Searching for new fulleride superconductors: Is U_3C_{60} possible?.

Supervisor: Ross H. Colman
Co-supervisors: Doc. L. Havela, J. Custers

Fullerene, the near-spherical molecule of carbon, packs in a face centered cubic lattice when in a solid. When we react C_{60} with alkali metals like K, Rb, or Cs in a 3:1 ratio, they form A_3C_{60}, with the A^+ ions (A = K, Rb, Cs) sitting between the C_{60} balls (figure 1a), and they all become **superconducting** at low temperature. The superconducting transition temperature reaches as high as T_c = 38 K in Cs_3C_{60}.

The C_{60} become metallic and then superconducting because of half filling of its t_{1u} molecular orbital, which happens when we add 3 electrons.

It has been theorised that adding 9 electrons instead of 3 could also lead to metallicity, and possibly superconductivity, but so far no $[C_{60}]^{9-}$ materials have been prepared experimentally.

The predicted material U_3C_{60} should have this electronic configuration, but despite previous attempts, no one has ever successfully prepared this material directly from uranium + C_{60}. This is likely because the reductive potential (reacticity) of elemental uranium is too high, and instead it causes the C60 to decompose before an intercalation reaction can occur. In this project, the student will attempt to use the softer reagent UH_3 as a source of uranium, to successfully prepare U3C60.

Methodology:

- The student will prepare mixtures of UH_3 + C_{60} whilst working in a protective atmosphere (glove-box), and with the help of the supervisor will seal these mixtures in quartz ampoules. The ampoules will be reacted in a furnace for several days.
- To check for reactions, the products will be analysed by X-ray diffraction.
- To check for superconductivity, any successfully reacted mixtures will be checked in a magnetometer at low temperatures.
- The results will be written up as part of the SFG report.

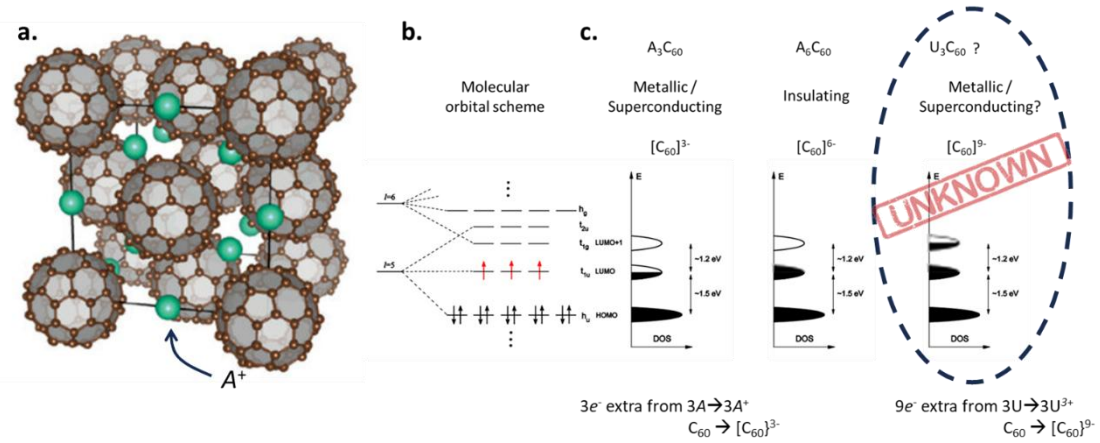

*Figure **1a**. The FCC lattice of C_{60} molecules, with ions sitting in the interstitial voids. **b.** part of the molecular orbital scheme of C_{60}, showing electron doping. **c.** Representations of the band filling when reacted with different amounts of electron donors.*