Visiting Professors

Visiting Professor
FUKUHARA, Takeshi *(from RIKEN)*

Quantum Gas Microscope for Rb-85 Atoms with a Tunable Atom–Atom Interaction

Ultracold quantum gases in optical lattices provide a clean and controllable platform for studying quantum many-body systems; especially they enable us to emulate a variety of fundamental models in solid-state physics. An "artificial" quantum spin system described by the spin-1/2 Heisenberg model can be realized by using ultracold bosonic atoms in optical lattices. In this realization, the anisotropy of the spin–spin interaction can be controlled by changing the interatomic interaction via a Feshbach resonance. Although, for quantum gas microscope experiments, rubidium-87 atoms have been utilized, in this study we performed experiments using rubidium-85 atoms which have a Feshbach resonance at a magnetic field of $B \sim 155$ Gauss. We succeeded in observing rubidium-85 atoms in a triangular lattice at the single-atom level. We also confirmed the Feshbach resonance through atom loss spectroscopy. This system is expected to be used for a quantum simulation of frustrated magnets that follow the spin-1/2 triangular-lattice antiferromagnetic Heisenberg model.

Visiting Professor
MATSUSHITA, Tomohiro *(from Nara Institute of Science and Technology)*

Development of Analysis Methods for Photoelectron Momentum Microscope

The photoelectron momentum microscope introduced at UVSOR is a highly powerful tool for observing the composition and electronic structure of samples using photoelectron spectroscopy. This pioneering analytical apparatus enables the observation of Fermi surfaces and band structures in various systems, including surface atomic sites, thin films, interfaces, surface adsorbates, and polycrystalline materials. Currently, we are developing two methods for analyzing the data. First, the observed photoelectron intensities from valence band depend on the transition probabilities of photoelectrons, resulting in modulation of these intensities. To calculate this intensity modulation, we are developing an analysis tool based on the first-principles calculation code OpenMX. Second, we are utilizing information technology to process data and extract hidden information. Specifically, we are applying principal component analysis to the data obtained from this instrument to visualize the behavior of phase transitions.

Visiting Associate Professor
NAKAYAMA, Yasuo *(from Tokyo University of Science)*

Epitaxially-Grown Single-Crystalline Organic Molecular Semiconductors

Single-crystalline organic semiconductor materials exhibiting "band transport" realize considerably high charge carrier mobility of over 10 $cm^2V^{-1}s^{-1}$ and have potential applications as flexible and efficient electronic devices. Whereas current organic semiconductor electronics are mostly composed of polycrystalline or amorphous molecular solids, our group has been working on single-crystalline organic semiconductor solids and their heterojunctions formed by "molecular beam epitaxy" techniques to pursue potential applications as flexible and efficient electronic devices. Recently, we discovered as a collaborative work with an IMS group that an n-type molecule C_{60} forms well-ordered epitaxial heterojunctions on the single-crystal surface of a high-mobility p-type molecule dinaphthothienothiophene (DNTT). This work was selected as one of the "Spotlight2023" articles. In addition, our group is also engaged in exploration into the fundamental properties of molecular single-crystal materials themselves, and have published collaborative works with the UVSOR facility on vibrational properties of the single-crystals of DNTT and pentacene.