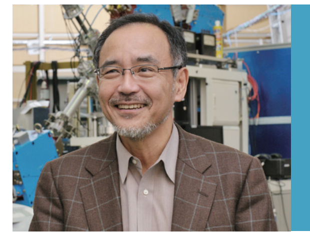
At ASI, scientists are engaged in research born of the individual's creative ideas as well as integrated, collaborative research that transcends disciplinary, organizational and national boundaries. This vigorous activity is giving birth to new research seeds and whole new research fields. The following is just a small sampling.



Atomic Physics Laboratory

Distinguished Senior Scientist

Yasunori Yamazaki

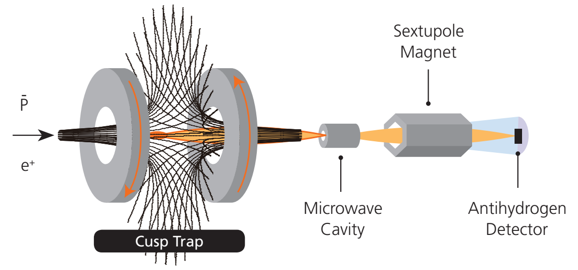
Why is there only matter in the universe? Creating very low-temperature antihydrogen and examining its properties sheds some light on the mystery

It is believed that matter and antimatter were produced in equal amounts when the universe was born 13.7 billion years ago. However, the universe now contains only matter. In the Atomic Physics Laboratory, researchers have succeeded in creating antihydrogen. By analysing this antihydrogen, they hope to understand why the antimatter disappeared.

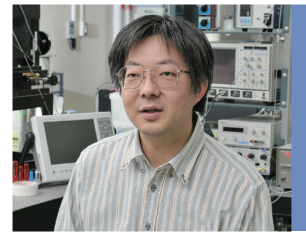
The team has created very low-temperature antihydrogen by mixing antiprotons and positrons gently in a magnetic bottle. They now plan to investigate the antihydrogen's properties by irradiating it with a laser and examining it through spectroscopy. They have also succeeded in making low-temperature antihydrogen efficiently by using a unique device, a cusp trap, with special electric and magnetic fields. They are preparing to create an antihydrogen beam and examine it through microwave spectroscopy.

If a difference between hydrogen and antihydrogen is found, the Standard Model, the entire foundation of physics, should be reconsidered.

The lab has also developed a proprietary microbeam technique using a tapered glass tube, enabling pinpoint radiation at an arbitrary point in a living cell. This has attracted attention as an approach for studying the effects of radiation on various parts of the cell.



▲ Antiprotons are united with positrons near the center of the cusp trap and very low-temperature antihydrogen atoms are synthesized for study using in microwave spectroscopy.



Terahertz Quantum Device Team

Team Leader

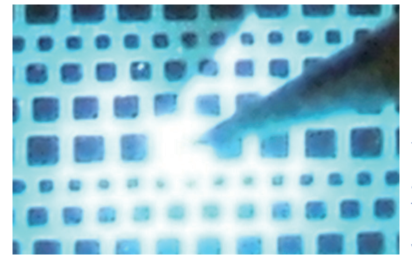
Hideki Hirayama

Deep-UV LED promises varied applications, including sterilization, cleaning of water, degradation of pollutants

With their low power consumption and durability, the use of LEDs for lighting is spreading rapidly. Now attention is focused on short-wavelength ultraviolet light. Deep-UV light of wavelengths 220~350nm has a bactericidal effect. If small, highly efficient and long lasting deep-UV LEDs can be developed, they could have applications in water purifiers, air cleaners, pollution treatment and medicine. The race to develop them is intense, and the front-runner in this competition is the Terahertz Quantum Device Team.

An LED's performance is determined by external quantum efficiency calculated by multiplying internal quantum efficiency, electron injection efficiency and light extraction efficiency, and output. The team has developed a new crystal growth method that has improved internal quantum efficiency to 80% from the previous less than 1%. In addition, electron injection efficiency rose to 80% from 20% through the use of a multiquantum barrier, and light extraction efficiency improved to 12% from 8% with a highly reflective electrode. External quantum efficiency at 270nm is 3.8% and output is 30 mW or more, both of these world-leading figures. The team is working to achieve a light extraction efficiency of 50% and an external quantum efficiency of 30%.

The team is also working on semiconductor lasers that emit long-wavelength terahertz light. If semiconductors that emit extreme wavelengths can be found, they are sure to impact both light science and industry.



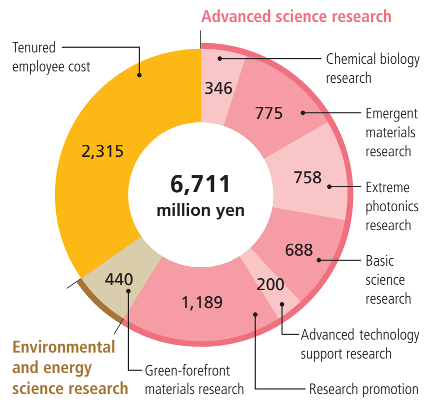
◀ In this deep-UV LED, UV and visible light are being emitted at the same time; the UV is invisible and the visible light is blue.

Budget Personnel

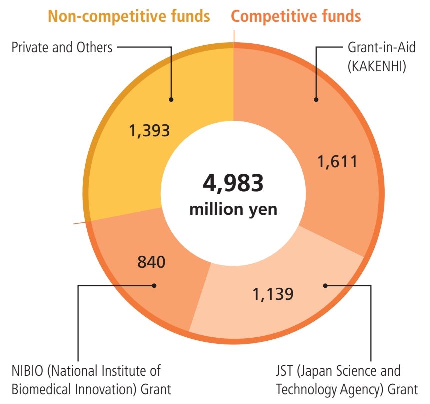
Budget ASI's budget revenue comes from government subsidies for operating costs and external funding such as grants-in-aid. While government subsidies total around 6.7 billion yen (FY 2011), external funds account for a significant portion at roughly 5 billion yen (FY 2010). Research initiated with the creative ideas of individual researchers is primarily paid for with external funding.

Personnel ASI has about 700 fulltime scientists conducting research. This is roughly 24% of the total number of fulltime RIKEN staff and makes ASI the largest organization within RIKEN in terms of manpower. The number increases to about 2,000 when visiting scientists, assistants and students are included.

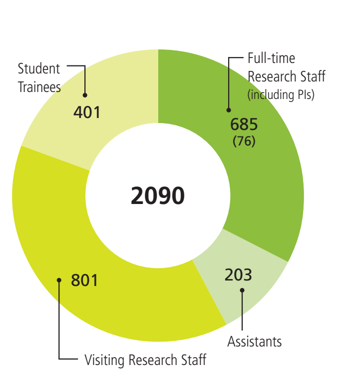
Funding from the government (FY2011)



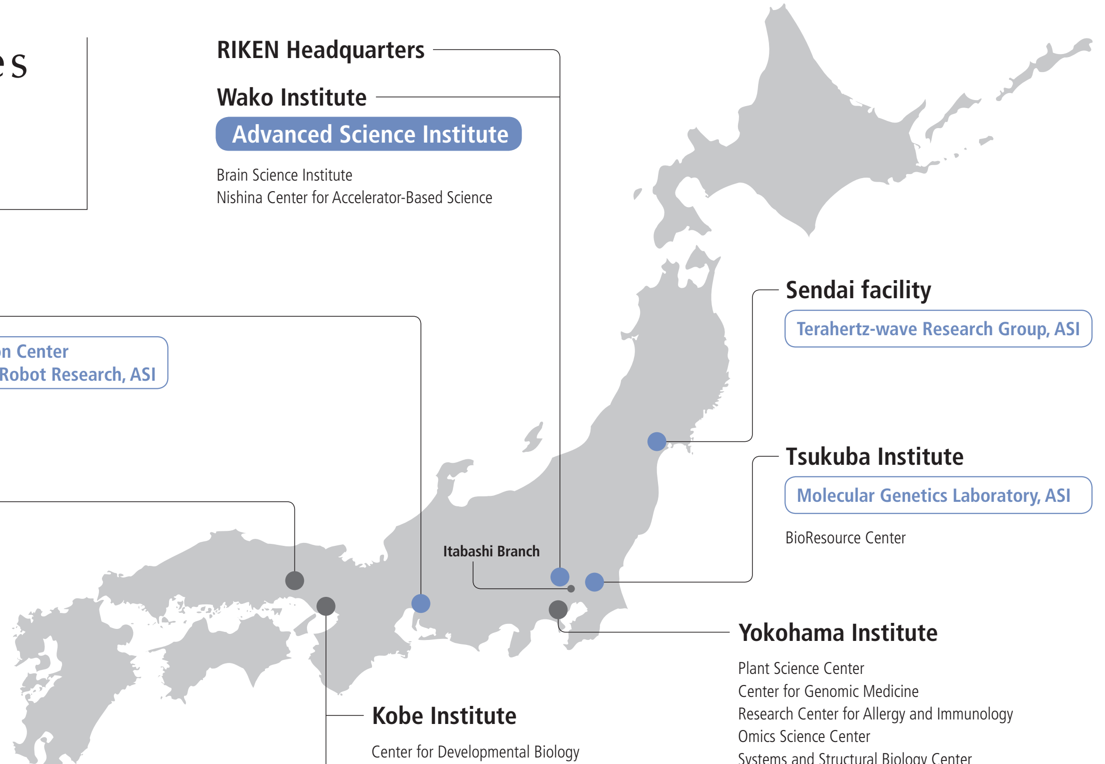
External budget (FY2010)



Personnel (as of April 1, 2011)



Facilities



RIKEN Headquarters

Wako Institute
Advanced Science Institute
Brain Science Institute
Nishina Center for Accelerator-Based Science

Nagoya facility
RIKEN-TRI Collaboration Center for Human-Interactive Robot Research, ASI

Sendai facility
Terahertz-wave Research Group, ASI

Tsukuba Institute
Molecular Genetics Laboratory, ASI
BioResource Center

Harima Institute
SPring-8 Center

Yokohama Institute
Plant Science Center
Center for Genomic Medicine
Research Center for Allergy and Immunology
Omics Science Center
Systems and Structural Biology Center
Bioinformatics And Systems Engineering division
Center of Research Network for Infectious Diseases

Kobe Institute
Center for Developmental Biology
Center for Molecular Imaging Science
Quantitative Biology Center
HPCI Program for Computational Life Sciences

Research Cluster for Innovation
Innovation Center
Program for Drug Discovery and Medical Technology Platforms
Biomass Engineering Program
Computational Science Research Program

Advanced Institute for Computational Science

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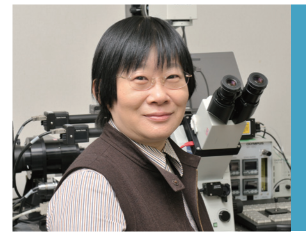
October 2011 No.2

RIKEN

Advanced Science Institute

http://www.asi.riken.jp/

Research covering all of the natural sciences and transcending disciplinary, organizational and national boundaries



Cellular Dynamics Laboratory

Chief Scientist

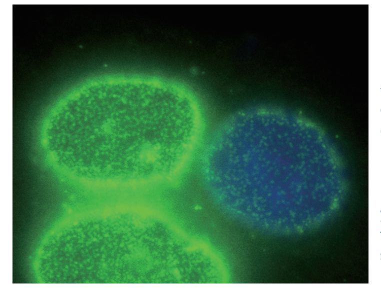
Naoko Imamoto

Revealing a mechanism of nuclear pore complex formation to better understand the regulation of nuclear functions

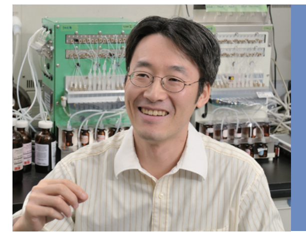
The nuclei of cells, which contain an organism's genetic information, are the targets of the Cellular Dynamics Laboratory. The surface of a cell nucleus has about 3,000 pores each about 100nm in diameter. Various molecules such as RNAs, proteins and ions migrate between the nucleus and cytoplasm through these pores, each of which consists of large protein complexes assembled from various proteins. While the molecular components and the structures of nuclear pore complexes are understood in detail, just how these nuclear pore complexes form on the nuclear surface remains a mystery.

In the lab, researchers are solving this mystery with experimental techniques they developed to allow them to visualize the formation of the nuclear pore complex. They found that the formation of nuclear pore complexes initiate when cyclin-dependent kinases (CDKs), cell cycle engines, send signals for the processes to begin. Collaboration with other research groups contributed to this research, including image processing technologies developed by the RIKEN Innovation Center's VCAD System Research Program, and cryo-scanning electron microscopy techniques developed by the Brain Science Institute's Support Unit for Neuromorphological Analysis.

The lab is now exploring the target molecules of CDKs. Revealing this will greatly advance understanding of the mechanism of nuclear pore complex formation.



◀ The nuclei of an acceptor cell (blue: histone) and a donor cell (yellow: nuclear pore complexes) in a heterokaryon obtained by the cell-fusion method; yellow spots appearing on the acceptor cell nucleus show newly formed nuclear pore complexes.



Nucleic Acid Chemistry Laboratory

Associate Chief Scientist

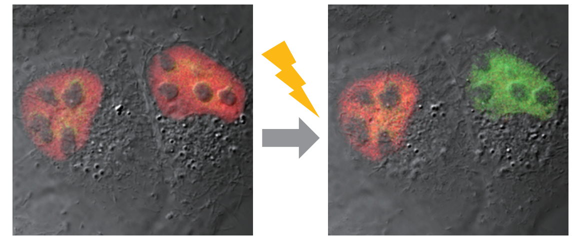
Akimitsu Okamoto

Using chemicals to examine changing DNA, RNA has promise in medical industry

The Nucleic Acid Chemistry Laboratory develops technologies for real-time visualization of DNA and RNA in living cells. One is based on the photochemical phenomenon known as exciton interaction. Artificial DNA with complementary base sequences, which bind to the RNA to be investigated, arrange two fluorescent dyes in parallel layers. When the artificial DNA meets the target RNA and binds to it, the fluorescent dyes separate and light up. Around twenty colors of fluorescent dyes have been developed, making it possible to track several RNA changes simultaneously. This technology is already being used with the SmartAmp2 method developed by the RIKEN's Omics Science Center, which allows detection of differences in a single nucleotide in a DNA molecule.

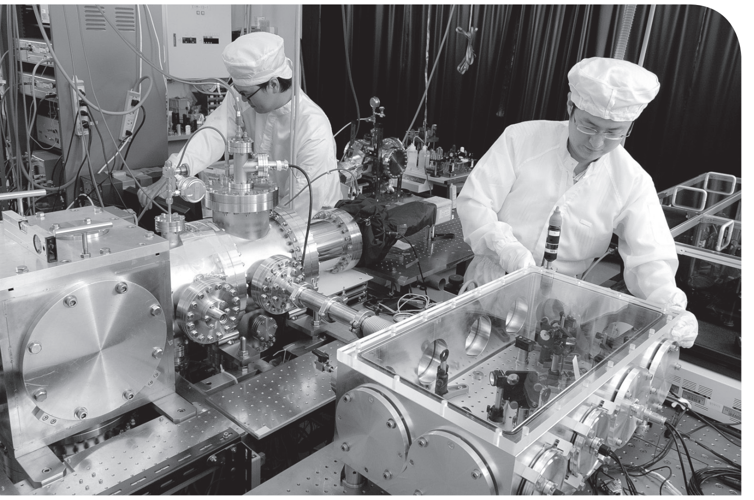
Another technique is the ICON method, also developed by the lab. When a methyl group sticks to a cytosine base, DNA expression is suppressed; the location and amount of abnormal DNA methylation are factors in the development of cancer and in aging. Finding one methyl group among more than 60 billion bases in a DNA molecule is difficult, but using osmium as an adhesive between the artificial DNA and the target area makes it possible.

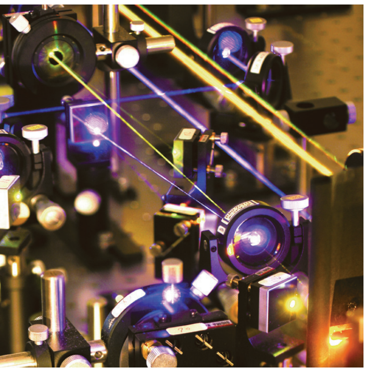
Combining organic chemistry, photochemistry and biology, the lab establishes easy-to-use technologies to visualize RNA as it changes.



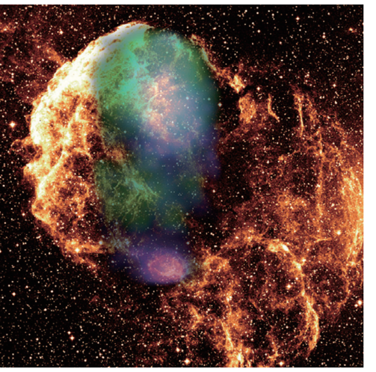
▲ Artificial DNA marked with red in cervical cancer cell nuclei turns green under a red laser (the cell on the right).

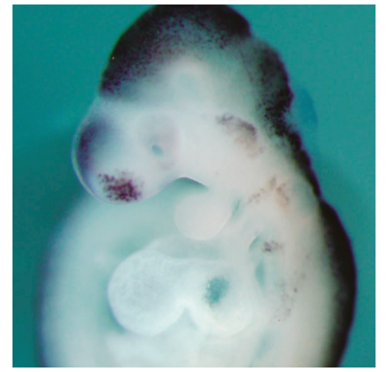
The RIKEN Advanced Science Institute, the Source of RIKEN's Vitality





The Source of RIKEN's Vitality





RIKEN is Japan's only fully comprehensive research institution for the natural sciences.

Since its establishment as the RIKEN Foundation in 1917, we have been active for more than 90 years in a multitude of fields encompassing physics, engineering, chemistry, and life and medical sciences, ranging from basic research to practical application.

RIKEN has three missions: Building the foundations for new technologies, expanding the frontiers of human knowledge, and applying its knowledge toward applications having practical and societal value. To achieve these objectives, there is close collaboration among three groups within RIKEN. The first is a core group consisting of departments and laboratories of the RIKEN Advanced Science Institute (ASI) where novel fields of research are being developed to accelerate progress in science and technology. Next are the strategic research centers that promote high priority projects of national or societal importance, and finally the research infrastructure centers that maintain and manage world-class facilities and equipment.

Cultivating new research seeds

New seeds with the potential to grow into new fields of research are constantly being created. A very important task is deciding which seeds to cultivate and deciding which of them have the potential to develop into strategic fields of research of national as well as scientific and technological importance. ASI has the systems in place for determining in a bottom-up fashion which laboratory developments should be cultivated into new collaborative projects in research centers, interdisciplinary research projects. It is the researchers themselves who decide which research seeds should be developed into full-fledged research departments. And because they are at the forefront of science, their appraisal is rigorous and the rate of success is high.

Discovering new research seeds

Throughout its history RIKEN has been lauded as "a paradise for scientists," a place where individual creativity is actively encouraged, leading to a wide range of important achievements. ASI has inherited this tradition and as such is viewed as the core of RIKEN. In the ASI's Chief Scientist laboratories, scientists continue to work in diverse areas of basic research to produce new seeds of research, applying their creative ideas without being constrained by conventional boundaries of discipline.

ASI is RIKEN's core organization.

The strategic research centers and the research infrastructure centers have names that indicate their focus, such as brain science, plant science, developmental biology, accelerator science, bioresources, and the like. The name of the RIKEN Advanced Science Institute or ASI, on the other hand, is not so self-evident. This is because ASI is the only research organization within RIKEN that engages in diverse basic research covering all disciplines of the natural sciences to cultivate new research seeds and foster their development into new research areas and later into new research centers.

Bringing research seeds to bloom as new research cores

The ASI's research groups and teams have novel names with special terms such as cross-correlated materials and extreme photonics. These names represent new research domains that have been carefully cultivated from the seeds of basic research. For example, RIKEN Brain Science Institute is the result of just such a project in leading-edge research that was spun off from what was formerly known as the Frontier Research System to become an independent center. Likewise, a number of former Chief Scientist laboratories have evolved over time into the RIKEN Plant Science Center, the RIKEN Nishina Center for Accelerator-Based Science and numerous other strategic research centers and research infrastructure centers. ASI has been charged with continuing this trend by developing more strategic research centers and research infrastructure centers that may later grow into new research cores of global scientific endeavor.

Transcending disciplinary, organizational and national boundaries

Integrated collaborative endeavors among different fields of research are indispensable in nurturing the tiny seeds of individual research so that they will blossom into new research domains. There are no national borders in science. ASI takes full advantage of RIKEN's resources as a comprehensive research institution not only to develop strategic research centers and research infrastructure centers within RIKEN, but also to promote collaborations with both domestic and international centers of research, as well as universities and corporations, to carry out large-scale research reaching across diverse fields.

The source of RIKEN's vitality

RIKEN conducts research in nearly every field of the natural sciences, and it is ASI that makes possible such great variation on such a broad scale. ASI is truly the source of RIKEN's vitality. ASI is also central to RIKEN's contributions to the crafting of national science and technology policy. Finally, as RIKEN's core institute, ASI works vigorously to encourage the free global exchange of researchers and thereby secure RIKEN's place in the international scientific community.

Organization

RIKEN

Strategic Research Centers

- Brain Science Institute
- Plant Science Center
- Center for Genomic Medicine
- Research Center for Allergy and Immunology
- Center for Developmental Biology
- Center for Molecular Imaging Science
- Quantitative Biology Center

Advanced Science Institute
Kohei Tamao, Director

Research Infrastructure Centers

- Nishina Center for Accelerator-Based Science
- BioResource Center
- SPring-8 Center
- Omics Science Center
- Systems and Structural Biology Center
- Advanced Institute for Computational Science

Research Departments are pursuing strategic research projects to foster the development of new research seeds.

Departments

Chemical Biology Department	Hiroyuki Osada
● Chemical Biology Core Facility	**Hiroyuki Osada**
Collaboration Promotion Team	Tamio Saito
Cheminformatics and Compound Creation Team	Shunji Takahashi
Chemical Library Validation Team	Nobumoto Watanabe
Molecular Characterization Team	Hiroyuki Koshino
Biomolecular Characterization Team	Naoshi Dohmae
Chemical Bank Unit for Drug Discovery Platform	Tamio Saito
RIKEN-KRIBB Joint Research Team	Hiroyuki Osada
RIKEN-USM Joint Research Team	Hiroyuki Osada
● Chemical Genomics Research Group	**Minoru Yoshida**
Molecular Ligand Discovery Research Team	Minoru Yoshida
Molecular Ligand Synthesis Research Team	Mikiko Sodeoka
Molecular Ligand Target Research Team	Charles M. Boone
Molecular Ligand Biology Research Team	Soichi Kojima
Seed Compounds Exploratory Unit for Drug Discovery Platform	Minoru Yoshida
● Systems Glycobiology Research Group	**Naoyuki Taniguchi**
Disease Glycomics Team	Naoyuki Taniguchi
Glycometabolome Team	Tadashi Suzuki
Structural Glycobiology Team	Yoshiki Yamaguchi
Glycan Recognition Team	Takashi Angata
● RIKEN-Max Planck Joint Research Center	**Hiroyuki Osada**
Bioprobe Application Team	Hiroyuki Osada
Disease Glycoprobe Team	Naoyuki Taniguchi

Emergent Materials Department	Yoshinori Tokura
● Nano-scale Science & Technology Research Group	**Mizuo Maeda**
Electronic Functions at Nano-scale Level Research Team	Yousoo Kim
Nano-functional Photonics Research Team	Satoshi Kawata
Functional Nano-spin Research Team	Koji Ishibashi
Nano Bio-functional Molecular Systems Research Team	Mizuo Maeda
● Single Quantum Dynamics Research Group	**Akira Tonomura**
Digital Materials Team	Franco Nori
Macroscopic Quantum Coherence Team	Jaw-Shen Tsai
Quantum Nano-Scale Magnetics Team	Yoshichika Otani
Quantum Phenomena Observation Technology Team	Akira Tonomura
● Cross-Correlated Materials Research Group	**Yoshinori Tokura**
Theoretical Design Team	Naoto Nagaosa
Functional Superstructure Team	Masashi Kawasaki
Exploratory Materials Team	Yasujiro Taguchi
● Nanoscience Joint Laboratory	**Hidenori Takagi**
Nanoscience Development and Support Team	Hikota Akimoto

Green-forefront Materials Department	Kohei Tamao
● Complex Electrons and Functional Materials Research Group	**Hidenori Takagi**
Inorganic Complex Electron Systems Research Team	Hidenori Takagi
Organic Complex Electron Systems Research Team	Reizo Kato
Nano-structured Complex Electron Systems Research Team	Yousoo Kim
● Functional Soft Matter Research Group	**Takuzo Aida**
Energy Conversion Research Team	Takanori Fukushima
Bioinspired Material Research Team	Yasuhiro Ishida
Photoelectric Conversion Research Team	Takuzo Aida
● Advanced Synthesis Research Group	**Zhaomin Hou**
Advanced Catalyst Research Team	Zhaomin Hou
Advanced Elements Chemistry Research Team	Masanobu Uchiyama
Green Nanocatalysis Research Team	Yasuhiro Uozumi

Extreme Photonics Department	Katsumi Midorikawa
● Extreme Photonics Research Group	**Katsumi Midorikawa**
Intense Attosecond Pulse Research Team	Katsumi Midorikawa
Live Cell Molecular Imaging Research Team	Akihiko Nakano
Ultrafast Molecular Manipulation Research Team	Tahei Tahara
Near-field NanoPhotonics Research Team	Satoshi Kawata
Molecular Reaction Dynamics Research Team	Toshinori Suzuki
● Terahertz-wave Research Group	**Katsumi Midorikawa**
Tera-photonics Team	Hiroaki Minamide
Terahertz Sensing and Imaging Team	Chiko Otani
Terahertz Quantum Device Team	Hideki Hirayama

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FIRST Program

● Correlated Electron Research Group	Yoshinori Tokura
Strong-Correlation Physics Research Team	Yoshinori Tokura
Strong-Correlation Theory Research Team	Naoto Nagaosa
Strong-Correlation Interfacial Device Research Team	Masashi Kawasaki
Strong-Correlation Materials Research Team	Yasujiro Taguchi
Strong-Correlation Hybrid Materials Research Team	Yoshihiro Iwasa
Strong-Correlation Quantum Transport Research Team	Harold Y. Hwang
Strong-Correlation Research Support Team	Izumi Hirabayashi

Laboratories and Research Units are working to discover, creative ideas to grow the seeds for new areas of research.

Laboratories

Computational Astrophysics Laboratory	Toshikazu Ebisuzaki
Atomic, Molecular & Optical Physics Laboratory	Toshiyuki Azuma
Condensed Matter Theory Laboratory	Akira Furusaki
Magnetic Materials Laboratory	Hidenori Takagi
Low Temperature Physics Laboratory	Kimitoshi Kono
Quantum Metrology Laboratory	Hidetoshi Katori
Laser Technology Laboratory	Katsumi Midorikawa
Nanophotonics Laboratory	Satoshi Kawata
Materials Fabrication Laboratory	Hitoshi Ohmori
Advanced Device Laboratory	Koji Ishibashi
Bioengineering Laboratory	Mizuo Maeda
Nano Medical Engineering Laboratory	Yoshihiro Ito
Molecular Spectroscopy Laboratory	Tahei Tahara
Condensed Molecular Materials Laboratory	Reizo Kato
Organometallic Chemistry Laboratory	Zhaomin Hou
Synthetic Organic Chemistry Laboratory	Mikiko Sodeoka
Surface Chemistry Laboratory	Kimitoshi Kono
Synthetic Cellular Chemistry Laboratory	Yukishige Ito
Antibiotics Laboratory	Hiroyuki Osada
Cellular Dynamics Laboratory	Naoko Imamoto
Chromosome Dynamics Laboratory	Tatsuya Hirano
Chemical Genetics Laboratory	Minoru Yoshida
Molecular Entomology Laboratory	Shogo Matsumoto
Lipid Biology Laboratory	Toshihide Kobayashi
Molecular Membrane Biology Laboratory	Akihiko Nakano
Theoretical Biology Laboratory	Atsushi Mochizuki
Cellular Informatics Laboratory	Yasushi Sako
Molecular Genetics Laboratory	Shunsuke Ishii
Cellular Memory Laboratory	Yoichi Shinkai
Genome Science Laboratory	Yoshihide Hayashizaki
Computational Condensed Matter Physics Laboratory	Seiji Yunoki
Metamaterials Laboratory	Takuo Tanaka
Surface and Interface Science Laboratory	Yousoo Kim
Nucleic Acid Chemistry Laboratory	Akimitsu Okamoto
Theoretical Biochemistry Laboratory	Yuji Sugita
RNA Biology Laboratory	Shinichi Nakagawa
Atomic Physics Laboratory	Yasunori Yamazaki

Special Research Units

Functional Elemento-Organic Chemistry Unit	Kohei Tamao
Viral Infectious Diseases Unit	Yoko Aida
Molecular & Informative Life Science Unit	Yoshihito Osada
Cellular & Molecular Biology Unit	Takehiko Shibata
Optical Green Technology Research Unit	Satoshi Wada

Initiative Research Units

Yu Initiative Research Unit	Hsiao-hua Yu
Zhang Initiative Research Unit	Kam Zhang

Initiative Research Units (Intl.)

Heddle Initiative Research Unit	Jonathan G. Heddle
Byon Initiative Research Unit	Hye Ryung Byon

Corporate and International Relations Division is promoting collaboration in the following four areas: with international partners, with universities and research institutions, with partners inside RIKEN and with private industry. Advanced Technology Support Division is providing support to meet the diverse needs of research.

Divisions

Corporate & International Relations Division	Masahiko Hara
● RIKEN-TRI Collaboration Center for Human-Interactive Robot Research	**Shigeyuki Hosoe**
Robot Control Research Team	Yoshikazu Hayakawa
Robot Sensor Systems Research Team	Toshiharu Mukai
Robot Motion Research Team	Ryojun Ikeura
Robot Implementation Research Team	Shijie Guo
● RIKEN-HYU Collaboration Research Center	**Masahiko Hara**
Flucto-Order Functions Research Team	Masahiko Hara
● Institutional Alliances Group	**Yoshihito Osada**
RIKEN-RIES, Hokkaido Univ. Joint Research Team	Yoshihito Osada
RIKEN-XJTU Joint Research Team	Kuniaki Kawabata
● Coordinated Space Observation and Experiment Research Group	**Kazuo Makishima**
MAXI Team	Kazuo Makishima
EUSO Team	Marco Casolino
Kibo In-cabin Research Team	Akihiko Nakano

Advanced Technology Support Division	Akitake Makinouchi
Advanced Manufacturing Team	Yutaka Yamagata
Materials Characterization Team	Yoshio Sakaguchi
Ultra High Precision Fabrication Team	Yutaka Yamagata
Bio-research Infrastructure Construction Team	Hideo Yokota