Visiting Professors

Visiting Professor
NAKAMURA, Masakazu *(from Nara Institute of Science and Technology)*

Giant Seebeck Effect in Pure π-Conjugated Molecular Solids

The Seebeck effect is a well-known phenomenon where a voltage appears in a material with temperature gradient. The origin of the Seebeck effect has been generally explained by the transport coefficients of charge carriers under electric field and temperature gradient using the linear response theory where the interaction between carrier and phonon is included only as a rare event called 'scattering.' Recently, our group found that irregularly large Seebeck coefficients appear in pure π-conjugated molecular solids at a near room temperature range, of which magnitude is a hundred times larger than the prediction by the conventional theory. A strong charge-vibration coupling in molecular solids is considered to be a driving force of this phenomenon and both experimental and theoretical studies are under progress. Such a large Seebeck coefficient is also interesting from an application point of view because it possibly produces revolutionary simple thermoelectric generators being free from the series connection of hundreds of p- and n-type blocks.

Visiting Professor
TAJIMA, Naoya *(from Toho University)*

Quantum Transport Phenomena in Molecular Massless Dirac Fermion Systems

We have found two dimensional massless Dirac fermion systems in an organic conductor α-(BEDT-TTF)$_2$I$_3$ under pressure. In contrast to graphene, this is the first bulk (multilayered) massless Dirac fermion system. Moreover, this massless Dirac fermion phase is close to the charge ordered insulating phase on the pressure–temperature phase diagram. Thus, this system provides the testing ground for the investigation of physical phenomena in strongly correlated Dirac particles. In this work, we develop the field effect transistor channeled by this system and then aim at the detection of fractional quantum Hall effect.

Visiting Associate Professor
YOSHIKAWA, Hirofumi *(from Kwansei Gakuin University)*

Development of Rechargeable Batteries Using Coordination Compounds as Cathode Materials

Recently, much attention has been focused on development of high-performance rechargeable batteries due to the global energy and environmental problems. Our research interest is to find novel cathode materials toward the next-generation rechargeable battery with a high capacity, a stable cycle performance, a rapid charging, and so on. We have examined battery performances of various organic and inorganic materials, which could take the place of the present general cathode materials, $LiCoO_2$ and $LiFePO_4$. Among various materials, porous redox-active coordination compounds are promising since they have an ionic conductive space and a robust structure. To realize a high capacity, a good cycle performance, and a rapid charging, we develop porous polyoxometalates and metal organic frameworks, and examine their battery performances. We also try to prepare their nanoparticles to increase electrochemical performances. Finally, we reveal these electrochemical reaction mechanism by using operando XAFS, XRD, solid-state NMR *etc*. and the obtained information is utilized to investigate new materials with high battery performances.