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Faculty of Science, University of Toyama

Mathematics

Physics

Chemistry

Biology

Earth Sciences

Environmental Biology and Chemistry

Mathematics

Laboratory

Research groups

Mathematical Analysis Group

We teach and research topics related to pure mathematics in geometry, algebra, and analysis. Our goal is to provide students a small taste of the world of pure mathematics, and to allow them to experience the beauty of abstract mathematics and learn how to create sound theories.
Our research topics include the following:

(1) Geometry, to explore the nature of spatial figures, and manifolds that generalize the concepts of curved lines and surfaces. (Are computers useful in sharpening our mathematical way of viewing abstract geometrical structures?)

(2) Complex function theory, to explore the nature of complex functions (functions that assign to each complex number another one). (Chaos, and fractals, with their extravagant shapes, also fall under this theory.)

(3) Number theory, to encode information into binary data, to verify transmitted data, and to authenticate Web transactions.

(4) Algebra, to explore the nature of "*groups*", "*rings*", and "*fields*" for abstractly handling addition, multiplication, and other calculations. (There is a subtle beauty to the theories behind this ancient field.)

A view of a class using a blackboard

Library of Mathematics

Mathematical Science and Informatics Group

The teachers in this group develop mathematical analyses and methods for mathematical phenomena. Our goal is to use computers to master the analysis of mathematical phenomena using mathematical methods.
Our research topics include the following:

(1) Differential equation theory, to investigate the nature of differential equation analysis. ("Differential equation" is a mathematical term used to describe various phenomena.)

(2) Modeling of mathematical phenomena and mathematical and numerical analysis of their model equations. (More complex phenomena for which model equations have only been solved numerically are also dealt with.)

(3) Probability theory, to analyze phenomena governed by chance. (Probability theory has contributed greatly to the advancement of financial theories.)

(4) Coding theory using algebraic methods. (Coding theory is critical in internet communications and will play a key role in its further development.)

(5) Fusing mathematics and systems engineering to open new possibilities in mathematics.

A class using computers

A research presentation

Chemistry

Laboratory

Research groups

Reaction and Molecular Field Chemistry Groups

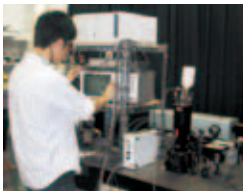
●Group 1 (Physical Chemistry)

Group 1 studies catalysts, which are important substances in the manufacture of numerous industrial chemicals. Catalysts are also widely used to eliminate pollutants, such as NOx, or mal-odors from the environment. Although catalysts are widely used, the underlying mechanisms of their activities can be complicated and varied. Our major interests lie in conducting both theoretical and experimental basic research to acquire a more thorough understanding of these catalytic interactions.

Determining the quantity of adsorbents on the surfaces of catalysts

●Group 2 (Photochemistry)

Group 2 researches the photophysical properties and photochemical reactions of luminescent transition-metal complexes with potential applications in organic light-emitting diodes and solar cells. Basic research into the photophysics and photochemistry of these complexes will lead to the development of new photofunctional compounds.



Measuring photoluminescence lifetimes at low temperatures

●Group 3 (Inorganic/Analytical Chemistry)

Strong laser irradiation can drive molecules in solution to an extremely hot (nonequilibrium) state so rapidly that the molecules can exhibit unusual, exotic properties. We combine methods of solution chemistry (thermodynamics) and photochemistry (lasers) to explore the structures and reactivities of such solutes, ions, and molecular assemblies, with a focus on their potential applications in medicine, therapy, and optical devices.

Synthesizing a complex compound

●Group 4 (Coordination Chemistry)

Coordination compounds, being composed of metal ions and organic/inorganic ligands, have huge diversity and potential. In this laboratory, coordination compounds with novel structures and properties are being prepared. Our interests are divided into three areas:

1. emissive coordination complexes;
2. multinuclear complexes that respond to external stimuli; and
3. functional complexes, inspired by renewable energy conversion in nature, which exhibit catalytic activity toward the reduction of CO_2, O_2, and N_2.

Synthesis of luminescent metal complexes

Synthetic Organic Chemistry Groups

●Group 1 (Organic Chemistry)

Group 1 synthesizes numerous compounds with new, hitherto unknown properties, and then investigates the intricacies of their structures. Some of the compounds we have created include fragrant compounds and emerald crystals. The nature of such compounds and their molecular structure are intimately related. Currently, we are developing compounds that are highly responsive to heat, light, and magnetic fields.

Synthesizing functional compounds

●Group 2 (Natural Products Chemistry)

Numerous bioactive organic compounds occur in nature, many of which possess complex structures with large numbers of asymmetrical carbon atoms. Group 2 is developing useful reactions for the synthesis of such complex-structured organic compounds, and is applying these compounds to the synthesis of bioactive natural products.

Synthesizing natural products

●Group 3 (Biofunctional Chemistry)

RNAs play versatile roles in biological systems because they not only serve as a genetic material but also act as functional molecules. Group 3 studies the molecular basis of naturally occurring RNAs with catalytic and receptor functions. Another interest of our group lies in the artificial generation of RNAs with desirable functions through rational and evolutional approaches.

3D structures of RNAs with catalytic and receptor functions

Biology

Laboratory

Research groups

Structural Biology Group

Biology is not constant; it changes with time. Part of that change is morphogenesis, which we can observe within individuals, and a longer process called phylogeny. However, biology is not just about describing processes. A major theme of biology is the search for explanations of why evolution happens and by what mechanisms. We comprehensively research these facets and strive to understand the diversity of all living things. The professors here are experts in plant and animal morphology, embryology, taxonomy, and phylogenetic systematics. Thus, the study of phylogenetic systems is one of the most distinctive research areas of this group. However, our research is not limited to just these topics; you will find professors who investigate plant chromosomes and research the various shapes and structures of insects, systems in marine life, and the phylogenetic relationships and evolution of animals using genetic information. As we enter the 21st century amid the concerns of massive animal extinctions caused by human activities, a proper understanding of animal diversity is becoming essential. Students and staff in the Structural Biology Group work intently around the clock to study the diversity of life.

Field study in zoology

Laboratory in structural biology

Graduation thesis presentation

Regulatory Biology Group

We humans, as well as many plants and animals, come from one fertilized egg and grow into multicellular organisms with a defined shape or form. The cells that make up an individual plant or animal differentiate into various types and play specific roles. We research, from various angles, how these diverse cells cooperate and come together to create an individual organism. Our professors of botany work to elucidate the mechanism of plant growth at the cellular and genetic levels; the regulatory mechanism of gene expression related to photosynthesis and fatty acid synthesis; and the genes related to the differentiation of leaves, roots, and other organs. The professors of zoology use morphological, physiological, and molecular biological methods to research various control mechanisms related to environmental conditions such as light, internal clock and sleep control mechanisms, various regulatory mechanisms related to water and electrolyte metabolism, and the role of neuropeptides in hormonal behavior. Here in the 21st century—the age of life sciences—we need to better understand various biological phenomena. Toward this end, we, together with our students, are all actively engaged in educational and research activities.

Laboratory in regulatory biology

Field studies in marine biology

Introductory seminar on biology

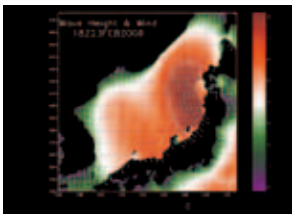
Earth Sciences

Laboratory

Research groups

Geosphere Physics Group

We research primarily three subjects: The first subject is "geomagnetism," which is generated by the Earth's core and is constantly changing in direction and strength. We use remanent magnetization ("petrified geomagnetism") recorded in rocks and sediment, as well as observations, to research these geomagnetic fluctuations. We are also investigating plate movement, environmental changes, ore genesis and their archaeological applications. The second subject is "glaciology." Our research interests are diverse and range from basic research into the physical properties and growth of snow and ice crystals to research into information related to atmospheric and environmental changes stored in accumulated snow. One particular feature is our research into the snow cover and snowy ravines of the northern Japanese Alps by making use of the regional characteristics of Toyama. The third area involves oceanic phenomena. We are analyzing ocean observational data and performing numerical simulations to clarify the structure and variability of the seas around Japan, such as Toyama Bay and the Japan Sea, to help solve global environmental problems.

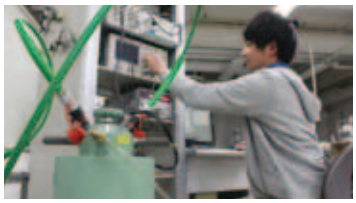


Results of a computer simulation of "Yorimawari waves".

Examining snow cover on Tateyama's Murodo Plateau.

Geodynamics Group

From deep within the Earth to the skies above us, we are studying ongoing dynamic phenomena of our planet. For understanding of earthquakes and plate motions, we are conducting surveys of active faults, GPS observations of crustal movements, and experimental studies on physical properties of rocks. We are also conducting marine observations, such as coastal gravity measurements utilizing airplanes and ships, and seabed surveys by submersible vehicles. Using global meteorological observation networks and climate models, we are exploring the mechanisms behind changes in monsoon circulations and extraordinary weather phenomena. We are also working to unlock the global warming problem using cloud and aerosol observations.



Experimental studies with high pressure apparatuses in a Geodynamics laboratory.

Measurements of aerosol and cloud optical properties at the Mt. Tateyama.

Geological Science Group

We research the evolution of the interior and surface environments of the Earth (Earth history) using clues in the rocks, minerals, strata, and fossils on the Earth's surface. We can observe on the Earth's surface fragments of mantle and a 4-billion-year-old continent; some rocks even carry information related to the Earth's core. By studying strata and fossils, we can reconstruct plate movements and environmental and biospherical changes of the past. Furthermore, past volcanic ejecta hold the key to predicting future eruptions. Attaching great importance to fieldwork, we aim to cultivate the ability of students to collect voluminous data and ideas from the outdoors. The ability to conduct proper fieldwork cannot be cultivated in physics, chemistry, or other disciplinary fields, and we hope it will greatly help you in your future career.

Geological survey into the summit crater of Nantai Volcano.

A scene from a geological survey in Mongolia.

Environmental Biology and Chemistry

Laboratory

Research groups

Environmental and Analytical Chemistry Group

As human activity continues to expand and diversify, the chemical substances from such activities have caused various environmental problems such as global warming and water and air pollution which require urgent attention.

The Environmental and Analytical Chemistry Group takes a chemical approach in order to clarify and solve environmental problems. For example, we are developing simple and rapid analytical methods to measure harmful components related to environmental pollution in the biosphere and are using these methods to survey the environmental water collected from rivers, lakes, seas (e.g., Toyama Bay), and ground water, as well as bottom sediment, soil, and air. We study the dynamics of these components, and on the basis of our findings, perform basic research into the removal and degradation of highly toxic components in waste water. Furthermore, we are investigating ways to elucidate the origins of and changes in substances deeply connected to the global environment, the distribution and cycling of these substances on the Earth's surface, and the mechanisms underlying their origin and distribution. Our indices include rainwater, river water, groundwater, seawater, gasses, and other components, trace components, and isotopes.

Collecting water from Toyama Bay

River flow measurement

Determination of anionic surfactants

Environmental Biology Group

The first life is believed to have appeared over a geologically brief period some 3.5 billion years ago. Since then, organisms have had an enormous effect on the formation of the Earth's environment; however, more to the point, the organisms themselves have adapted to their environment and evolved an exquisite system for living.

The Environmental Biology Group conducts a broad range of research on the mechanisms underlying biofunctions, from the cellular level to the ecosystem level, to deepen our understanding of interactions between organisms and the environment. Examples of our research include the following:

1. Elucidation of tolerance mechanisms to environmental stress in higher plants.
2. Methods of evaluating and reclaiming polluted water in the environment using microorganisms.
3. The relationship between plants and insect pollinators.
4. The effects of global environmental changes on alpine vegetation in the Tateyama Mountains.

We are also making strides in our research into the conservation of wild organisms, such as mammals and parasites.

Dissection of a wild animal (Raccoon Dog)

Plant survey on Satoyama

Field trip to the Tateyama Mountains

Physics

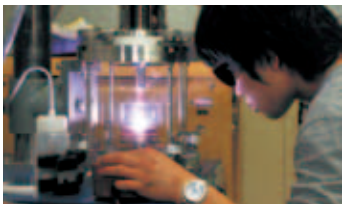
Laboratory

Research groups

Solid-State Physics Group

●Solid-State Physics Research Group

The work of our group is centered on the physics of intermetallic compounds of rare-earth and actinide elements. We use a variety of sample growth techniques to prepare high-quality single crystals, and are able to measure electrical resistivity, magnetization, specific heat, thermal expansion, and thermoelectric power at low temperatures, in high magnetic fields, and under high pressures. Our current research focuses on (1) remarkable magnetically ordered states, (2) anomalous behavior in the vicinity of a quantum critical point, (3) exotic superconductivity, and (4) multipolar ordering in strongly correlated *f*-electron systems. Our ultimate goal is to discover new materials with novel physical properties and to contribute to the welfare of humanity through their practical application.



Preparation of rare-earth compounds in an arc furnace

●Crystal Physics Research Group

All mater is made of atoms. The differences in their arrangements and interatomic bonds give matter its various fascinating properties. We analyze atomic-level structures and measure the various properties of condensed matter, and investigate the relationships between the microscopic structures and properties of matter. We use X-rays and synchrotron radiation in our structural analyses and measure electrical and optical properties under various conditions. Come explore the world of nano-space with us!

A graduate student demonstrating the use of vacuum deposition equipment

Quantum Physics Group

●Theoretical Physics Research Group

In what form does ultimate matter exist, and how does it react? What theories are needed to describe the world of elementary particles? How did the universe come into existence, and how will it continue to expand?

We engage these and similar questions head-on. We conduct theoretical research to investigate the deepest mysteries of nature by using the full power of our brains and computers. We use observations based on keen physical intuition in conjunction with advanced mathematics and calculations performed on computers.

A physics seminar

●Microwave and Laser Research Group

We use electromagnetic waves—from microwaves to laser light—to research physical phenomena of the microscopic world, including molecules in a gaseous state and atomic and molecular ions trapped in enclosed spaces. In particular, we are closely investigating molecular structures and interactions between atoms and molecules and how they absorb and emit light.

This knowledge of atoms, molecules, and light will not only deepen our understanding of matter, but will also be useful in our search to understand what molecules exist, and in what state, in the universe tens of thousands of light years away.

A spectral measurement experiment using microwaves

For all those who wish to be a part of Faculty of Science

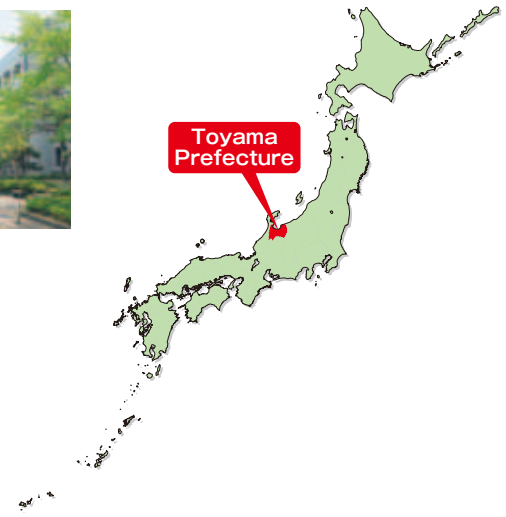
Our Faculty of Science is a prestigious institution where students learn nobility, culture, and academics. They receive a well-rounded education through interactions with professors and friends, and cultivate intellectual, moral, and applied skills that they will need later in life.

Our faculty comprises six departments: Mathematics, Physics, Chemistry, Biology, Earth Sciences, and Environmental Biology and Chemistry. The professors, undergraduates, and graduates in each department work together in various research fields to elucidate the mechanisms of nature. We also conduct research into the application of the principles and laws of nature, as well as into local and global environmental problems. The ability of "science" to add to the vast wealth of our knowledge is truly fascinating and creates the foundation for today's technology.

Our faculty develops students into skilled professionals who can apply what they have learned to identify and solve problems with a broad field of view. Besides our advanced specialized subjects, our faculty offers fundamental subjects that span all scientific fields. Students can also take specialized courses in other departments. Foreign professors conduct workshops on scientific English and foreign languages as well as overseas foreign language study programs to give students an advantage on the international stage. Our faculty places great emphasis on small class sizes and interactive education, providing extensive one-on-one guidance for graduate thesis research—the culmination of four years. We are working tirelessly toward education reform, with every professor here striving to produce active scientific professionals.

Our faculty is located in the midst of Toyama's spectacular nature, a 4000m stretch from the Tateyama Mountains to Toyama Bay. Our location is ideal for studying science.

We have completed the expansion and renovation of the faculty buildings, thereby improving our ability to provide a fulfilling education. We truly hope that you enjoy studying science here and perfect your scientific skills. We are looking forward to welcoming you to our faculty.



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