Master / PhD Thesis Project

Squeezing the superconducting secrets out of UTe_2

Three years ago, a highly unusual superconducting state was found in the compound UTe_2, triggering a lot of excitement. Indeed, this superconductivity appeared to be extremely robust in an applied magnetic field, demonstrating that it is a rare spin-triplet superconductor, where Cooper pairs are formed by electrons having the same spin direction. This implied that it could also be a topological superconductor, an exciting prospect with possible applications in quantum computing. Superconductivity in UTe_2 is not only robust under magnetic field, it can even be induced by a magnetic field applied in specific directions of the crystal lattice. Moreover, under pressure we discovered that multiple superconducting phases appear, of different symmetries, an extremely rare phenomenon. UTe_2 can be considered as a prototype quantum material, where physical properties are governed by electronic correlations, emerging among flat bands at the Fermi level, and topological effects.

Left: a standard diamond anvil pressure cell. Right: our new ultra-compact cell.

With this Master 2 project, we will further explore the superconducting properties of UTe_2 under pressure. Indeed, putting solids under pressure squeezes the atoms closer together and can completely change the properties of a material. It is particularly effective for quantum matter, which often lies close to instabilities toward new quantum states: pressure can reveal and help understand these new states. However, these are challenging experiments, requiring a pressure cell able to generate pressures of typically $10^4 - 10^5$ bars, often associated with other extreme conditions of low temperature and high magnetic field. Hence, the size of the pressure cell is often a limiting factor. To overcome these limits, we have designed a tiny pressure cell, smaller than a 1 cent coin, using diamond anvils, making it possible to orient the sample in any field direction under pressure and at low temperatures.

During the Master project, we will perform the first measurements in this new pressure cell, and notably electrical transport, suitable to probe the field-induced superconducting phases of UTe_2. This Master project can be followed by a PhD, where extensive studies using this cell are planned, including rotating the sample *in-situ* at low temperature and high magnetic field, in order to understand the interplay of magnetic fields, and more generally of magnetism, with the superconductivity of UTe_2.

APPLY NOW!

To apply for this position, or just to discuss further, contact by e-mail (including your CV): daniel.braithwaite@cea.fr

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