Visiting Professors

Visiting Professor
IMURA, Kohei *(from Waseda University)*

Development of Advanced Super-Resolution Microscopy and Their Application to Nanomaterials

Elementary excitations in nanomaterials generate amplified optical fields in the vicinity of the materials. Near-field interactions of molecules with the localized fields provide new frameworks in optical excitations. In order to utilize the novel optical excitation schemes for various applications, understanding of the near-field light-matter interaction is crucial. Near-field optical microcopy, which achieves a super-resolution, is promising for this purpose. Spectroscopic methods in the near-field optical microscope, however, have not been well developed. We have been extending the near-field optical microscope to linear- and non-linear spectroscopic imaging methods. Recently, we have developed reflection and ultrafast near-field imaging methods, and applied them to study optical properties of nanomaterials. We found that giant nonlinearity is effectively induced at the localized fields in the nanomaterials. We are currently extending these studies to controlling linear and non-linear optical properties of nanomaterials in space and time resolved manner. The study will open the door to coherent control of elementary excitations and photochemical reactions.

Visiting Associate Professor
YAMADA, Toyo Kazu *(from Chiba University)*

Dimensional Dependence of Organic Molecular Electronic States

Scanning tunneling microscopy (STM) has been used to visualize material topology with an atomic scale. For 2000–2016, I have developed spin-polarized STM setups to visualize not only atomic structures of materials but also electronic, spin, and quantum structures combined with spectroscopy techniques. 1-nm-size nano-materials, such as nano-magnets, single atoms, single molecules, and graphene nano-ribbons have been studied for realizing new nano-electronic devices with low cost, low power consumption, and high performance. In 2016, we have developed a new low-temperature STM setup and now try to fabricate two-dimensional molecular networks on an atomically-flat noble metal substrate. Subsequently, a magnetic metal will be deposited on the network, and try to make a new two-dimensional magnetic nano-dot array.

Visiting Associate Professor
HIRAHARA, Toru *(from Tokyo Institute of Technology)*

Spin-Split States at the Surface/Interface of Nonmagnetic Ultrathin Films

Recently there has been growing interest in utilizing the spin degree of freedom in electronic devices, the so-called *spintronics*. The conventional way is to use magnetic materials and manipulate the spin using a magnetic field. However, it is sometimes troublesome to apply a magnetic field to nano-scale materials and it is much easier to control the spin properties of materials using an electric field. By making use of the Rashba effect in which electrons become spin polarized in k-space due to spin–orbit coupling effects at the surface, such manipulation of electron spin with an electric field becomes possible, *i.e.*, a spin field effect transistor can be realized in such materials. We are developing a high-resolution spin- and angle- resolved photoemission spectroscopy measurement system equipped with *in situ* surface sample preparation facilities at BL-5U and characterize the novel spin property at the Rashba-split surface/interface states of nonmagnetic ultrathin films. We will also try to grow thin films of novel topological materials such as Dirac/Weyl/line-nodal semimetals.

Visiting Associate Professor
KISHIMOTO, Tetsuo *(from University of Electro-Communications)*

Development towards Continuous Production of Bose-Einstein Condensates

Our goal is to realize continuous production of Bose-Einstein Condensates (BEC) based on all-optical techniques. By using sympathetic cooling techniques, this can further extend the possibility of realizing CW BECs for many other different atomic species or even molecules that are not eligible for direct evaporative cooling. Currently we are exploring different laser cooling transitions in the fine structure of the 6P levels in 87-Rubidium atoms to obtain higher phase space density. As a separate project from this, we have also started to seek for a new method to manipulate quantum gas with high spatial resolution, using special wavelengths. With these special wavelengths, AC Stark effect from the irradiated laser light will be cancelled out on one of the hyperfine ground sublevels of the atoms, while there will be AC Stark effects on all the other sublevels. So far we are searching for such special wavelengths by spectroscopic measurements, using thermal vapor gas of rubidium.