Division of Transdisciplinary Sciences

Department of Advanced Materials Science

Laboratory	Faculty	Introduction of research activities and laboratory	Key words	Projects or activities summer program students can participate
Arima-Tokunaga Laboratory	Prof. Taka-hisa ARIMA Assoc.Prof. Yusuke TOKUNAGA	We are interested in transition-metal oxide compounds which show novel physical responses like 1) control of electric polarization of matter with a magnetic field, 2) change in shape of matter with a magnetic field, 3) control of magnetism of matter with an electric field, 4) control of optical property with a magnetic or electric field, and 5) directional birefringence/dichroism. All of these physical responses are related to the simultaneous breaking of more than one symmetry operation, referred to as 'multiferroicity'. We design multiferroic materials which are expected to host such novel responses, grow crystals, measure their physical properties, and investigate the origin of the physical responses from the microscopic point of view. We often utilize synchrotron and neutron facilities to reveal the symmetry breaking.	1) Multiferroics 2) Magnetism 3) Ferroelectrics 4) Crystal Growth 5) X-ray Diffraction	Summer-program students can participate in experimental researches on magnetic ferroelectrics, which are often referred to as multiferroics. They can grow single crystals of some transition-metal oxide compounds by a floating zone method, flux method, or chemical vapor transport method. They can perform measurements of x-ray diffraction, dielectric constants, magnetization, and optical absorption spectra at room temperature and low temperatures to study the crystallographic, magnetic, dielectric, and optical properties of the materials.
Nakatsuji Laboratory	Prof. Satoru NAKATSUJI Dr. Takahiro TOMITA Dr. Akito SAKAI Dr. Tomoya HIGO	Material innovation has made various breakthroughs in basic science and applications. Recent research has shown that magnetic materials have great potential when they have topologically nontrivial electronic structures. To advance our understanding of novel and potentially useful electronic and magnetic materials, our research utilizes a combination of high quality single crystal growth, thin film growth and measurements under extreme conditions (low temperature, high magnetic field, and high pressure). One of our primary aims is to search for new materials that exhibit exotic topological properties,	1) Topology 2) New Materials 3) Condensed matter 4) Superconeuctor 5) Spintronics	We are planning to perform the following studies in the summer program. (1) Probing the Fermi surface of materials through quantum oscillation in their transport properties and magnetization in high fields up to 16 T and at low temperatures using the dilution and Helium-3 refrigerators. Students will learn the basics of high magnetic field and low temperature measurements, and how these conditions

		which are currently a flourishing field in condensed matter physics. Recently, a large anomalous Hall effect, which has been seen only in ferromagnet, was discovered in an antiferromagnet at room temperature in our group. This striking phenomenon indeed come from topological structure called the Weyl points in the momentum space. Such novel properties in topological magnets can be potentially useful for spintronics application such as high-density non-volatile memory devices in smartphones and computers, and energy harvesting for the internet of things.		can be utilized to study the structure of the Fermi surface of quantum materials. (2) Searching for room temperature energy harvesting materials through a combination of single crystal growth and electrical and thermal transport measurements. Students will learn how to grow single crystals using various techniques and the method for measuring their electrical and thermoelectric properties. Students may choose one of these for their program, and we will guide them accordingly.