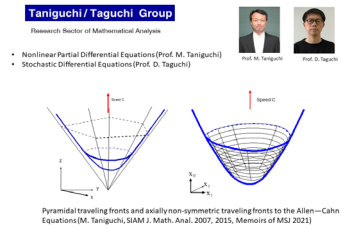
Interdisciplinary Sciences

Mathematical Analysis



Research Area “Mathematical Analysis” is devoted to theory on partial differential equations, theory of probability, functional analysis, dynamical systems and statistics.
For theory on partial differential equations, we study multi-dimensional traveling fronts appearing in reaction-diffusion models in physics, chemistry and biology. For theory of probability, we study stochastic partial differential equations and their discrete models.

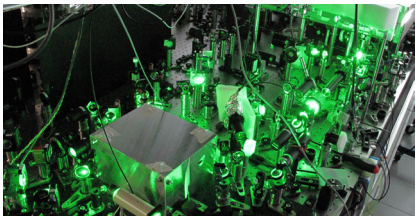
Prof. TANIGUCHI Masaharu

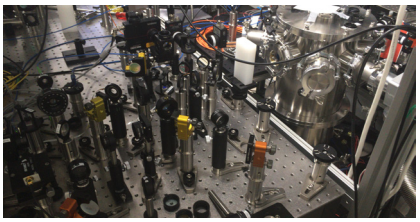
■ Research Themes
Partial differential equations/Theory of probability/Functional analysis/ Dynamical systems/Statistics

Assoc. Prof. KAWAMOTO Masaki

■ Research Themes
Partial Differential Equations/Quantum Mechanics/ Nonlinear Analysis

Extreme Quantum Physics





We are creating new research fields, e.g. innovative quantum optics using the nucleus, and a coherent quantum beam based on a novel principle and so on, aiming at future development of both fundamental and applied science.

Prof. YOSHIMURA Koji

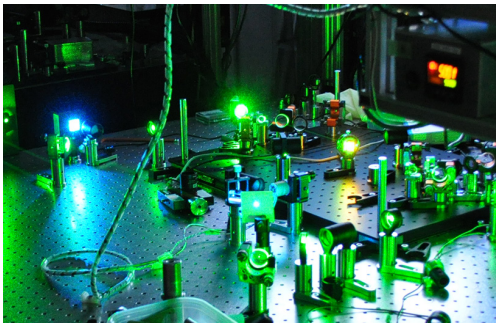
■ Research Themes
Nuclear physics/Low-energy particle physics/ Atomic physics

Assoc. Prof. YOSHIMI Akihiro

■ Research Themes
Nuclear physics/ Low-energy particle physics/ Atomic physics

Physics of Quantum Universe

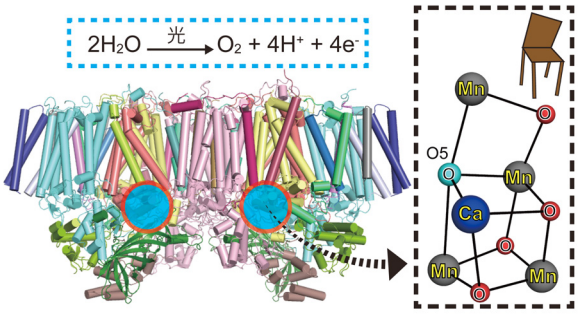
Based on knowledge and techniques developed in various fields of physics, such as particle-nuclear physics, astrophysics, and atomic, molecular, optical physics, experimental research leading to the construction of physics models beyond the new laws of fundamental physics: the particle standard theory. We are mainly carrying out table-top experiments that do not use high-energy accelerators. We have developed various key technologies such as high-performance lasers, high-performance detectors, targets with high quantum coherence, and molecular cooling techniques, and are conducting research using experimental apparatuses that are unique in the world.



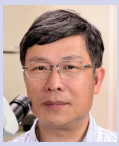
Assoc. Prof. UETAKE Satoshi

■ Research Themes
Atomic physics/Quantum optics/Particle physics

Structural Biology



Proteins are responsible for all life phenomena. We study protein structures using cryo-electron microscopy and synchrotron radiation X-rays to understand protein function better. The knowledge gained will help us to understand protein functions profoundly and to create new catalysts and technologies.



Prof. SHEN Jian-Ren
■Research Themes
Photosynthesis/Membrane proteins/Plant mineral transporter/Structural biology

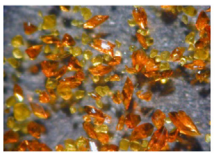
Prof. SUGA Michihiro
■Research Themes
Photosynthesis/Membrane proteins/Plant mineral transporter/Structural biology

Assoc. Prof. AKITA Fusamichi
■Research Themes
Photosynthesis/Membrane proteins/Plant mineral transporter/Structural biology

Asst. Prof. NAKAJIMA Yoshiki
■Research Themes
Photosynthesis/Membrane proteins/Plant mineral transporter/Structural biology

Asst. Prof. SAITOH Yasunori
■Research Themes
Photosynthesis/Membrane proteins/Plant mineral transporter/Structural biology

Coordination Chemistry

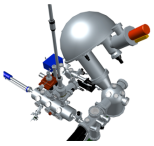


***Total* and *Absolute* Spontaneous Resolution**

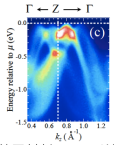
In our research group, we are studying on the synthesis of novel transition metal and lanthanoid complexes with unique molecular and crystal structures, which are expected to exhibit useful magnetic and optical properties and highly selective reactivity. In particular, we are challenging to synthesize manganese model clusters for the oxygen-evolving center in photosystem-II, metal complexes that exhibit stimuli-responsible spin-crossover or chromotropic behavior, and to elucidate the mechanism of absolute spontaneous resolution, which selectively generates optically active compounds from non-chiral sources.

Prof. SUZUKI Takayoshi
■Research Themes
Oxygen-Evolving Catalyst/ Polynuclear Complexes/ Spontaneous Resolution/ Chirality

Physics of Solid Surfaces and Interfaces



ARPES装置



熱電材料のバンド構造

Functionalities of solid materials are studied from the viewpoint of electronic states. Experimental studies of electronic states lead to elucidating the origin and/or mechanism of the functionalities and also give the strategy to improve the functionalities in materials. Advanced electron spectroscopy techniques are employed to conduct the research for electronic states in materials in detail. Researches of self-organized nanostructured thin films and development of new thin films with functionalities such as superconductivity and metal-insulator transition are performed. The physical properties of the films are investigated from the viewpoint of electronic states.

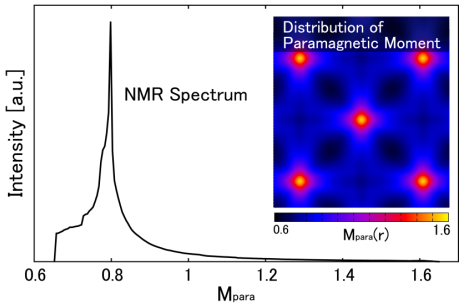
Prof. YOKOYA Takayoshi

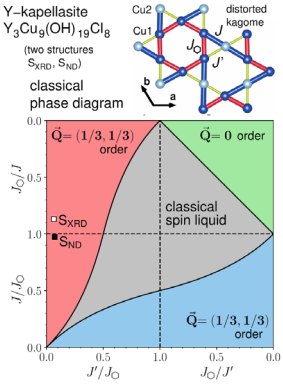
■ Research Themes
Electronic states/
photoemission spectroscopy/Elucidation of the mechanism of functionality

Assoc. Prof. MURAOKA Yuji

■ Research Themes
Thin films/Surface/Interface

Quantum Many-Body Physics





We are interested in modern problems of solid state theory and computational materials science. We focus on connecting the microscopic structure of materials to experimental measurements. The objective is to understand complex properties like magnetism and superconductivity and to discover and design new materials. Our method development aims at more precise and realistic description of materials and at making more physical quantities accessible by increasing computational efficiency.

Prof. ICHIOKA Masanori

■ Research Themes
Magnetism/Superconductivity/Solid state physics/Computational physics

Assoc. Prof. ADACHI Hiroto

■ Research Themes
Magnetism/Superconductivity/Solid state physics/Computational physics

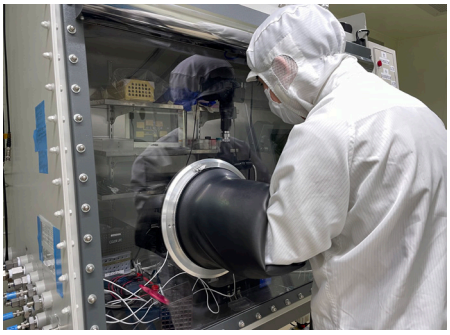
Prof. JESCHKE Harald Olaf

■ Research Themes
Magnetism/Superconductivity/Solid state physics/Computational physics

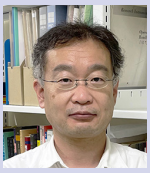
Assoc. Prof. OTSUKI Junya

■ Research Themes
Magnetism/Superconductivity/Solid state physics/Computational physics

Quantum Physics in Condensed Matter



The objective of our group is to study new functional materials and devices through chemical and physical approaches. Main research subjects are to develop superconductors with high transition temperature and novel physical properties, and to exploit new functional devices made of organic molecules, two-dimensional layered materials, and topological materials.



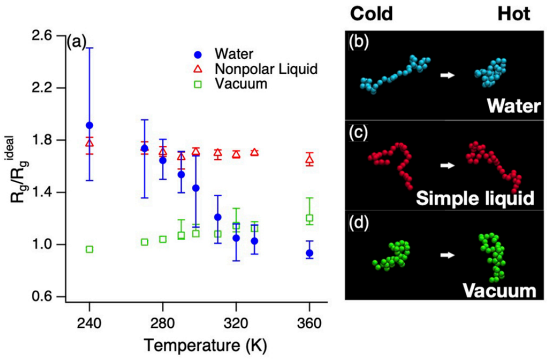
Assoc. Prof. GOTO Hidenori

■ Research Themes

Solid-state chemistry/Superconductor/ Two-dimensional layered material/ Organic FET

Theoretical Physical Chemistry

By using theoretical approaches such as statistical mechanics, thermodynamics, and molecular simulation, we are tackling a wide range of research issues related to liquids, solutions, interfaces, phase transitions, polymers, proteins, viruses, and cells. The latest research topics include solute size dependence of hydrophobic interactions, solubility of solutes, effective interactions, ion-specific effects on phase separation, structure of interfaces near the triple critical point of three-phase equilibrium systems, structural stability of proteins, co-solvent effects on proteins, and design principle of biological molecular motors and their efficiency of the free energy transduction, etc.



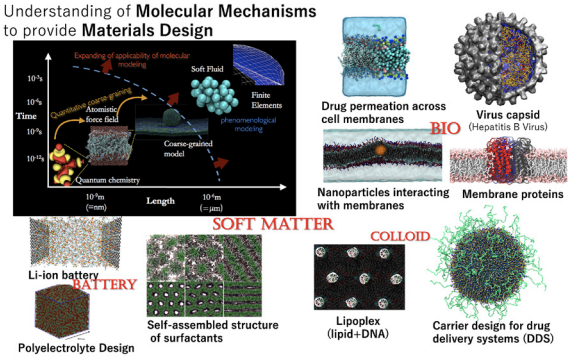
Prof. KOGA Kenichiro

■ Research Themes

Interface/Nano-confined system/ Wetting transition/Phase transition/ Solvent-induced interaction/ Hydrophobic interaction/Aqueous solution/Ion-specific effect

Theoretical and Computational Chemistry

We use molecular simulation techniques to understand and predict various functions of molecules and molecular assemblies such as lipid membranes, aiming to inform the design of new materials. In order to tackle technical issues in bio- and soft-materials, we utilize multiscale molecular modeling, ranging from sub-atomic scales of quantum mechanics, to the coarse-grained molecular level, reaching to the micron scale. By developing these simulation techniques and applying them to contemporary problems, we expand the frontiers of molecular simulations.

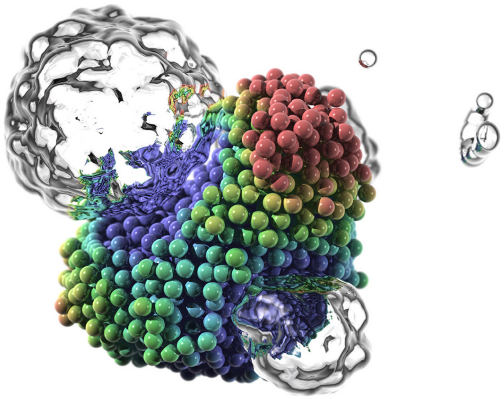


Prof. SHINODA Wataru

■ Research Themes

Computational chemistry/Molecular simulation/Biomembranes/Lipid membranes/ Biomolecular self-assembly/Soft materials

Theoretical Chemistry

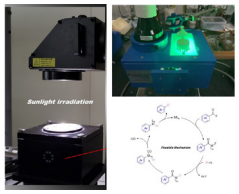


We use computer simulations and statistical mechanics theory to explore the unusual properties of water and ice.

Assoc. Prof.
MATSUMOTO Masakazu

■ Research Themes
Theoretical chemistry/Molecular dynamics/Science of water and ice

Functional Organic Chemistry



By utilizing transition metal catalysts, we can develop organometallic reagents and complexes that exhibit reactivities and selectivities distinct from those observed in classical methods. Additionally, precise control over the reactivities of both the reagents and catalysts can be achieved by fine-tuning the ligands (organic compounds) bonded to the transition metals. Our focus is on advancing the development of new carbon-carbon bond-forming reactions, capitalizing on the unique characteristics of organometallic complexes composed of metals and organic compounds. These reactions serve as a foundation for synthetic organic processes.

Prof.
NISHIHARA Yasushi

■ Research Themes
Transition metal catalysts/ Organic photovoltaics/ Organic field-effect transistors/Bond activation/Organoboron chemistry/ Organofluorine chemistry

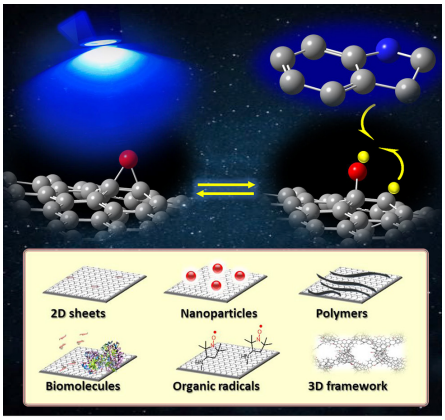
Asst. Prof.
MORI Hiroki

■ Research Themes
Transition metal catalysts/ Organic material chemistry/ Functional polymers/Organic solar cells/ Organic semiconductors/Semiconducting polymers/Heteropolycyclic aromatic compounds

Asst. Prof.
TANAKA Kenta

■ Research Themes
Synthetic organic chemistry/ Photocatalysis/Visible light/ Organophotocatalyst/Flow synthesis/ Electrosynthesis

Functional Molecular Engineering



We create materials that enrich our lives by designing, synthesizing, and evaluating functional molecules and materials. In collaboration with academia and industry both in Japan and overseas, we will develop a variety of applications, including catalysts, power storage devices, high-strength materials, biomaterials, antibacterial and antiviral materials, and environmental improvement. We aim to conduct cutting-edge research by exploring new fields and integrating different fields, without being confined to existing research fields.

Prof. NISHINA Yuta

■ Research Themes
nanomaterials/organic materials/carbon materials/biomaterials/electrochemistry/catalysis