μSR studies of non-centrosymmetric superconductor $CaIrSi_3$

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Non-centrosymmetric superconductors (NCSC) have been predicted to show novel physics such as mixed spin-singlet/triplet pairing states and spontaneous time-reversal symmetry (TRS) breaking due to strong spin-orbit splitting in the absence of inversion symmetry [1, 2]. Although the first NCSC materials were synthesized nearly 10 years ago, many of these predicted properties have yet to be observed and much remains to be understood regarding NCSCs. Part of the difficulty stems from the fact that most NCSCs, such as $CePt_3Si$ [3], are strongly correlated f-electron systems in which the non-centrosymmetric physics is difficult to disentangle from the correlation effects. Recently, a new class of d-electron compounds has been discovered in which the effects of strong correlation are less important [4, 5]. It was suggested that these systems may therefore allow the non-centrosymmetric effects to be probed more directly than in strongly correlated NCSCs [6].

$CaIrSi_3$ is one of these newly discovered d-electron NCSC materials. We have conducted a detailed μSR study to investigate its superconducting properties and search for evidence of non-centrosymmetric physics. Using a dilution refrigerator, we performed transverse-field (TF) and zero-field (ZF) measurements of co-aligned single crystals down to 30 mK. The TF spectra reveal a robust superconducting state below $T_C \sim 3.4$ K that can be well fit by an analytical Ginzburg-Landau model with a zero-temperature penetration depth of $\sim$300 nm and coherence length of $\sim$36 nm. The temperature evolution of the superfluid density is well described within a conventional s-wave pairing scenario. The ZF spectra show no change in relaxation rate above and below T_C within the statistical uncertainties of our measurements, indicating that TRS is preserved in this system. These results suggest non-centrosymmetric effects may not be dominant in $CaIrSi_3$.

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