

# Faculty Members, Graduate School of Pure and Applied Sciences - Doctoral Programs - Doctoral Program in Mathematics

Field of Research	Faculty	Detailed Description of Research Field
A l g e b r a	AKIYAMA Shigeki * (MORITA Jun)  CARNAHAN Scott  SAGAKI Daisuke  * (FUJITA Hisaaki)  MASUOKA Akira [KIMURA Ken-ichiro] * ([HOSHINO Mitsuo]) [MIKAWA Hiroshi]	Number theory, Ergodic theory, Self-similar structure Algebraic groups, Lie algebras and aperiodic structures  Moonshine, Automorphic forms, Algebraic geometry, Vertex algebras  Representation theory of Lie algebras and quantum groups  Non-commutative Noetherian ring theory, Structure of orders  Hopf algebra, Quantum group Algebraic cycles, Motives Representatio theory of algebras Prime number theory
G e o m e t r y	INOUCHI Jun-ichi KAWAMURA Kazuhiro TASAKI Hiroyuki  HIRAYAMA Michihiro [AIYAMA Reiko] [ISHII Atsushi] [NAGANO Koichi]	Differential geometry (Integrable systems) Geometric topology Differential geometry, Integral geometry and their applications  Dynamical systems, Ergodic theory Differential geometry, Submanifolds theory Low dimensional topology, Knot theory Global Riemannian geometry, Geometry of metric spaces
A n a l y s i s	KAKEHI Tomoyuki  TAKEUCHI Kiyoshi  KINOSHITA Tamotsu TAKEYAMA Yoshihiro  LIANG Song [KUBO Takayuki]	Global analysis, Differential equations on symmetric spaces  Algebraic analysis and its applications to singularity theory  Weakly hyperbolic equation, Microlocal analysis Mathematical physics, Quantum integrable system, Difference equation  Probability, Stochastic calculus Mathematical analysis of nonlinear partial differential equation in fluid dynamics
Mathematics of Information	AOSHIMA Makoto  ※TSUBOI Akito KOIKE Ken-ichi SHIOYA Masahiro YATA Kazuyoshi	Statistical science, High-dimensional statistical analysis, Bigdata analysis, Asymptotic theory Mathematical logic, Model theory, Stability theory Statistical sequential estimation Axiomatic set theory Multivariate analysis, Sequential analysis, High-dimension low-sample-size data analysis, Asymptotic theory

Field of Research	Faculty	Detailed Description of Research Field
	TERUI Akira	Computer algebra, Symbolic-numeric computation

(Note)

- ◆ Those marked with \* will be retiring by March 31, 2020. Only application of Ph.D. candidates for the Early Completion Program will be accepted to these members. Applicants who wish to do research under the supervision of one of these members should consult the faculty member prior to the application.
- ◆ Those marked with ※ will be retiring by March 31, 2021. Only application of Ph.D. candidates for the Early Completion Program will be accepted to these members. Applicants who wish to do research under the supervision of one of these members should consult the faculty member prior to the application.
- ◆ Applicants cannot choose faculty members surrounded by “[ ]” as an academic supervisor. Instead, they should choose from the other members in the same research field. They can conduct the research theme with the cooperation of these members.
- ◆ Applicants should have a thorough discussion, prior to the application, with a faculty member of their research field about their research plan.

Inquiries about the entrance examination should be sent to:

Prof. Shigeki Akiyama, Chair, Doctoral Program in Mathematics

Email: akiyama#@#math.tsukuba.ac.jp (Remove “#” before sending an email)

Telephone: 81-29-853-4009

Website of Mathematics major: <https://nc.math.tsukuba.ac.jp>

## Doctoral Program in Physics

Field of Research		Faculty	Detailed Description of Research Field
Particle physics	Theory	ISHIBASHI Nobuyuki *(KANAYA Kazuyuki) KURAMASHI Yoshinobu ISHIZUKA Naruhito TANIGUCHI Yusuke YAMAZAKI Takeshi YOSHIE Tomoteru 〔SATOY Yuji〕 〔MOHRI Kenji〕 〔ISHIKI Goro〕 〔OHNO Hiroshi〕	(1) Research on nonperturbative aspects of elementary particle physics by numerical analyses based on lattice field theory (QCD, physics beyond the standard model including string theory, tensor renormalization group) (2) Research on mathematical aspects of quantum field theory and string theory (nonperturbative formulation of string theory, quantum gravity, gauge/gravity correspondence)
	Experiment	UKEGAWA Fumihiko HARA Kazuhiko TAKEUCHI Yuji 〔SATO Koji〕 〔OKAWA Hideki〕 〔IIDA Takashi〕 〔YOSHIDA Takuo〕 〔IKEGAMI Yoichi〕	(1) Studies of elementary particles at hadron-hadron colliding beam experiments (Higgs particle physics, top quark properties, electroweak interactions, bottom quark physics, quantum chromodynamics and strong interactions, and searches for new particles such as supersymmetry). (2) Development of new particle detectors for the LHC accelerator upgrade, future linear electron-positron collider experiments, and cosmic neutrino background decay searches.
Astrophysics	Theory	UMEMURA Masayuki OHSUGA Ken MORI Masao 〔YOSHIKAWA Kohji〕 〔WAGNER Alexander〕	(1) Formation of Cosmic Structure and Observational Cosmology (2) Formation of the First Generation Objects (3) Formation and Evolution of Galaxies (4) Formation of Black Holes (5) Evolution of Stars and Planetary Systems Theoretical researches on these issues by using simulations with supercomputers and by analytic methodology.
	Observation	KUNO Nario 〔NITTA Tom〕 〔WATANABE Yoshimasa〕	Observational study of our Galaxy, galaxies, active galactic nuclei, distant universe, et al., and development of radio telescopes and detectors. Projects of submillimeter and terahertz telescopes which will be installed in the Antarctic plateau are advancing, in addition to observing with existing telescopes such as the Nobeyama 45-m telescope and ALMA.
Nuclear physics	Theory	NAKATSUKASA Takashi YABANA Kazuhiro 〔HASHIMOTO Yukio〕 〔HINOHARA Nobuo〕	(1) Theoretical researches on quantum many-body systems with the strong interaction, such as microscopic structure of unstable nuclei and neutron stars, nuclear reaction for element

Field of Research		Faculty	Detailed Description of Research Field
			<p>synthesis in the universe, etc.</p> <p>(2) Computational approaches to interaction between ultra-short laser pulse and material.</p>
	Experiment	<p>OZAWA Akira * (MIAKE Yasuo) Peitzmann Thomas Van Leeuwen, Marco ESUMI Shinichi SASA Kimikazu [CHUJO Tatsuya] [MORIGUCHI Tetsuaki] [SAKO Hiroyuki] [OZAWA Kyoichiro] [YAMAGUCHI Takayuki]</p>	<p>(1) Experimental Study of Nuclear physics using relativistic heavy ion collider (Quark Gluon Plasma, Big Bang Cosmology, Reaction mechanism of high energy nuclear collision)</p> <p>(2) Evolution of Nucleosynthesis using RI beam (Nucleosynthesis, Unstable nuclei, Precise mass spectroscopy of rare nuclei)</p> <p>(3) Accelerator Mass Spectrometry (AMS) of cosmogenic nuclides(Global environmental changes, Age dating, Cosmic-ray intensity variation and Ultrasensitive detection method for radionuclides), Environmental radiation and Radiation physics</p> <p>(4) R&amp;D of new experimental devices (Accelerator, detector, new application of accelerator beam)</p>
Condensed matter physics	Theory	<p>HATSUGAI Yasuhiro ONO Tomoya TANIGUCHI Nobuhiko [YOSHIDA Tsuneya]</p>	<p>(1) Quantum theory of matter( Y. Hatsugai, T. Yoshida): Theoretical/numerical studies of quantum phases of matter (theory of bulk-edge correspondence, graphene, quantum (spin) Hall systems, strongly correlated systems, exotic superconductors, quantum spins, Berry phases, topological insulators, etc.)</p> <p>(2) Nano Quantum Physics (Taniguchi): Quantum properties and quantum transport phenomena in semiconductor nanostructures; Quantum field theories of nonequilibrium steady states; Quantum field theories of low dimensional systems, random systems or chaotic systems.</p> <p>(3) Surface and interface physics (Ono): Development of first-principles calculation methods. Analysis and design of interfaces for novel devices using first-principles calculation and super computers. Systematization of computational material and device design technique.</p>
	Experiment	<p>NISHIBORI Eiji MORITOMO Yutaka IKEZAWA Michio ONODA Masashige [HIGASHIYAMA</p>	<p>(1) Magnetism and Materials Science (Onoda): Multilateral and comprehensive study for correlated electron system (novel superconductivity, metal-insulator transition), quantum spin-fluctuation system, and</p>

Field of Research		Faculty	Detailed Description of Research Field
		Kazuyuki] [KUBO Atsushi] [TOMIMOTO Shinichi] MORISHITA Masashi [KASAI Hidetaka] [KOBAYASHI Wataru] [NIWA Hideharu] [Hathwar, Venkatesha Rama]	<p>functional system (novel ion battery, thermoelectric conversion) with NMR, ESR, structure analysis, and conventional measurements of electrical, magnetic or thermal properties.</p> <p>(2) Low temperature physics (Morishita):            Low dimensional quantum properties in quantum fluids and quantum solids (helium) which appear with structural control.</p> <p>(3) Energy materials science (Y. Moritomo, W. Kobayashi, H. Niwa, and H. Higashiyama) Research of the energy materials and devices, such as, sodium-ion secondary battery, organic solar cell. thermoelectrics, catalyst, superconductor, and so on with use of Synchrotron-radiation X-ray (SPring-8, PF) and nano probes (NIMS), and so on.</p> <p>(4) Structural Materials Science ( Nishibori, Kasai, Hathwar): Structural materials science using advanced x-ray region photon sources. Ultra-high resolution charge density study; In-situ observation of nano-particle synthesis; structural studies of thermoelectrics, battery materials, molecular functional materials. International research collaboration using research unit project.</p> <p>(5) Nanophotonics (Ikezawa, Kubo, Tomimoto): [Semiconductor Optics] We investigate optical properties, spin characteristics and quantum optics in low dimensional semiconductor nanostructures such as quantum wells, quantum dots and defects using various spectroscopy, including femto/pico-second laser spectroscopy. [Surface Dynamics] Studies on dynamics of charge carriers, collective excitations such as surface plasmons, and wave packets excited on solid surfaces, hetero-interfaces, and nanostructures. Developments of novel ultrafast time-resolved microscopy methods.</p>
Biophysics	Theory	SHIGETA Yasuteru [SHOJI Mitsuo]	We theoretically investigate the biological macromolecules (proteins, nucleic acids, sugars), which are important in life, and the biological

Field of Research		Faculty	Detailed Description of Research Field
			system ranging from a protein to aggregates of proteins by using computational methods to reveal structure-function relationship of biomolecules and elucidate the mechanism of life.
Plasma	Experiment	SAKAMOTO Mizuki KARIYA Tsuyoshi MINAMI Ryutaro YOSHIKAWA Masayuki [KOHAGURA Junko] [HIRATA Mafumi] [NUMAKURA Tomoharu]	(1) Study on plasma transport and confinement by magnetic and electric fields, and divertor simulation study using a tandem mirror device. (2) Study on plasma heating and electric field formation by using microwave, radio frequency wave and neutral beam, and control of heat and particle transport in core and boundary plasmas. (3) Plasma diagnostics with X ray, infrared, microwave, particle beam, visible light, laser, etc. Using these diagnostics, especially, study on relation between plasma transport and instability and fluctuation. (4) Theoretical analysis and computer simulation related to above experiments and its application to astrophysics. (5) Study on plasma-wall interaction.

(Note)

- ◆ Those marked with \* will be retiring by March 31, 2020. Only application of Ph.D. candidates for the Early Completion Program will be accepted. Applicants who wish to do research under their supervision should consult the faculty adequately prior to the application.

**【Cooperative Graduate School System】**

Field of Research		Faculty	Detailed Description of Research Field
Advanced Interdisciplinary Physics		MARUYAMA Toshiki (JAEA) MIYAMOTO Yoshiyuki (AIST) NISHIMURA Shunji (RIKEN)	Simulation researches on dynamics of quark and hadrons (Maruyama) Condensed matter physics: Ultra-fast phenomena by electron excitation(Miyamoto) Study of nuclear astrophysics using new accelerator and new experimental techniques (Nuclear Structure, Nuclear Cosmology, Neutron-Rich Nuclei)
Nuclear Fusion and Plasma Physics		IDE Shunsuke  SAKAMOTO Keishi  NAKANO Tomohide ( Q S T )	(1) Study on plasma heating system for a large nuclear fusion device. (2) Study on core-boundary plasma physics for a large nuclear fusion device. (3) Simulation study of a large nuclear fusion device.

(Note)

- ◆ Applicants cannot choose faculty members who are surrounded by “[ ]” as an academic supervisor. Instead, choose from other members in the same research field, and you can conduct the research theme with their cooperation.

(1) Please refer to the website below. Applicants should have a thorough discussion with a professor of their research field about your research plan two weeks before the examination.

Inquiries about the entrance examination should be sent to:

Prof. yasuhiko Hatsugai, Chair, Doctoral Program in Physics

Email: : hatsugai.yasuhiko.ge##@#u.tsukuba.ac.jp (Remove “#” before sending an email)

telephone: 81-29-853-4277

Website of Physics major : <http://www.px.tsukuba.ac.jp/senkou/>

(Remarks) Two faculty members in the list of the “Advanced Interdisciplinary Physics” research field by cooperative graduate school system offer their instruction by joint cooperative graduate school system. If you wish to apply for this method of instruction, contact the person above prior to the application.

(JAEA) = Japan Atomic Energy Agency

(AIST) = The National Institute of Advanced Industrial Science and Technology

(RIKEN) = Institute of Physical and Chemical Research

(QST) = National Institutes for Quantum and Radiological Science and Technology

## Doctoral Program in Chemistry

Field of Research	Faculty	Detailed Description of Research Field
Inorganic and Analytical Chemistry	KOJIMA Takahiko	Supramolecular redox chemistry of non-planar porphyrins. Creation of multi-nuclear metal clusters with controlled structures and electronic states; Low-coordination and Multiple Bonded Compounds of Heavier Group 14 Elements.
	SUEKI Keisuke	Studies of environmental long-lives radioisotopes and radioactive substances released from the Fukushima Daiichi Nuclear Power Plant accident.
	NAKATANI Kiyoharu	Studies on chemical processes at microdroplet/solution and microparticle/solution interfaces using electrochemical and spectroscopic techniques.
Physical Chemistry	*(MORIHASHI Kenji)	Computational quantum chemistry: Applications of density functional theory (DFT) to the molecular properties and reactivities of radical compounds. Development of DFT calculation method including solvent effect; Organoelement chemistry of Group 13-14, particularly low-coordinate compounds.
	ISHIBASHI Taka-aki	Studies on interfaces and condensed phases by linear and nonlinear molecular spectroscopy; Synthesis of emissive compounds and kinetic analyses of formation and deactivation processes of the emissive state by TCSPC; Studies on photofunctions and photochemical properties of newly fabricated molecular assemblies and inorganic particles in mesoscopic scale.
Organic Chemistry	ICHIKAWA Junji	Studies on acceleration and control of synthetic organic reactions. Development of synthetic reactions using organofluorine and organometallic compounds; Isolation, structural elucidation, synthesis, and bioorganic studies of bioactive natural products.
Interdisciplinary Chemistry	YAMAMOTO Yasuhiko	Investigation of architecture of metalloprotein and metalloenzyme structures; Nuclear magnetic resonance spectroscopy of paramagnetic metal complexes; Development of molecular probes for second harmonic generation imaging.



**【Cooperative Graduate School System】**

Field of Research	Faculty	Detailed Description of Research Field
Solid State Chemistry	KAMATA Toshihide ( A I S T )	Studies on the super-structured thin film of molecular compounds and its application to the organic transistors.
Surface Electrochemistry	SATO Yukari ( A I S T )	Functionalization of solid and electrode surfaces. Redox flow battery for renewable energy introduction. Construction of micro multi sensing devices for marine environment.
Materials Organic Chemistry	HAN Li-Biao ( A I S T )	Studies on the efficient preparation of heteroatom compounds (organophosphorus chemicals in particular) via catalysis and development of heteroatom-containing functional materials.
Nano-Carbon Materials Chemistry	OKAZAKI Toshiya ( A I S T )	Synthesis of the functionalized nano-carbons and their spectroscopic characterizations.
Organometallic Chemistry	NAKAJIMA Yumiko ( A I S T )	Design and synthesis of novel transition metal catalysts, Development of catalytic reactions for precise synthesis of new organometallic compounds containing main group elements.
Photofunctional Materials Chemistry	NORIKANE Yasuo ( A I S T )	Photofunctional organic molecules especially showing photo-induced solid-liquid phase transitions and lightdriven mechanical motion.

**【International Institute for Integrative Sleep Medicine】**

Field of Research	Faculty	Detailed Description of Research Field
Pharmaceutical Science	NAGASE Hiroshi	Design and synthesis of orexin receptor agonists/Design and synthesis of opioid ligands/Research and development for narcorepsy, severe pain, depression, pollakiurea, malaria, other protozoal diseases, and cancer drugs.

(Note)

- ◆ Those marked with \* will be retired by March 31, 2020. Only application of Ph.D. candidates for the Early Completion Program will be accepted. Applicants who wish to do research under their supervision should consult the faculty adequately prior to the application.
- ◆ Applicants should have a thorough discussion with a professor of their research field about your research plan in advance.

Inquiries about the entrance examination should be sent to:

Prof. Takahiko Kojima, Chair, Master's Program in Chemistry/

Prof. Taka-aki Ishibashi, Member of the Academic Committee Master's Program in Chemistry

telephone: 81-29-853-6505•4310

Website of Chemistry major: <http://www.pas.tsukuba.ac.jp>

(AIST) = The National Institute of Advanced Industrial Science and Technology

## Doctoral Program in Nano-Science and Nano-Technology

Field of Research	Faculty	Detailed Description of Research Field
Nano-Science	OKADA Susumu	Condensed matter physics and computational material sciences: Using the first-principles techniques based on the quantum mechanics, we study physical and chemical properties of nanoscale materials, ranging from the semiconductor to biomaterials.
	KANDA Akinobu	Mesoscopic electron transport in nanoscale systems: quantum transport in graphene and other 2D materials. Observation and control of quantum vortices in mesoscopic superconductors.
	YAMAMURA Yasuhisa	Structure and property of soft molecular systems, and dynamics and phase transitions in them.
	※NABESHIMA Tatsuya	Design and synthesis of functional organic compounds, responsive artificial receptors, hybrid functional supramolecules, self-assembled supramolecules, supramolecular sensors, host-guest chemistry, supramolecular chemistry.
	TOKURA Yasuhiro	Theory of quantum transport in nano-structures made of various semiconductors. Non-equilibrium dynamics and quantum coherence in compound quantum system and possible application to quantum computations.
	NOMURA Shintaro	Studies on optical and spin properties of semiconductor nanostructures by advanced optical techniques. Properties of electron systems such as in heterostructures, atomic layered compounds, and topological materials.
Nano-Technology	HASUNUMA Ryu	Development of highly reliable gate dielectric films for future LSI.
	SANO Nobuyuki	Simulation and theoretical studies of Electron transport phenomena under nanoscale semiconductor structures, and device modeling and simulation of device characteristics.
	NAKAMURA Junji	Methanol synthesis catalysts from CO <sub>2</sub> , fuel cell catalysts and surface chemistry of graphitic materials are studied using surface science techniques at the atomic level.
	KONDO Takahiro	A substitute material of Pt at the Fuel Cell electrode using nitrogen-doped carbon, two-dimensional material of boron and reaction dynamics at surface based on the fundamental surface science and fine experimental measurements.

Field of Research	Faculty	Detailed Description of Research Field
	SUZUKI Hiroaki	Development of electrochemical and photonic biosensing devices, microfluidic devices, and micro/nanomotors.
	KURODA Shinji	Experimental studies on spin-related phenomena in the solid state. We develop novel materials exhibiting spin properties, such as magnetic semiconductors, topological insulators and their nanostructures, and clarify the spin-related properties aiming at the application to spin-based electronic devices.
	SUEMASU Takashi	High-efficiency Si-based tandem solar cells, thermoelectric devices, and spintronics materials using safe, stable, and abundant elements
	OHNO Yuzo	Studies of electronic, optical, and spin properties of semiconductor nanostructures, and spin coherence for quantum information and low-power devices.
	UMEDA Takahide	Electron-spin-resonance (ESR)-based characterization on nano-electronics devices and power-electronics devices
	MARUMOTO Kazuhiro	Development and characterization of semiconductor materials, and their application to semiconductor devices such as solar cell, light-emitting diodes, transistors, etc. using functional materials such as organic materials, perovskites, low-dimensional materials, etc.
	TOKO Kaoru	Thin film synthesis technology and device application highly functional materials to create new energy semiconductor electronics

**【Cooperative Graduate School System】**

Field of Research	Faculty	Detailed Description of Research Field
Nano-Science	AKIMOTO Junji ( A I S T )	Studies on inorganic solid state chemistry and electrochemistry for advanced functional materials (including lithium ion battery positive and negative electrode materials, and advanced solid electrolyte materials).

Field of Research	Faculty	Detailed Description of Research Field
	YOSHIDA Yuji ( A I S T )	Research on structural properties and photo-electrical properties of thin films based on polymers, molecular compounds and organic-inorganic hybrid materials, and chemistry on organic electronics such as organic photovoltaic cells (solar cells).
	HARA Yusuke ( A I S T )	Research and development of functional polymers and polymer gels for application to soft actuators, soft robots, micro fluidic devices.
	YAMAMOTO Tsuyoshi ( N E C )	Research on devices which harness the nature of quantum mechanics. They include quantum-dot based infrared photodetector, and superconducting devices for quantum information processing.
	KAWAI Takazumi ( N E C )	Theoretical research to clarify the dynamics of chemical reaction and electronic states in atomic scale using first-principles electronic states calculations and molecular dynamics simulations aiming for the design of emerging materials.
	GOTOH Hideki ( N T T )	Characterization of optical properties in semiconductor nanostructures with high-energy-resolution laser system and high-spatial-resolution spectroscopy. Exploration new physics on electron, exciton and spin properties and those applications to quantum devices and novel functional devices.
	SASAKI Ken-ichi ( N T T )	We study the electronic properties of graphene and carbon nanotube using the method of condensed matter physics. We aim for theoretical proposal of new and versatile ideas.

(Note)

- ◆ Those marked with ※ will be retired by March 31, 2021. Only application of Ph.D. candidates for the Early Completion Program will be accepted. Applicants who wish to do research under their supervision should consult the faculty adequately prior to the application.
- ◆ Applicants should have a thorough discussion with a professor of their research field about your research plan in advance. Inquiries about the entrance examination should be sent to:  
Prof. Shinji Kuroda, Chair, Doctoral Program in Nano-Science and Nano-Technology  
telephone: 81-29-853-5365

(NEC) = NEC Corporation Tsukuba Research Laboratories

(AIST) = The National Institute of Advanced Industrial Science and Technology

(NTT) = NTT Basic Research Laboratories

## Doctoral Program in Applied Physics

Field of Research	Faculty	Detailed Description of Research Field
Optical and Quantum Engineering	※ (ITOH Masahide) HATTORI Toshiaki YASUNO Yoshiaki  KANO Hideaki	(1) Optical Information processing and optical metrology. Development of optical instrumentation and devices. (2) Sensing using terahertz waves and terahertz spectroscopic study of bio-related materials (3) Fundamental, instrumentation, application research on optical tomographic imaging for medical and lifescience applications. It includes optical coherence tomography and quantitative three-dimensional functional microscopy. (4) Exploring new frontiers in biomedical molecular imaging using nonlinear Raman spectroscopy; Research on optical information processing and optical metrology
Instrumentation Physics	SASAKI Masahiro  SIRAKI Kentaro FUJITA Jun-ichi  ITO Yoshikazu  KOBAYASHI Nobuhiko  TERADA Yasuhiko	(5) Observations and controls of surface/interface properties by using supersonic molecular/atomic beams, scanning probe microscopes and other spectroscopic and microscopic techniques (6) Technology of protein folding and application of biomaterials (7) Synthesis of carbon nanotube and graphene based low dimensional nanomaterials for application researches of realizing in-situ imaging using local electric field, revealing physical and catalytic properties for functional devices (8) Synthesis, characterizations and fabrications of 3D materials using graphene and two dimensional materials for developments of catalyts, device applications and energy havesting devices with renewable energy sources (9) Condensed matter theory. Computational materials science. Density functional theory for nonequilibrium systems. Theory of charge, heat and spin transport in nanoscale systems. (10) Developemnt of new imaging methods based on NMR and MRI
Quantum Beam and Plasma Engineering	EZUMI Naomichi	(11) Study of plasma-gas interaction and plasma-wall interaction in boundary plasmas (edge-divertor plasmas) of magnetically confined nuclear fusion utilizing an open magnetic field structure of the largest tandem mirror plasma device GAMMA 10/PDX. To control the high heat flux boundary plasma, we are investigating the plasma behavior using advanced

Field of Research	Faculty	Detailed Description of Research Field
	TOMITA Shigeo	plasma measurement systems. (12) Experimental studies on advanced atomic physics and atmospheric science using charged particle beams from accelerators
Nano-Technology	※(SHIGEKAWA Hidemi)  HASE Muneaki  TAKEUCHI Osamu  MAKIMURA Tetsuya	(13) Our research target is to understand and develop the nanoscale science and technologies of such as surface science, molecular physics, and new functional materials and devices. To realize these studies, we develop new microscopy techniques based on scanning probe microscopy and advanced laser technologies, which, for example, enable ultimate spatial and temporal resolutions, simultaneously. (14) Ultrafast laser spectroscopy on semiconductors and dielectric materials using femtosecond laser and application to optical device and controlling phase transitions (15) Development of new microscopy techniques by combining nanometer-resolving scanning probe microscopy and optical measurement techniques, in order to reveal nanometer-scale optoelectronic processes in solar cells, light emitting diodes, and spintronics devices and to improve their device performance (16) Nano- and Micro-machining and materials synthesis using laser produced plasma EUV light and laser light
Semiconductor Electronics (Power Electronics)	UEDONO Akira	(17) Study of defects in materials by means of positron annihilation, and developments of positron annihilation spectroscopy
Optoelectronics and Spintronics (Power Electronics)	SAKURAI Takeaki  YANAGIHARA Hideto	(18) Development of highly efficient organic and inorganic thin-film solar cells. Characterization of defects in power semiconductor devices. (19) Thin film growth of advanced magnetic oxides for spintronics devices
Power Electronics	IWAMURO Noriyuki  ISOBE Takanori	(20) Research on improvement of power semiconductor devices characteristics for achieving a low loss and high withstand capability (21) Study on circuit topologies and control for efficiency and power density improvement in power converters, and its emerging applications

Field of Research	Faculty	Detailed Description of Research Field
	YANO Hiroshi	(22) Research on ultra-low-loss SiC power semiconductor devices, particularly improvement in SiC-MOS device performance and understanding of its interface physics, toward power electronics innovations.

**【Cooperative Graduate School System】**

Field of Research	Faculty	Detailed Description of Research Field
Semiconductor Electronics	MAKINO Toshiharu (AIST)	(24) Diamond growth, and electronic device fabrication using unique properties.
Optoelectronics and Spintronics	YUASA Shinji (AIST)	(25) Research and development of magnetic tunnel junctions, magnetoresistive random access memory MRAM and other spintronic devices.
Power Electronics	OKUMURA Hajime (AIST)	(26) Research and Development on widegap semiconductors such as SiC and GaN, and their electronics application.
	YAMAGUCHI Hiroshi (AIST)	(27) R&Ds of packaging and power circuit technologies for making the full potential use of wide bandgap semiconductor power devices such as SiC.
	KOJIMA Kazutoshi (AIST)	(28) Research and development on wide gap semiconductor epitaxial growth technique such as SiC and its characterization. Development of power device with new structure by using epitaxial growth technique.

(Note)

- ◆ Those marked with ※ will be retired by March 31, 2021. Only application of Ph.D. candidates for the Early Completion Program will be accepted. Applicants who wish to do research under their supervision should consult the faculty adequately prior to the application.
- ◆ Applicants should have a thorough discussion with a professor of their research field about your research plan in advance.

Inquiries about the entrance examination should be sent to:

Prof. Masahiro SASAKI, Chair, Doctoral Program in Applied Physics  
telephone: 81-29-853-4966

For more information, please refer to the following websites:

Website of the Graduate School of Pure and Applied Sciences: <http://www.pas.tsukuba.ac.jp/>

Website of Applied Physics major: <http://www.bk.tsukuba.ac.jp/>

(AIST) = The National Institute of Advanced Industrial Science and Technology



## Doctoral Program in Materials Science

Field of Research	Faculty	Detailed Description of Research Field
Quantum Physics of Solid State	MATSUISHI Kiyota	(1) Study on optical properties and high-pressure physics of semiconductors (amorphous, low-dimensional nanostructured, organic-inorganic hybrid, etc.) for search of new optically-functionalized materials
	FUJIOKA Jun	(2) Research on electronic, optical and thermal property in strongly correlated electron material and topological quantum material. Searching new quantum phenomena and functions by using state-of-the-art material synthesis technique, spectroscopy and fundamental characterization.
	[TSUJIMOTO Manabu]	(3) Towards high-speed, high-sensitive and phase-sensitive applications, we are developing superconducting quantum devices utilizing high-temperature superconductivity. Our goal is to establish an epoch-making technology based upon front-line microfabrication and cryogenic techniques.
Theoretical Quantum Physics	※TAKEMORI Tadashi	(4) Theoretical investigation of properties of condensed matters in a broad sense, and its application to analytical methods such as simulation techniques of quantum systems, function analysis of microscopic systems including biological molecules
	HINO Ken-ichi	(5) Theoretical studies of optical properties of condensed matter: ultrafast phenomena in ultrashort-pulse driven semiconductors, coherent phonon generation, Floquet topological insulators, exciton dynamics, photo-induced phase transitions.
	KOIZUMI Hiroyasu	(6) Theoretical study of high temperature superconductor in strongly-correlated system and its application to quantum computers
	SUZUKI Shugo	(7) First-principles study of structural and electronic properties of materials
	TONG Xiao-Min	(8) Understand dynamical processes of atoms, molecules and solids in an ultrashort intense laser field and search an effective way to control the processes with intense laser in femtosecond domain by first principles simulations.

Field of Research	Faculty	Detailed Description of Research Field
Materials Physics and Engineering	KIZUKA Tokushi	(9) Development and electron microscopy of next-generation metallic nanowires, heat resistance materials for aircrafts and engines, photovoltaic power generation and light emitting nanodevices, and single molecular devices.
	KIM Hee Young	(10) Development and characterization of novel functional alloys and biomaterials including biomedical superelastic alloy, high temperature shape memory alloy and gum metal
	TOKORO Hiroko	(11) Development of novel materials with advanced light-responsive functionalities, accompanying changes of optical, magnetic, and electric properties. Metal complexes and metal oxides are the main target materials
	KOYANO Tamotsu	(12) Research on phase transformation and microstructure of high nitrogen steel. Our goal is production of the low alloy steel for automobile and molds without comprising rare metals
	SUZUKI Yoshikazu	(13) Development of new inorganic materials for energy and environmental applications such as solar cells and environmental purification filters
	TANIMOTO Hisanori	(14) Research on characteristic properties and application of nanostructured materials such as nanocrystalline metals, amorphous alloys and metallic nanoparticles
Materials Chemistry and Biotechnology	KANBARA Takaki	(15) Development and characterization of novel functional polymers and organometallic compounds directed toward organic devices and catalysts
	KIJIMA Masashi	(16) Development of highly functionalized materials based on conjugated polymers, biomass, and carbon.
	NAGASAKI Yukio	(17) Design of functional polymer materials for biomaterials and environmental friendly materials (Drug delivery systems, nanomedicines, biosensing, biodegradable polymers)
	FUJITANI Tadahiro (AIST)	(18) Development and characterization of heterogeneous catalysts for biomass conversion, environment, and energy.
	YAMAMOTO Yohei	(19) Self-assembly of $\pi$ -conjugated molecules, polymers, and biomolecules to construct electronic, optical, and energy conversion devices.

Field of Research	Faculty	Detailed Description of Research Field
	KOBAYASHI Masami	(20) Photosynthesis (pigment analysis). Photodynamic Therapy by Chlorophylls. Algae and algal oil.
	GOTO Hiromasa	(21) Synthesis and properties of low-molecular mass compounds and polymeric materials having magnetism, electrical conductivity, photo-isomerization, optical rotation, and circular dichroism
	CHOI Jun-Chul (AIST)	(22) We aim at the development of high efficiency catalyst for green synthetic processes and material design of highly dispersed metal catalyst.
	TSUJIMURA Seiya	(23) Electrochemistry of redox enzymes and its application to biosensors and biofuel cells

**【Cooperative Graduate School System】**

Field of Research	Faculty	Detailed Description of Research Field
Materials Physics and Engineering	KATAURA Hiromichi (AIST)	We have realized precise structure sorting of single-wall carbon nanotubes. By using the structure controlled nanotubes, we will clarify physical properties of nanotubes and will develop new electronic devices.
Materials Chemistry and Biotechnology	KURITA Ryoji (AIST)	We conduct R&D from basic research to device development as regard a novel biomolecule analysis, and contribute to the development of next-generation medical and life science.

(Note)

- ◆ Those marked with ※ will be retired by March 31, 2021. Only application of Ph.D. candidates for the Early Completion Program will be accepted. Applicants who wish to do research under their supervision should consult the faculty adequately prior to the application.
- ◆ Applicants cannot choose faculty members who are surrounded by “[ ]” as an academic supervisor. Instead, choose from other members in the same research field, and you can conduct the research theme with their cooperation.
- ◆ Applicants should have a thorough discussion with a professor of their research field about your research plan in advance.

Inquiries about the entrance examination should be sent to:

Prof. Ken-ichi Hino, Chair, Doctoral Program in Materials Science

Telephone: 81-29-853-4994

Prof. Masashi Kijima, Member of the Academic Committee, Doctoral Program in Materials Science

Telephone: 81-29-853-5295

Related Websites  $\left( \begin{array}{l} \text{http://www.pas.tsukuba.ac.jp/} \\ \text{http://www.ims.tsukuba.ac.jp/} \\ \text{http://www.tsukuba.ac.jp/} \end{array} \right)$

(AIST) = The National Institute of Advanced Industrial Science and Technology

## Doctoral Program in Materials Science and Engineering

Field of Research	Faculty	Detailed Description of Research Field
Metals and ceramics	* (SAKURAI Kenji)	X-ray spectrometry and imaging. Novel X-ray analytical metrology to see changes of nano-meterscale structures and chemical states in realtime.
	※ (TSUCHIYA Koichi)	Research on the development of metallic functional/structural materials, such as, shape memory alloys, intermetallics, Ti alloys and metallic glass by phase transformation and deformation process, and clarification of the underlying physics and mechanisms of their functionality.
	HONO Kazuhiro	Development of magnetic and spintronic materials for energy efficient devices such as high density recording media and read sensors for next generation hard disk drives, magnetoresistive devices for high capacity MRAMs and high performance permanent magnets for automotive applications. These materials and devices are developed based on atomistic characterizations using transmission electron microscopy and atom probe tomography.
	MITANI Seiji	Development of magnetic materials and nanostructures by Atomic scale control based on state-of-the-art thin film growth techniques. Searching and understanding new functionalities in spin transport and their application to Spintronic devices.
	TAKANO Yoshihiko	We are focusing on the physical properties of high-Tc superconductor, diamond superconductor, Fe-based superconductor and carbon nanotube. Development of novel devices, including optical and field effect devices, using superconductors and nano-technologies are targets.
	MORI Takao	We focus on developing highly functional energy environment materials, such as, thermoelectric and battery materials, through atomic network control, synthesis of new materials, nano/microstructure control of materials with strong structure-property relationships from their topology.
	WATANABE Ikumu	We have developed a computer aided engineering framework to accelerate material research and development, based on multi-scale and multi-discipline modeling to characterize material behaviors and properties. We focus on especially structural materials for automotive and aviation industries.

Field of Research	Faculty	Detailed Description of Research Field
Nanomaterials	※(SASAKI Takayoshi)	Synthesis of functional nanosheets as a new class of nano-materials and organization of the nanosheets as a building block into nanostructured integrated systems with a sophisticated function such as photocatalytic, electronic, magnetic properties.
	TAKEDA Yoshihiko	We investigate femtosecond spectroscopy of inorganic and organic nanomaterials to develop functional materials for photonic-applications. We also study control of nano-scale structures, surface modification of organic and inorganic materials with advanced ion beam technology and nanoparticle assembly with biomolecules for bio-applications.
	NAKAYAMA Tomonobu	Fabrication and characterization of inorganic- / organic- / bio-nanostructures toward realization of novel functionalities at the nanometer scale, for future nanoelectronics and information technology, by using multiple-scanning-probe microscopy and related techniques.
	TANG Jie	Design and fabrication of functional structures, characterization of properties, and development for industrial applications of one-dimensional nanomaterials including carbon nanotubes and rare-earth boride nanowires.
	HASHIMOTO Ayako	Development and applications of transmission electron microscopy techniques and systems. We especially focus on in-situ observations of environmental and energy materials such as photovoltaic materials, fuel cells, rechargeable batteries and so on.
	YOSHIKAWA Genki	Development of new molecular sensors/systems towards mobile breath diagnostics, global-standard artificial olfaction, and new blood/fluid test. Fusion of physics, chemistry, biology, engineering, and economics.
Organic and Bio-Materials	TAKEUCHI Masayuki	Creation of new organic nanochemistry through the design, synthesis, and characterization of organic, macromolecular, and supramolecular materials with photo- and electro-active components, chemosensing functions, dynamic mechanical characters.
	CHEN Guoping	Preparation of biocompatible and biofunctional polymer biomaterials with controlled porous and surface structures using biodegradable polymers and bioactive factors, and their application for tissue engineering.

Field of Research	Faculty	Detailed Description of Research Field
	EBARA Mitsuhiro	Our research group is interested in developing smart biotechnologies using stimuli-responsive polymers. These smart biomaterials are designed to act as an “on-off” switch for drug delivery technologies, gene therapy, affinity separations, chromatography, diagnostics.
	TAGUCHI Tetsushi	Fundamental studies on the biomedical materials for minimal invasive therapy. We synthesize soft materials which show sol-gel transitions under the physiological environment and apply them for tissue/cell adhesives and drug-eluting stent, etc.
	NAITO Masanobu	Design and creation of nano-composite materials with emergent functions. Especially, our research covers multimaterial adhesive and coating based on polymeric / organic nanomaterials.
	KAWAKAMI Kohsaku	Development of pharmaceutical/cosmetic materials are of our research interests, where self-assembly and crystallization of organic molecules are utilized to add novel functions to those materials. Also focused is contribution to progress in physical chemistry behind the materials science.
Condensed Matter Physics	※ (UJI Shinya)	Using world-class superconducting magnet systems, we perform systematic measurements of various physical properties in strongly correlated superconductors and the related compounds, and try to find novel quantum phenomena.
	HU Xiao	Starting from the basic physics principles, we engage in exploring new frontiers of condensed matter physics and materials science, and discovering new quantum functionalities. Our recent focuses include topological electronic states in solids and novel topological phenomena in photonic & phononic metamaterials, as well as other wave systems.
	YAMAGUCHI Takahide	Research on superconductivity and quantum transport phenomena in carbon-based materials such as diamond and organic crystals. We perform sample fabrication using micro/nano-fabrication techniques and analysis at ultra low temperatures.
Semiconducting Materials	FUKATA Naoki	Fundamental and applied research on next-generation high-speed semiconductor transistors with low power consumption and new energy-related materials using functionalized semiconducting nanostructures and composite nanomaterials.

(Note)

- ◆ Applicants should discuss with a professor of their research field in advance.
  
- ◆ A professor with \* is retiring by 31 March, 2020.  
Only application of Ph.D. candidates for the Early Completion Program will be accepted.  
Please consult the faculty adequately prior to the application.
- ◆ Those marked with ※ will be retired by March 31, 2021.  
Only application of Ph.D. candidates for the Early Completion Program will be accepted.  
Please consult the faculty adequately prior to the application.

Inquiries about the entrance examination should be sent to:

Prof. Yoshihiko Takeda,

Chair, Doctoral Program in Materials Science and Engineering

e-mail: [nims\\_admin@pas.tsukuba.ac.jp](mailto:nims_admin@pas.tsukuba.ac.jp)

telephone: 029-863-5476

Relevant Homepages: <http://www.pas.tsukuba.ac.jp/>

[http://www.nims.go.jp/graduate/index\\_en.html](http://www.nims.go.jp/graduate/index_en.html)