Magneto-Raman Spectroscopy of URu_2Si_2

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Introduction

Recently, the heavy Fermion compound URu_2Si_2 has attracted a lot of attention due to its interesting temperature-magnetic field phase diagram. Linear thermal expansion and magnetostriction measurements indicate the presence of three distinct phases at high magnetic fields (see Fig. 1) [1]. The sample length change was found to be discontinuous at the entrant and exit fields of the phase III due to contraction of the crystallographic c-axis. The nature of the temperature-magnetic field (T-B) phase diagram points towards the presence of an underlying quantum critical end point and these results are yet to be confirmed. We attempted magneto-Raman spectroscopic measurements on URu_2Si_2 to check the feasibility of the experiments.

Experimental

Magneto-Raman spectroscopy was performed using 532 nm laser at temperatures down to 4 K in high magnetic fields up to 31 T. The 31 T magnet at Cell 9 and 17 T magnet at the EMR division were utilized for these measurements. The sample was placed on X-Y-Z actuator to obtain the best alignment as well as for position selectivity. Raman spectra were collected for temperatures between 4 K and 10 K.

Results and Discussion

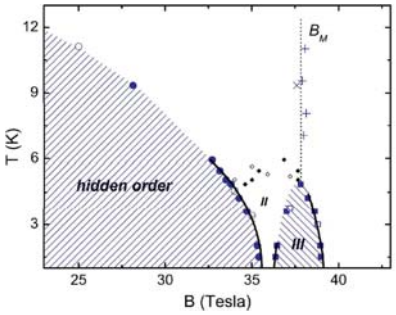

Fig.1 Temperature-magnetic field phase diagram of URu_2Si_2 for magnetic fields up to 45 T (Reproduced from Ref. [1]).

Our first results of the magneto-Raman spectroscopy on URu_2Si_2 are illustrated in the Fig. 2. Here, we show the data obtained at zero magnetic field in comparison with that of 31 T at temperature of about 8.5 K. The measured spectra are of good quality with reasonable signal-to-noise ratio at both 0 T and 31 T. We were successfully able to observe two phonon modes B_{1g} and A_{1g} within the measured energy range in agreement with previous reports [2,3]. Nevertheless, we could not observe any significant changes with the application of magnetic fields up to 31 T. This outcome is not very surprising when one takes a closer look at the T-B phase diagram shown in the Fig. 1. The transition at which the hidden order was suppressed is not strongly observable in the field range below 33 T. Most obvious field-induced changes occur at fields above 33 T and temperatures below 6 K as implied by the experimental data points on the phase diagram. Furthermore, in order to probe the newly reported field-induced phase III, magnetic fields above 35 T is required. Therefore, as a next step magneto-Raman measurements need to be performed at highest possible fields i.e., up to 45 T.

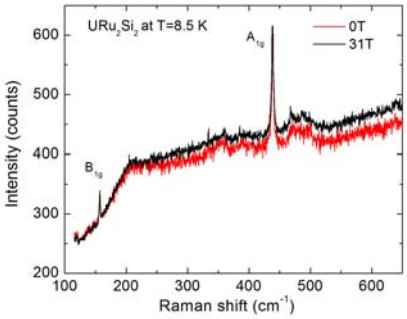

Fig.2 An exemplary plot of Raman spectra of URu_2Si_2 at the temperature of 8.5 K in zero magnetic field and 31 T.

Conclusions

We performed magneto-Raman spectroscopic investigation on heavy fermion compound URu_2Si_2 at magnetic fields up to 31 T. The spectrum consists of two phonon modes of symmetry B_{1g} and A_{1g} in the measured energy range. Changes in Raman spectrum corresponding to field-induced phase transitions will soon be probed at magnetic fields up to 45 T.

Acknowledgements

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References

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