# MAGNETIC EXCITATIONS IN AN ITINERANT 5$f$ ANTIFERROMAGNET $UPt_2Si_2$*

N. Metoki[a,b], Y. Koike[a,c], Y. Haga[a], N. Bernhoeft[d]
G.H. Lander[a,e], Y. Tokiwa[a,f] and Y. Ōnuki[a,f]

[a]Department of Physics, Tohoku University, Aoba Sendai 980-8578, Japan
[b]JST Corporation, Kawaguchi, Saitama 332-0012, Japan
[c]Advanced Science Research Center, JAERI, Tokai, Ibaraki, 319-1195, Japan
[d]DRFMC, DEA/Grenoble, 38054 Grenoble Cedex 9, France
[e]EC-JRC, Inst. for Transuranium Element, 2340-76125 Karlsruhe, Germany
[f]Graduate School of Science, Osaka University, Toyonaka, Osaka 560-0043, Japan

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The magnetic excitation in a 5$f$ antiferromagnet $UPt_2Si_2$ was studied by means of neutron inelastic scattering. A remarkable low energy quasi-elastic component has been observed around the antiferromagnetic zone center (100). We concluded that the low energy quasi-elastic response would be the excitation of the quasi-particles due to hybridization between 5$f$ and conduction electrons.

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## 1. Introduction

The wide variety of behavior exhibited by 5$f$ electrons is one of the most intriguing problems in strongly correlated electron systems. The spectrum, encompassing localized, heavy fermion, non-fermi liquid and itinerant aspects, depends on the strength of the hybridization with valence and ligand electron states. Materials in the $UT_2Si_2$ system play an important role in our understanding as the hybridization can be controlled by varying the transition metal element T. In this respect the unusual transition at $T_0 = 17\,\mathrm{K}$ and the superconductivity in $URu_2Si_2$ are especially interesting with, on the other hand, $UPt_2Si_2$ being considered as an example of an antiferromagnet with localized 5$f$ states. $UPt_2Si_2$ has the $CaBe_2Ge_2$-type structure with

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space group P4/$nmm$. The uranium magnetic moments along the $c$-axis ($M = 1.7\mu_B$) order antiferomagnetically with $Q$=(001) below $T_N = 37$ K as shown in Fig. 1(a). The susceptibility [1] and specific heat [2] of the latter material were understood in terms of the crystalline electric field (CEF) levels suggested by a previous neutron scattering study on a polycrystalline sample [3] whilst the large drop of the resistivity at $T_N$ and the anisotropic behavior remained unexplained [3]. The purpose of this study is to reveal the magnetic excitations of $UPt_2Si_2$ in single crystalline samples.

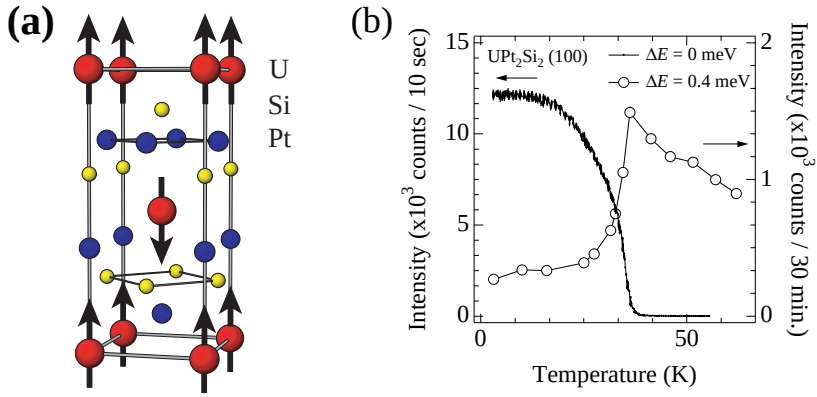


Fig. 1. (a) Crystal and magnetic structure of $UPt_2Si_2$. (b) The intensity of the (1 0 0) antiferromagnetic peak and the inelastic component at $\Delta E = 0.4$ meV.

## 2. Experimantal

Single crystalline samples were grown by the Czochralski-pulling method in a tetra-arc furnace under argon gas atmosphere. The magnetic excitation was measured with three single crystal rods aligned within the accuracy of 0.3 degrees on a triple axis spectrometer LTAS with fixed $E_f = 3.5$ meV.

## 3. Result and discussion

The temperature dependence of the (100) antiferromagnetic Bragg intensity is plotted in Fig. 1(b). The intensity exhibits a clear nature of the magnetic order parameter. The intensity at the neutron energy loss $\Delta E = 0.4$ meV increases with elevating temperature and showed a maximum at $T_N$. It means that there is a low energy magnetic excitation.

The existence of the low energy component is clearly demonstrated by the inelastic scattering profile shown in Fig. 2. On the (1 0 0) antiferromagnetic zone-center we observed pronounced quasi-elastic peak at $T = 38$ K, slightly above $T_N$. This quasi-elastic scattering can be fitted by Lorentzian

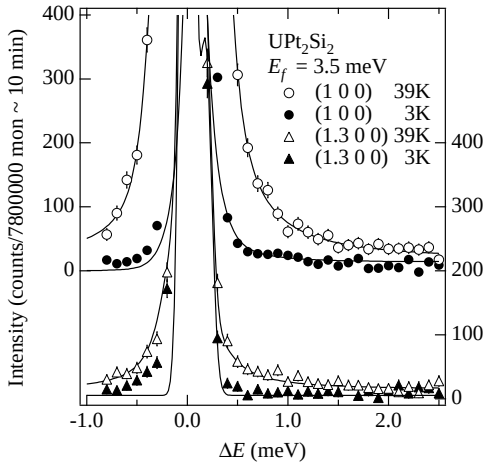


Fig. 2. The inelastic scattering profile at $Q$ =(1 0 0) and (1.3 0 0), denoted by circles and triangles, respectively. The spectra were measured at 3.1 K (closed symbols) and 38 K (open symbols), respectively.

line shape with the full width of 0.15 meV. This excitation decreases in intensity with decreasing temperature. At $Q$ =(1.3 0 0) a weaker and broader quasi-elastic scattering with width of 0.4 meV was observed. Fig. 3 shows the magnetic excitation spectra of $UPt_2Si_2$ measured as a function of $Q$.

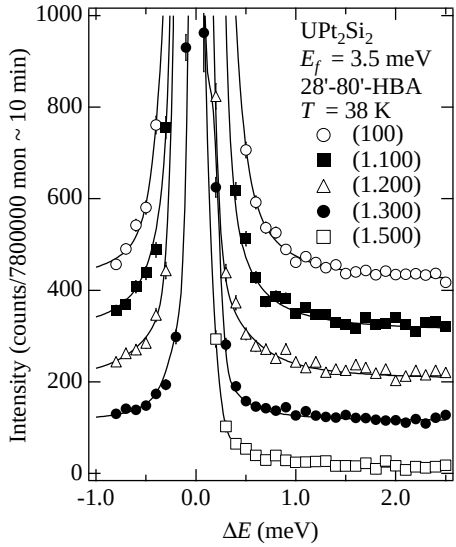


Fig. 3. Constant-$Q$ profile of $UPt_2Si_2$ as a function of $Q$ measured at $T = 38$ K.

The low energy quasi-elastic scattering has a maximum intensity around the antiferromagnetic zone center (100). Our preliminary neutron inelastic scattering experiments observed the magnetic excitation continuum above 5 meV with no CEF excitation. Therefore, we concluded that this low energy quasi-elastic component would be the spin fluctuations of the heavy quasi-particles due to hybridization between $5f$ and conduction electrons. Very recently similar low energy excitation and two component magnetic excitation have been observed in heavy fermion superconductors $UPd_2Al_3$ [4], $UPt_3$ [5], and $5f$ itinerant antiferromagnet $UGa_3$. [6] It is also found even in a localized $5f$ antiferromagnet, $U_3Pd_{20}Si_6$. [7] Therefore, these phenomena would be a general feature in uranium intermetallic compounds, because $5f$ electrons in uranium has rather strong hybridization effect.

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