From pre-fabricated nano building blocks to macroscopic materials: designing exotic electronic phenomena from the bottom up

If we view nanostructures as “artificial atoms” or “building blocks” to make assemblies of matter, we may realistically hope to fashion a wide range of new “nanostructured” materials.

To explore this approach for making materials, we use a prototype system of two nano-building blocks with contrasting electronic behaviour, namely “conducting” (gold) nanoparticles and nominally “insulating” (alkanedithiol) molecular crosslinkers. A goal of this talk is to provide a survey of the rich range of material electronic behaviours that even just these two building blocks can generate, e.g. single electron effects, metal-insulator transitions, semiconductor transistor-like conductance gating, and correlated electronic behaviour.

The talk will survey both new insights and new opportunities that arise as a result of using nanostructures to assemble materials from the bottom-up. Being able to nanoengineer materials with correlated electrons, for example, is very exciting as correlated electrons are thought to lie at the heart of the most exotic and widely studied behaviours in the history of condensed matter science (e.g. high Tc superconductivity in the cuprates). Such materials can also provide inspiration for new technologies.