Tuning the uranium ferromagnetic superconductors with hydrostatic and uniaxial pressure

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The microscopic co-existence of superconductivity and ferromagnetism is established in three uranium based heavy-fermion systems: UGe_2, URhGe and UCoGe. This coexistence strongly suggests an unusual superconducting state, with triplet pairing, where the Pauli limiting mechanism is not active and the Cooper pairs can survive in the strong exchange field. Hydrostatic pressure is a powerful method to tune and understand unconventional superconductivity in many systems, often by driving them close to the threshold of a magnetic instability. Indeed in the first discovered ferromagnetic superconductor UGe_2, superconductivity appears only under pressure. In UCoGe, like in UGe_2, hydrostatic pressure suppresses the ferromagnetic order. In both theses systems we have studied the rich phase diagram of the ferromagnetic and superconducting phases versus pressure, temperature and magnetic field. However in URhGe, hydrostatic pressure increases the Curie temperature, driving the system further away from its instability. We demonstrate that in URhGe, uniaxial stress can act as negative pressure leading to a decrease of the Curie temperature and to a strong increase of the superconducting critical temperatures at zero field and under field[1]. The driving force for the enhancement of pairing mechanism under uniaxial stress, even in zero magnetic field, seems to be the increase of the *b*-axis susceptibility, moving the system away from the Ising-type limit. This mechanism is predicted by microscopic theories of anisotropic ferromagnetic superconductors, as arising from an enhanced coupling of the spin-polarized bands by transverse fluctuations.

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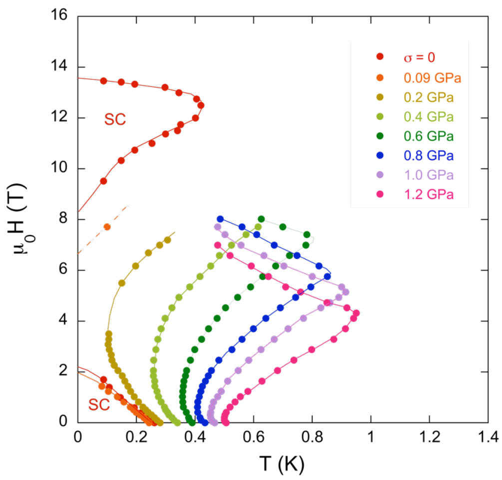

Figure 1. Uniaxial stress along the b-axis in URhGe suppresses T_{Curie} and strongly enhances superconductivity, reuniting the two superconducting pockets[1]. Hydrostatic pressure has the opposite effect.

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