【Grant - in - Aid for Scientific Research on Innovative Areas(Research in a proposed research area)】
Science and Engineering

Title of Project : J-Physics: Physics of conductive multipole systems

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Research Project Number : 15H05882 Researcher Number : 50211496

【Purpose of the Research Project】

Electrons are responsible for conduction phenomenon of material. An isolate electron has charge and spin of degrees of freedom. However, a variety of conduction phenomenon could not be understood, when we consider electrons just with charge and spin.

Orbital angular momentum of an electron in an atom couples its spin by the spin-orbit interaction, so a total angular momentum **J** becomes its characteristic. In solids, by the influence from the surroundings, the property of **J** changes into a multipole, which is microscopic freedom reflecting the atomic characteristic and the environment of the solid. The purpose of our project is to understand the various conduction phenomena by considering such a characteristic multipole.

With comprehensive cooperation, many researchers study together to establish the physics of conductive multipoles, and cultivate functional material leading to new applications. Besides, young researchers are trained to become key players in material science.

【Content of the Research Project】

Four groups both of planned researches and publicly invited researches promote the project.

A01: Correlation effect between localized multipoles and conduction electrons
-To study novel conduction phenomena produced by strong interactions between localized multipoles and itinerant conduction electrons.

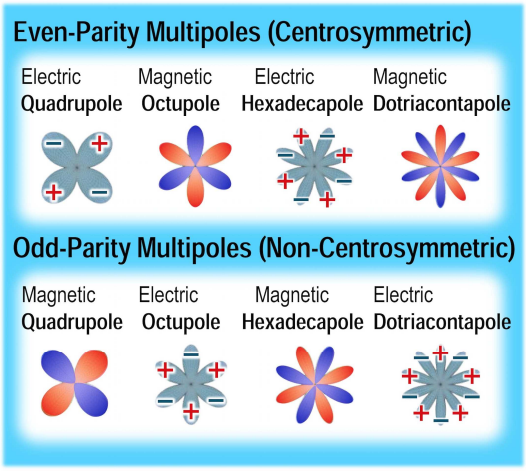

Figure: Multipoles. Odd-parity multipoles are allowed only in non-centrosymmetric case.

B01: Novel quantum phase with itinerant multipoles
-To study novel conduction phenomena, such as superconductivity, and ordered states relating with itinerant multipoles.

C01: Dynamical response from extended multipoles
-To search new dynamic response from multipoles, which are extended to several atoms, by using precise measurements.

D01: Development of strongly correlated multipole materials
-To develop new functional substances including high-temperature superconductors, where multipoles play a crucial role.

Odd parity multipoles allowed only in non-centrosymmetric case is expected to play a crucial role in a variety of systems. Therefore materials with a zigzag structure and a chiral structure are focused in research.

【Expected Research Achievements and Scientific Significance】

Unconventional conduction phenomena, such as ferromagnetic superconductors are clarified. Newly synthesized functional materials will be utilized as a huge responsive substance in multiferroics or spintronics fields. The concept of extended multipoles will be diverted to the field of functional molecules or biopolymers.

Focusing on multipoles together with young researchers, it brings a paradigm shift in solid state physics to contribute significantly to the science and technology innovation.

【Key Words】

spin-orbit interaction: interaction between the electron spin and orbital angular momentum in the central field, as a relativistic correction term derived from the Dirac eq.

total angular momentum: sum of spin angular momentum **S** and orbital angular momentum **L**, coupled by the spin-orbit interaction. It is usually expressed in **J**.

multipole: characteristic of the electrical or magnetic spatial distribution of electrons classified in point symmetry.

【Term of Project】

FY2015-2019

【Budget Allocation】

1,173,100 Thousand Yen

【Homepage Address and Other Contact Information】

http://www.jphysics.jp