Contribution ID: **119** Type: **not specified**

Stability of the Q -phase of CeCoIn5 in the presents of localized magnetic impurities

Tuesday, 29 October 2019 18:20 (50 minutes)

In heavy fermion superconductors, the strong interlocking of charge and spin degrees of freedom creates unconventional superconductivity in the vicinity of complex magnetic ground states - an ideal test bed to study quantum phase transitions. A special case for the coexistence of superconducting and magnetic order is the well-known Q-phase in CeCoIn5 [1] where the antiferromagnetism coexists at low-temperature and high field with the superconducting phase [2] and is a rare example of cooperative coexistence [3]. The magnetic order was evidenced to be an incommensurate spin density wave (SDW). For a 5% substitution of Ce with Nd, an antiferromagnetic phase is stabilized within the superconducting phase already at zero magnetic field. Previous experimental evidence suggests that both antiferromagnetic phases are separated by a quantum critical point (QCP) that separates two antiferromagnetic states with identical symmetry [3]. We present our recent studies on 2% and 3.5% Nd-doped CeCoIn5 which both feature the Q-phase magnetic order at high-field region along (0.554, 0.554, 0.5) as well as a low-field SDW phase with the same order. Interestingly, the low-field SDW phase vanishes with increasing magnetic fields before the Q-phase is stabilized. This suggests that these two phases are separated by a disordered magnetic phase for low Nd-doped CeCoIn5. The separation of SDW phases represents for two magnetic instabilities in the NdxCe1-xCoIn5 series, suggesting different origins of the two phases. Our study presents a unique case where two magnetic phases of identical symmetry are separated by a disordered phase.

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Session Classification: Poster session

Track Classification: Poster