Magnetism and Superconductivity in Heavy Fermion Superconductor CeCo(In$_{1-x}$Cd$_x$)$_5$

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The heavy fermion superconductor CeCoIn$_5$ has the highest $T_c$ (= 2.3 K) in a series of Ce-based materials. Recently, it has been found [1] that Cd substitution on the In site drives the system towards antiferromagnetism (AFM). Remarkably, applying pressure can reverse this effect. Recent NMR studies [2] suggest that the magnetism develops locally in the vicinity of the Cd atoms. Neutron scattering experiments [3] on a sample with a nominal [1] Cd concentration of 10% showed the coexistence of superconductivity and AFM. The AFM order develops below $T_N$ with the commensurate wave vector $Q_{AF} = (1/2, 1/2, 1/2)$ and the magnetic intensity does not increase below $T_c$.

Zero field $\mu$SR measurements on single crystalline samples of CeCo(In$_{1-x}$Cd$_x$)$_5$ ($x = 0.03, 0.10$ and $0.15$) were performed in order to further elucidate the magnetic and superconducting properties. In contrast to neutron scattering, $\mu$SR can independently measure both the magnitude of the local field and the magnetic volume fraction. A single muon precession signal was observed below $T_N$ in both the $x = 0.10$ and $0.15$ samples, with different magnetic volume fractions. The muon frequency, which is proportional to the AFM moment, leveled off below $T_c \sim 1.3$ K in $x = 0.10$, similar to the neutron results. The observed frequency in $x = 0.15$ is 20% larger than that in $x = 0.10$, suggesting enhancement of internal field in $x = 0.15$. No magnetic signal in zero applied field was observed for $x = 0.03$. We will discuss these results in view of the microscopic interplay of magnetism and superconductivity in this material.


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