POSSIBLE CONNECTION BETWEEN HIDDEN ORDER AND $^{29}\text{Si}$ NMR LINE-INTENSITY DROP IN UR$_2$Si$_2$

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Introduction

UR$_2$Si$_2$ undergoes a phase transition to hidden order with concomitant small-moment antiferromagnetism at about 17 K ($T_0$). The nature of this transition is still under investigation both theoretically and experimentally. Under pressure the system undergoes magnetic transitions and at high fields (30–50 T) there are several other phases in which the system has been found to exist [1]. It is important to provide microscopic information about the development of internal effective fields as the material undergoes high-field/high-pressure induced phase transitions. Instrumentation necessary for this undertaking was developed at NHMFL. NMR measurements to probe the high pressure and high field states of UR$_2$Si$_2$ are in progress.

Experimental

$^{29}\text{Si}$ NMR measurements were performed as a function of field up to 23 T in a single crystal of UR$_2$Si$_2$ at ambient pressure and at a hydrostatic pressure of 4.8 kbar. Low abundance of the nuclear probes and sample size constraints made it necessary to perform Carr-Purcell-Meiboom-Gill pulse sequences for data acquisition. The CPMG technique allows one to obtain an increase in signal to noise ratio by taking data at faster rates, and is useful for the understanding of spin/spin relaxation phenomena in this particular system. Experiments were performed for field orientations from zero to 180 degrees with respect to the $c$-axis of the tetragonal crystal structure. In powder samples, an onset of internal field distribution below the transition temperature $T_0$ is always found [2]. We succeeded in recording single-crystal spectra and spin-lattice relaxation time ($T_1$) data. In this report we describe briefly the results for NMR intensity at an angle of 70 degrees and ambient pressure.

Results and Discussion

Figure 1 shows an ambient-pressure temperature sweep at 70 degrees orientation. The rate of transient acquisition constant in the CPMG echo train was kept at 100 $\mu$s. The line is symmetric and relatively strong in the normal state. The signal drops abruptly at $T_0$, and appears to split. It starts to recover when the temperature is lowered further. The question arises as to whether these are effects induced by the CPMG method, in which case, the method would become of great help in understanding hidden order. We also found strong orientation dependence of the intensity (not shown). Indicating that the spin/spin relaxation time “$T_2$” is highly anisotropic and possibly disordered.

Conclusions

More work is required to understand our results. We will continue hydrostatic and ambient pressure measurements using single crystals. Our experiments seem to supply a method to reveal hidden-order physics using NMR as can be inferred by the behavior of the intensity, its anisotropy, and the observed line splitting effects under CPMG pulse conditions.

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References