Odd ways to unconventional superconductivity

Prof. Dr. Elena Hassinger

Institut für Festkörper- und Materialphysik, Technische Universität Dresden

Superconductivity is a fascinating state of matter that transforms metals at very low temperature into perfect conductors and perfect diamagnets. This enables numerous technical applications for magnetic levitation, electric current transport without loss and for quantum information technology. A desired but rare type of unconventional superconductivity with possible uses in topological quantum computing is one where the superconducting condensate is odd under inversion symmetry, so-called odd-parity superconductivity. Only a handful of uranium-based materials have this property and it is usually explained by the presence of ferromagnetism enforcing a parallel alignment of the electrons forming the Cooper pair.

In the colloquium talk I will present our astonishing discovery that superconductivity in the material CeRh2As2 with a critical temperature of only 0.4 kelvin switches its state in a magnetic field and is then stable up to the extreme magnetic field of 16 tesla. The switching is understood as a unique phase transition from even-parity to odd-parity superconductivity that likely relies on a special crystallographic feature of the underlying material, CeRh2As2, and not on ferromagnetic interactions. I will show our experimental investigations into the question what stabilises such a transition that we address by tuning superconductivity and other coexisting orders with temperature, magnetic field and hydrostatic pressure. The resulting knowledge paves the way for the design of other odd-parity superconductors with higher transition temperatures useful for applications.