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Superconductivity and antiferromagnetism in $CeCu_2Si_2$

O. Stockert
Max-Planck-Institut für Chem. Physik fester Stoffe, D-01187 Dresden, Germany

The availability of high quality single crystals with well defined physical properties renewed the interest in the heavy-fermion compound $CeCu_2Si_2$, especially in the interplay between its superconducting and antiferromagnetic phases. In a first set of experiments we demonstrated that the magnetic order, initially called A phase, is determined by the nesting properties of the Fermi surface [1]. Subsequently we performed extensive neutron scattering and muon spin rotation (μSR) experiments on $CeCu_2Si_2$ single crystals showing either both, antiferromagnetism and superconductivity (A/S-type), or becoming only magnetic (A-type). The experiments give clear evidence that in A/S-type $CeCu_2Si_2$ (with $T_N > T_c$) superconductivity expels antiferromagnetic order at low temperatures and both phenomena do not coexist on a microscopic scale. Furthermore, the transition from antiferromagnetism at higher temperature to superconductivity at low temperatures is first order in nature even in zero magnetic field with the occurrence of phase separation around the transition. Recently we measured a crystal where the Néel temperature and the superconducting transition temperature are roughly degenerate. In this crystal antiferromagnetism is observed down to lowest temperatures, although the crystal shows superconductivity. However, the measurements point to phase separation also in this crystal.
[1] O. Stockert et al., Phys. Rev. Lett. **92**, 136401 (2004).

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