琉球大学学術リポジトリ

ThCr_2Si_2型構造をとるEu化合部の価数と磁気状態の微視的解明

メタデータ	言語: 出版者: 琉球大学 公開日: 2018-06-21 キーワード (Ja): キーワード (En): 作成者: Higa, Nonoka, 比嘉, 野乃花 メールアドレス: 所属:
URL	http://hdl.handle.net/20.500.12000/41485

Abstract

Understanding of the interplay between $4f$ and conduction electrons in intermetallic compounds has been one of the important issues in strongly correlated electron systems. We focused on the rare-earth Eu intermetallic compounds with the $ThCr_2Si_2$-type crystal structure. Eu has two kinds of valence state. The divalent Eu state Eu^{2+} ($4f^6$) is magnetic ($J = S = 7/2$, $L = 0$), where J is the total angular momentum, S is the spin angular momentum, and L is the orbital angular momentum. Therefore, the compounds with divalent Eu ions tend to order magnetically, following the Ruderman-Kittel-Kasuya-Yosida (RKKY) interaction. In contrast, the trivalent Eu state Eu^{3+} ($4f^7$) is nonmagnetic ($J = 0, S = L = 3$). The valence of Eu varies with temperature, magnetic field, and pressure. Some compounds indicate the intermediate valence state. In order to investigate magnetic and electronic states of the Eu compounds with divalent, trivalent, and intermediate state from a microscopic view point, I carried out nuclear magnetic resonance (NMR) measurement.

1. The divalent Eu compounds: $EuCo_2X_2$ (X = P and As).

   $EuCo_2P_2$ and $EuCo_2As_2$ show a helical antiferromagnetic order below the Néel temperature T_N = 66.5 K and 45 K, respectively. For each compound, NMR measurements under external magnetic fields and zero magnetic field (ZF) were performed to reveal a magnetic structure and the propagation vector $\boldsymbol{k}$. I succeeded in observing NMR signals by all nuclei contained in the compound. From the analysis of the observed ^{153}Eu and ^{59}Co ZF-NMR spectra, we determined the A-type AFM structure and propagation vector $\boldsymbol{k}$.

2. The trivalent Eu compounds: $EuCo_2Si_2$.

   The ground state of the trivalent Eu ion is nonmagnetic. The J-multiplets of Eu^{3+} splits into seven levels. The characteristic of Eu^{3+} is adjacent J-multiplet energy levels. To clarify these features from the viewpoint of low energy excitation, ^{59}Co-NMR was performed. The temperature dependence of the Knight shift and the relaxation time T_1 was analyzed based on the model and the energy gap was estimated to be about 400 K.

3. The intermediate valence Eu compound: $EuNi_2P_2$.

   $EuNi_2P_2$ shows an intermediate valence state, and the valence of Eu changes from the divalent side to the trivalent side as temperature decreases. ^{31}P-NMR was performed to determine the detailed temperature and magnetic field dependence of the Knight shift and T_1. The change in valence of Eu and the formation of

heavy electron states were found from the temperature dependence of $1/T_1$ and the Knight shift. In addition, we found the presence of spin fluctuations in a low-magnetic-field and low-temperature regions and clarified the specificity of heavy electron states in Eu compounds.