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Straining unconventional superconductors: Exploring the changes in Sr_2RuO_4 and FeSe under strong uniaxial compression

For strongly correlated materials the established tuning parameters are temperature, magnetic field, hydrostatic pressure and chemical composition. For continuous in-situ tuning of an external parameter often only temperature and magnet field remain in the physicists toolbox. Here we highlight the possibility of another tuning parameter: uniaxial strain. Two examples of the strong response to such a tuning are presented. Via a piezo-actuated device we can achieve high compressions of up to 1% in single crystalline materials and show the significant changes to their electronic properties.

In Sr_2RuO_4 the nature of the superconducting order parameter is still under heavy debate despite the availability of high-quality samples, excellent knowledge of the electronic band structure and numerous thermodynamic and transport experiments. Whereas there is evidence for a time reversal symmetry broken state from results of the Kerr effect and evidence for triplet pairing from NMR results other experimental probes are at odds with these findings. To probe the proposed anti-symmetric response of the superconducting T_c to uniaxial strain we have performed experiments on a number of single crystals and observed a dramatic increase in T_c and correspondingly in the upper critical field. We compare these findings with calculations of the electronic structure which indicate that the dominant effects are located only in specific areas of the Brillioun zone.

A different approach to influence not only superconducting transitions but also structural phase transitions is shown via recent measurements on FeSe. Here this material, as many other in the class of the iron-based superconductors, undergoes a tetragonal-to-orthorombic phase transition before becoming superconducting at lower temperatures. To apply uniaxial strain to FeSe we developed a technique that can be applied to thin and ductile materials. First results indicate that we can probe the elastoresistance above and within the nematic state and also influence T_c.