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Pressure effects on the magnetic behavior of the local moment ferromagnet CeCuSi

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Abstract content
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Interest in Ce or U based ternary intermetallics has been ongoing for the last three decades, because they show a variety of exotic magnetic-electronic ground-states (e.g. heavy fermion behavior , non Fermi-liquid characteristics, etc). Most magnetic CeTX compounds order antiferromagnetically (T is a transition-metal and X is a p-band element). One candidate, CeCuSi, is among a select number that exhibits ferromagnetic ordering at low temperatures; other candidates being CePdX (X = P, As, Sb). The ferromagnetic transition in this compound has been established from both specific heat data (lambda;-type anomaly manifested at T_C =15 K) and magnetization measurements in which an ordered moment of ˜1 mu;_B has been obtained. The hybridization (J) between the localized 4f and more extended d orbitals (Ce 5d and T 3d), which influences intersite magnetic ordering of Ce moments via the RKKY indirect interaction mechanism involving the d conduction electrons, is readily tuned under pressure. Consequently new ground states can be stabilized at reduced inter-atomic spacing without the complexity of disorder from doping. Many well known antiferromagnetic CeTX compounds have been the focus of attention in pressure studies in the last decade. There has been much less done, if any, in elucidating the pressure response of ferromagnetic analogs. We present the results of our pressure studies on the title compound. These studies have entailed : (i) SQUID magnetization measurements to ˜10 GPa in a turn-buckle magnetic diamond anvil cell (TM-DAC) to monitor both T_C and magnetic susceptibility, (ii) x-ray absorption spectroscopy (XAS) at the Ce L₃-edge (˜5.7 keV) to pressures of ˜16 GPa. The latter necessitates use of “perforated” diamond anvils in a membrane-DAC for both a near edge spectroscopy (XANES) probe of Ce valence and x-ray absorption dichroism (XMCD) at 6 K to monitor shell-specific 5d-3d conduction electron spin polarization in the magnetically ordered state. We evidence increasing T_C values (from 15 K to 30 K), and yet collapse of the XMCD signal, with rising pressure up to 10 GPa; beyond which signatures of a valence change are manifest in the XANES profiles.

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