation of quantum systems
  - Hydrogen anion (applications in beam physics)
- Analysis of Hyper-K image data to produce simulated detection events
  - with D-Wave, and Wojtek
  - potential applications in other detector experiments, and medical imaging too!

Interested?

- Come to the lecture series
- Suggest applications related to your work
- Teach me about particle physics and what you work on so I can do my job better!