【Grant-in-Aid for Scientific Research(S)】

Science and Engineering (Mathematical and physical sciences)

Title of Project : Interdisciplinary exploration of novel properties taking advantage of the controllability in molecular materials

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Research Area : Condensed matter physics

Keyword : Molecular materials, Correlated electrons, Dielectric properties, Dirac electrons

【Purpose and Background of the Research】

As expressed by the well known "More is different", gathering of many particles leads to an emergent existence as an assembly. Its behavior is diverse, which has fostered Materials Science. Research to relate or connect different topics would make materials science more fertile and systematic. However, this is not straightforward experimentally because particular topics originate from the specific structures of materials and it is hard to continuously change one structure of interest to a different structure of another interest. In recent years, molecular materials have been attracting attention in that they exhibit interesting properties in various research fields including strong electron correlation. Noticeably, some of them are emergent in similar structures.

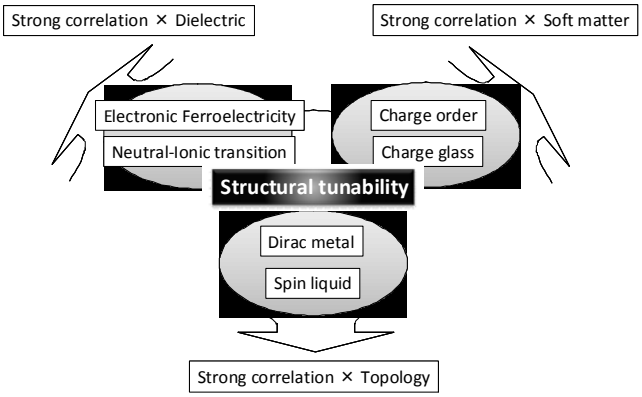
The present research aims at exploring frontiers between different research interests such as dielectricity, conductivity, magnetism and semiconductor by controlling the flexible structures of molecular materials. Specifically, we tackle the following subjects: i)phase control between electronic and ionic ferroelectrics, and metallization of them; ii) exploration of strongly correlated charge glass; iii) exploration of strongly correlated massless Dirac fermions; iv) exploration of novel phases between spin liquid and superconductivity.

【Research Methods】

A series of molecular materials having similar structures and exhibiting properties of different interests are physically or chemically pressured so as to tune the structures for pursuing possible phase changes. Besides the conventional hydrostatic and uniaxial pressures, their combination is adopted as well. The electronic state is characterized with both of microscopic and macroscopic experimental probes. For the former, the spin and charge states are probed by nuclear magnetic resonance (NMR) and nuclear quadruple resonance (NQR), while the macroscopic characterization is made by magnetization, electron transport and dielectric measurements.

【Expected Research Achievements and Scientific Significance】

The points of the present research is to make it possible to study, in common experimental states, different condensed-matter issues of keen interest such as charge glass, electronic ferroelectrics, metal-insulator transitions, Dirac electrons, spin liquid and superconductivity by controlling the flexible lattices of molecular materials. This enables us to explore frontiers in between so far separately investigated issues. As depicted below, interdisciplinary research areas between electron correlation and dielectric-, soft-matter- or topology-related fields are expected to emerge.



【Publications Relevant to the Project】

・K. Kanoda and R. Kato, “Mott physics in organic conductors with triangular lattices”, Ann. Rev. of Condensed Matter Physics 2, 167 (2011).
・F. Kagawa, T. Sato, K. Miyagawa, K. Kanoda, Y. Tokura, K. Kobayashi, R.Kumai, and Y. Murakami, “Charge-cluster glass in an organic conductor”, Nature Physics 9, 419 (2013).

【Term of Project】 FY2013-2017

【Budget Allocation】 168,500 Thousand Yen

【Homepage Address and Other Contact Information】

http://park.itc.u-tokyo.ac.jp/kanoda_lab/e/index.html