Structural instabilities in strongly correlated electron systems

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Strongly correlated electron systems belong to the most intriguing and versatile materials. In these systems, competing interactions lead to the emergence of a multitude of exotic states, including unconventional superconductivity and magnetism, valence fluctuations, heavy fermions, Mott insulators, non-Fermi liquids, phases with charge stripes or pseudogaps. Here, subtle changes in chemical composition, pressure, temperature or magnetic field may tip the balance between the competing tendencies, resulting in huge responses to the stimuli. One example would be a colossal magnetoresistance, where enormous variations in resistance are produced by small changes in magnetic field strength. Other examples include temperature- or pressure-induced metal-insulator transitions. The strong competition between different phases is not only essential for applications, but it also increases the potential for novel electronic behaviour.

In this project, you will investigate selected intermetallic compounds in which strong coupling between charge, spin, orbital, and lattice degrees of freedom leads to complex phase diagrams. The project will involve producing samples of the desired materials using synthesis methods available in the newly developed Synthetic Solid State Physics lab at UCLan. Structural and compositional characterization of grown phases will be carried using Bruker D2 Phaser powder X-ray diffractometer and JCM-6000Plus scanning electron microscope. Detailed investigations of crystal structure by means of single-crystal X-ray diffraction will be performed in the X-ray laboratory at the Lancaster University. If the student wishes to continue on a PhD level, diffraction measurements over broad temperature ranges and/or under high pressure will be proposed at world-leading research facilities.