Title of Project : Study of Local Electronic State and the Hybridized Orbital Order under Magnetic Field and Pressure by Resonant Soft X-ray and Neutron Scattering

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Research Area : Condensed Matter Physics

Keyword : Synchrotron Radiation, Neutron, Resonant X-ray Scattering, Orbital Ordering

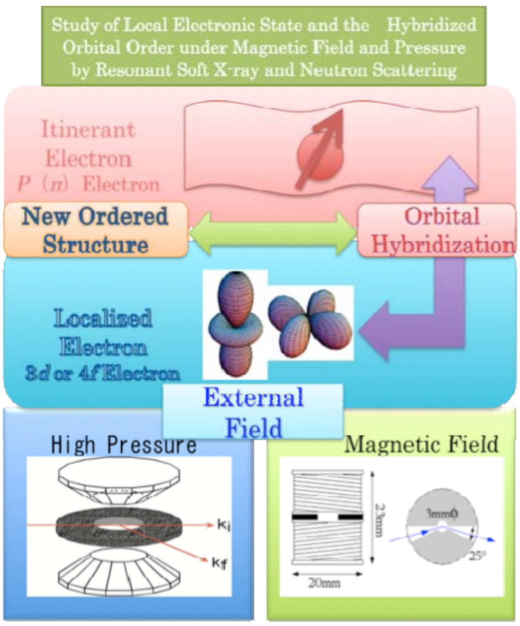
【Purpose and Background of the Research】

It is well known that electronic degrees of freedom (charge, spin, and orbital) play important roles in the electronic and magnetic properties of strongly correlated electron systems. The field control of these ordered states has been studied vigorously because of the potential ability of the materials function to electronic devices. However, the basic understanding of the formation mechanism of the function is not enough. In this study we will try to find the relation between the microscopic ordering states and the materials function.

We investigate three types of materials with strong electron correlation: π-d electron system, 3d transition metal oxide system, and 4f multi-pole ordered system. The formation mechanism of the novel properties (magnetoresistance, metal-insulator transition, multiferroics and so on) of these materials will be elucidated by the observation of ordered states of the localized and itinerant electrons in the systems.

【Research Methods】

Resonant soft and hard x-ray scattering technique is used to observe the ordered states



of itinerant and localized electrons, respectively. The orbital hybridization between the localized and itinerant electrons is observed by inelastic neutron scattering. These measurements are performed under high pressure using diamond anvil cell or strong magnetic field using superconducting magnet.

【Expected Research Achievements and Scientific Significance】

(A) π-d electron system: Some molecular systems with the localized d-electron and the itinerant π-electron show novel magnetoresistance and spin liquid behavior due to the frustration effect. The mechanism of these novel phenomena will be elucidated.

(B) 3d transition metal oxides: Some perovskite-type transition oxides show multiferroic behavior. The hybridization between the localized 3d orbital and the itinerant oxygen 2p orbital makes the novel properties. We can deduce useful information by the observation the ordered states of these electrons under pressure and magnetic field.

(C) 4f multi-pole ordered compounds: Strong hybridization between the localized 4f and itinerant p electrons makes the novel metal-insulator transition. We make clear the transition mechanism by the observation of the multi-pole ordering states of 4f and p electrons.

【Publications Relevant to the Project】

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- D. Bizen et al., Phys. Rev. B **78**, 224104 (2008).

【Term of Project】 FY2009-2013

【Budget Allocation】 168,900 Thousand Yen

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