２１世紀ＣＯＥ拠点リーダー　鈴木　厚人　殿

平成１６年度ＣＯＥ特別研究奨励費研究計画調書

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		物理学専攻	ＣＯＥフェロー・博士（４年・３年・２年・１年）
研究課題	４０文字以内で記入すること。 Multipole order and superconductivity in strongly correlated electron systems		

研究指導者	職　名	氏　名	15年度奨励費採択の有無
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研究目的	募集要領の趣旨に沿った目的を箇条書きで具体的に記入すること。

The nature of internal degrees of freedom of particles aroused common interest in various fields of physics ranging from particle physics to condensed-matter physics. In condensed matter, localized electrons can have multipole moments as a kind of internal degrees of freedom in addition to spin and charge. The multipole moments, though difficult to observe, seem to play an important role in magnetism and superconductivity, for example. The purpose of my research is to understand the multipole degrees of freedom by examining typical systems with strong electron correlations.

1. The rare-earth filled skutterudites show interesting behavior depending on the rare-earth: there are exotic superconducting phases in $PrOs_4Sb_{12}$, metal-insulator transition in $PrRu_4P_{12}$, antiferro-quadrupolar ordering in $PrFe_4P_{12}$, while $NdFe_4P_{12}$ shows ferromagnetism. One of my purposes is to identify the key parameters which control the diversity of the skutterudites.

2. As typical 5f multipole systems, NpO_2 deserves special attention. I would like to understand why this system favors the octupole order through comparison with antiferromagnetic UO_2 that has the same crystal structure with NpO_2.

3. The localized character of electrons become weaker generally in the order of 4f, 5f and 3d. In this connection I take up $BaVS_3$ which displays multiple phase transitions including the metal-insulator and structural ones.

研究計画	研究経費との関連も含めて、何をどこまで明らかにしようとするかがわかるように焦点を絞り、箇条書きで記入すること。 また、設備備品費又は旅費が９０％を超える場合は、研究計画の特殊性ないし特殊事情について記入すること。

1. I wish to understand the nature of the antiferro-quadrupolar ordering in $PrFe_4P_{12}$ in detail: first try to decide that the ordered phase appears below 6.5K can be ascribed to the O_2^2 or O_2^0 Γ_3-type quadrupolar moments. Then, I would like to examine how we can explain the measured anisotropy of the magnetization curves within the quadrupolar ordered phase. After, I would like to study dynamical properties and the Kondo effect in this skutterudite.

2. The superconducting phases and properties of $PrOs_4Sb_{12}$ are far from the fully explored yet. I would like to examine the nature of the heavy fermions which may originate from a mechanism different from Kondo effect, and to understand some of the unusual superconducting properties of this compound (for example the missing of the entropy balance).

3. It seems that NpO_2 is the first system in which the ordering of the octupolar moments as a primar order parameter is realized at the 25K phase transition. After some recent analysis about the nature and properties of a ferro-octupolar ordering model in external magnetic field, now I wish to investigate the realistic triple-**q** four-sublattice antiferro-octupolar order in NpO_2 system. At the same time it would be interesting to compare the NpO_2 and UO_2 systems, and examine and explore the differences between them with respect to the multipolar orderings.

4. I would like to describe the sequence and the nature of phase transitions of $BaVS_3$. I wish to make a model considering coexistence of wide-band a_{1g} and narrow band e_g 3d-electrons and focusing on the strongly correlated e_g electrons.

I would like to participate in the Yukawa-workshop which will be organized in Kyoto in November 2004 in order to interact and discuss with excellent theoretical and experimental physicists from Japan an from other countries.