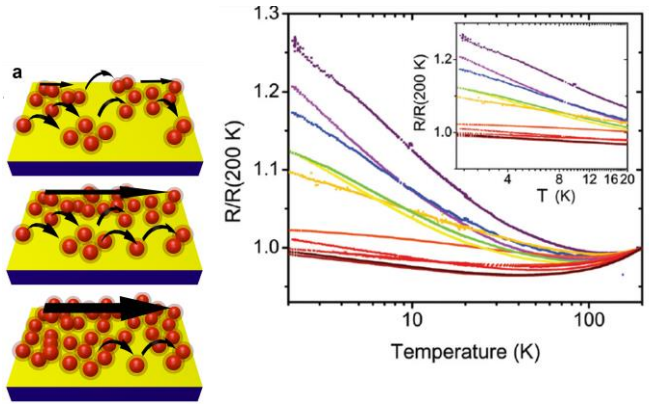
Nanoengineering Quantum Electronic Behaviour – Dhirani group

When we get to the very, very small world---say circuits of seven atoms---we have a lot of new things that would happen that represent completely new opportunities for design. … We can use, not just circuits, but some system involving the quantized energy levels, or the interactions of quantized spins, etc….

Richard Feynman, APS meeting 1959

This quote is from Feynman's talk entitled, *"There's Plenty of Room at the Bottom: An Invitation to Enter a New Field of Physics."* Feynman's physical insight is legendary. He envisioned new opportunities for designing electronics using quantum behaviour of electrons (i.e. their wave nature and their spin).

There have been tremendous advances over the past few decades in the fabrication of various types of nanostructures. A theme of our research is to use nanostructures as building blocks to make new materials and devices. The motivation/goal is to take advantage of the range of nanostructures and control over their properties that are available to "nanoengineer" behaviour from the bottom up. This approach is of interest both in basic science (e.g. a new way to study exotic quantum effects previously only observed in more traditional systems – see below) and applications (e.g. sensors for detecting heavy metals in drinking water, biosensors, more efficient solar cells, hyperthermal cancer therapy, etc).



Some recent results from the Dhirani group. Left panel. Self-assembling nanoparticles into films. Right panel. At lower temperature, films exhibit a large, log increase in resistance due to quantum hybridization between delocalized electrons and localized electrons with unpaired spins in quantized energy levels.

In this research opportunity, students will fabricate, characterize and study functional nanostructured materials. The goal is to continue to design and explore the range of their quantum behaviour.

DESCRIPTION OF STUDENT PARTICIPATION:

Students will begin by performing a literature review. They will then perform an experiment. In the first phase of the experiment they will fabricate and characterize films. In the second phase of the experiment, students will help take measurements of properties (electrical, magnetic, optical).