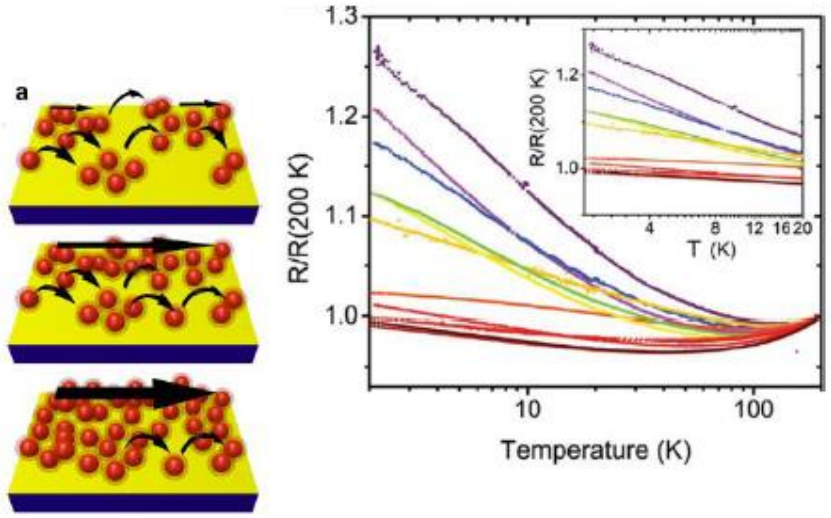
DHIRANI GROUP

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, "There's Plenty of Room at the Bottom: An Invitation to Enter a New Field of Physics."

Rather than using atoms, but still in the spirit of using a bottom-up approach, 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: Self-assembling nanoparticles into films. Right: At lower temperature, films exhibit a large Kondo effect: a famous log increase in resistance due to quantum hybridization between delocalized electrons and localized electrons with unpaired spins in quantized energy levels.

The goals of this research opportunity are to:

- design, fabricate, characterize and explore the range of behaviours of quantum nanostructured materials,
- develop their potential applications to quantum devices.

DESCRIPTION OF STUDENT PARTICIPATION:

Students will begin by performing a literature review. In the first phase of an experiment, they will fabricate and characterize nanostructured materials. In the second phase of the experiment, students will help take measurements of and/or apply material properties (electrical, magnetic, optical).