

Interdisciplinary Science

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Mathematical Analysis



Taniguchi / Taguchi Group

Research Sector of Mathematical Analysis

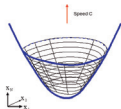
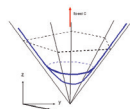
- Nonlinear Partial Differential Equations (Prof. M. Taniguchi)
- Stochastic Differential Equations (Prof. D. Taguchi)



Prof. M. Taniguchi



Prof. D. Taguchi



Pyramidal traveling fronts and axially non-symmetric traveling fronts to the Allen-Cahn Equations (M. Taniguchi, SIAM J. Math. Anal. 2007, 2015, Memoirs of MSJ 2021)

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

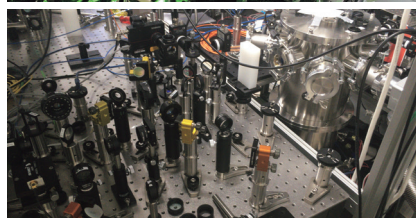
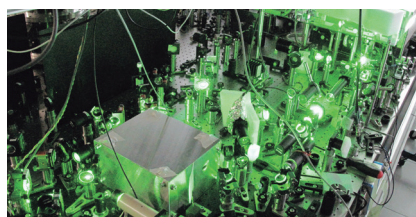
Partial differential equations/Theory of probability/Functional analysis/Dynamical systems/Statistics

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

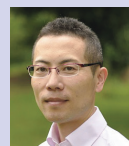
Physics of Quantum Universe



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.

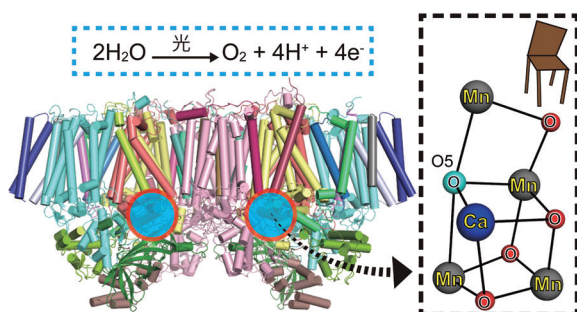


Assoc. Prof. UETAKE Satoshi

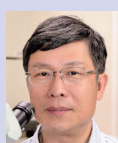
■ Research Themes

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.



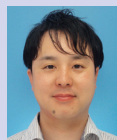
Prof. SHEN Jian-Ren
 ■ Research Themes
 Photosynthesis/Membrane proteins/Plant mineral transporter/Structural biology



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

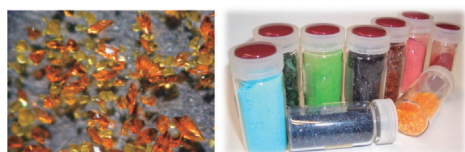
Assoc. Prof. AKITA Fusamichi
 ■ Research Themes
 Photosynthesis/Membrane proteins/Plant mineral transporter/Structural biology

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



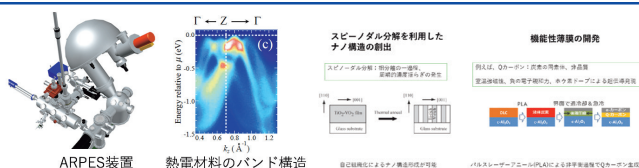
of absolute spontaneous resolution, which selectively generates optically active compounds from non-chiral sources.

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-responsive spin-crossover or chromotropic behavior, and to elucidate the mechanism



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

Physics of Solid Surfaces and Interfaces



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

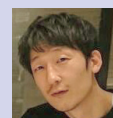
Assoc. Prof. MURAOKA Yuji



Research Themes

Thin films/Surface/Interface

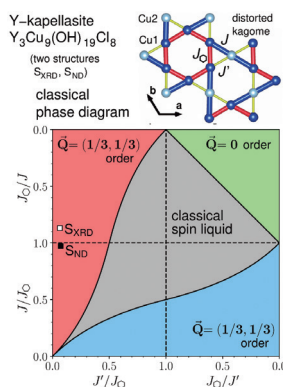
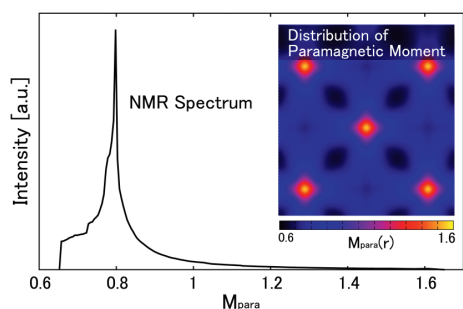
Assoc. Prof. OOTSUKI Daiki



Research Themes

Electronic Structure/Photoemission Spectroscopy/
Strongly Correlated Electron Systems/Functional Materials

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



Prof. JESCHKE Harald Olaf

Research Themes

Magnetism/Superconductivity/Solid state physics/Computational physics



Assoc. Prof. ADACHI Hiroto

Research Themes

Magnetism/Superconductivity/Solid state physics/Computational physics

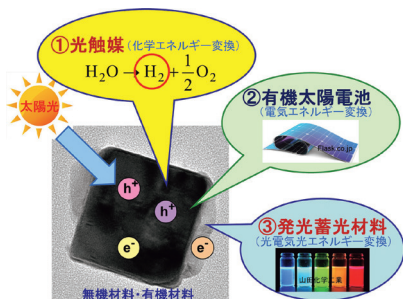


Assoc. Prof. OTSUKI Junya

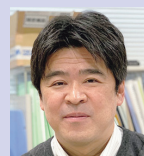
Research Themes

Magnetism/Superconductivity/Solid state physics/Computational physics

Surface Physical Chemistry



Photocatalysts have attracted considerable attention due to their potential applications for water-splitting to generate hydrogen gas by using solar energy. As H₂ is clean and free from CO₂ emissions, photocatalysts are expected to address many problems such as the energy crisis, environmental pollution, and global warming. However, the efficiency of photocatalysis is still not sufficient for industrial use; hence, further activity enhancement is required. The efficiency of photocatalysis is determined by the competition between electron-hole pair recombination and the rate of charge transfer to the reactant molecules. Therefore, we are studying the behaviors of photogenerated charge carriers to elucidate the mechanism. These researches should shed light on the development of highly efficient solar light driven water splitting photocatalysts.



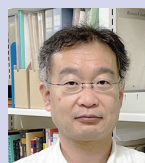
Prof. YAMAKATA Akira

■ Research Themes
 Photocatalysis/Solar cells/
 Ultrafast laser spectroscopy/
 Reaction dynamics

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.



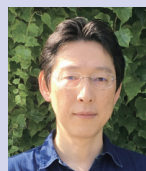
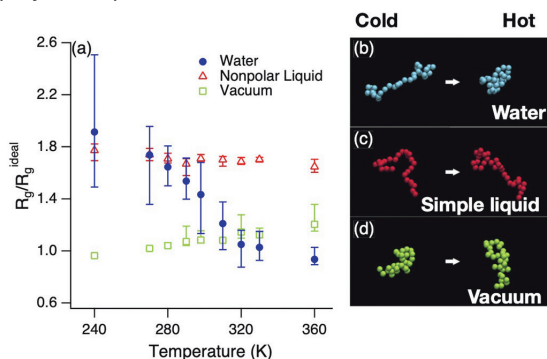
Assoc. Prof. GOTO Hidenori

■ 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

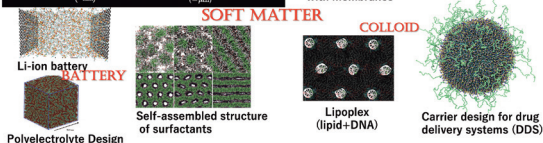
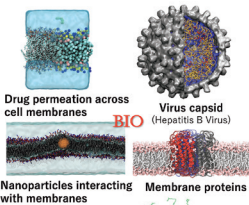
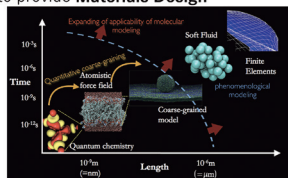
■ Research Themes
 Interface/Nano-confined system/
 Wetting transition/Phase transition/
 Solvent-induced interaction/
 Hydrophobic interaction/Aqueous
 solution/Ion-specific effect

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.

Understanding of **Molecular Mechanisms** to provide **Materials Design**

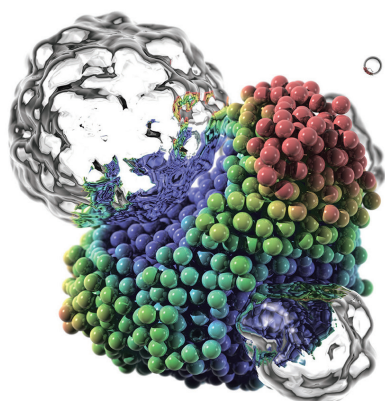


Prof. SHINODA Wataru

Research Themes

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

Theoretical Chemistry



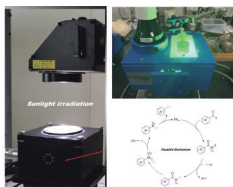
We use computer simulations and statistical mechanics theory to explore the unusual properties of water and ice.

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



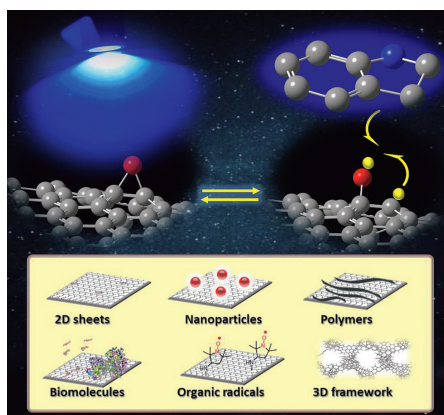
Asst. Prof. TANAKA Kenta

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