Epitaxial Engineering and the Materials Physics of Uranium Thin Films

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Non-magnetic elements with large spin-orbit coupling are of particular interest in various fields from topological insulators, to superconductors and spintronics. In this context, the study of uranium, U, with the largest atomic number for a naturally occurring element, is of considerable interest. The complex physics of uranium's 5f electrons shows charge-density wave order, superconductivity and proximity-induced magnetism, to name but a few of the fascinating electronic properties found in this elemental metal. On top of all of this, the ability to create U, or U-based compounds or alloys in thin film form opens up a vast arena to explore heterostructures and device architectures for fundamental science as well as applications.

In Bristol we have the capability to grow (poly)crystalline thin films and heterostructures of U at ambient and elevated temperatures. In this talk I will give an overview of recent work using this growth chamber, focusing in particular on the stabilization of a cubic phase of U using epitaxially matched substrates and Mo-doping. Here the Mo addition competes with the natural preference of U for an anisotropic local neighbourhood, encouraging a more symmetric atomic arrangement. We have recently found that the conflict is resolved by the production of correlated disorder where every atom is displaced, lowering the local symmetry, while maintaining the higher average symmetry imposed by the lattice. This correlated disorder dramatically suppresses phonon-lifetimes, suggesting an interesting route to designer phonon-engineered materials [1].

[1] D. Chaney *et al*., arXiv:2009.03226.