Degree Programs in Pure and Applied Sciences
Graduate School of Science and Technology

Doctoral Program in Mathematics

Field of Research	Faculty	Detailed Description of Research Field
Algebra	※AKIYAMA Shigeki	Number theory and Ergodic Theory, in particular the interplay between them. Tilings.
	SAGAKI Daisuke	Combinatorial representation theory of Lie algebras and quantum groups.
	MASUOKA Akira	Hopf algebra theory, including its applications to quantum groups, and Galois theory of differential and difference equations.
	YAMAKI Kazuhiko	Arithmetic of algebraic varieties and nonarchimedean geometry
	CARNAHAN Scott	Moonshine, Automorphic forms, Algebraic geometry, Vertex algebras, Conformal fields
	KANEKO Hajime	Analytic number theory, uniform distribution theory and transcendental number theory
	KIMURA Ken-ichiro	Algebraic geometry and number theory: Study on K-groups and Chow groups.
	MIHARA Tomoki	p-adic number, global geometry, derived rigid geometry
	※〔MIKAWA Hiroshi〕	Prime number theory
Geometry	ONO Hajime	Differential Geometry, in particular the existence problem of canonical Riemannian metrics. Kähler manifolds, Sasaki manifolds
	KAWAMURA Kazuhiro	Geometric Topology, Geometry of Function spaces and Topological combinatorics.
	ISHII Atsushi	Low dimensional topology,　Knot theory
	TANGE Motoo	Handle decomposition and differential structure of 4-manifold, Dehn surgery
	NAGANO Koichi	Global Riemannian geometry, Geometry of metric spaces
	HIRAYAMA Michihiro	Dynamical systems, Ergodic theory
	YAMAMOTO Hikaru	Differential geometry. In particular, special geometry and geometric flow.
	AIYAMA Reiko	Differential geometry for surfaces and submanifolds.

Field of Research	Faculty	Detailed Description of Research Field
Analysis	KAKEHI Tomoyuki	Differential equations on symmetric spaces, Integral geometry.
	TAKEYAMA Yoshihiro	Special functions and their applications to mathematical physics and number theory
	HAMANA Yuji	Theory of stochastic processes, Stochastic analysis
	FUKUSHIMA Ryoki	Probability theory. In particular problems related to random media
	KINOSHITA Tamotsu	Hyperbolic systems, Wavelet.
	KUWABARA Toshiro	Representation theory of noncommutative algebras and vertex algebras via microlocal analysis.
Mathematics of Information	AOSHIMA Makoto	Statistical science, Large complex data, High-dimensional statistical analysis, Asymptotic theory
	YATA Kazuyoshi	High-dimensional statistics, Asymptotic theory, Machine learning, Sequential analysis
	OIKAWA Issei	Numerical analysis, Finite element methods, Discontinuous Galerkin methods
	SHIOYA Masahiro	Axiomatic set theory, in particular, infinitary combinatorics and large cardinals.
	TERUI Akira	Algorithms and applications in Computer Algebra, Symbolic Computation and Symbolic-Numeric Computation.
	TAKEUCHI Kota	Mathematical logic, Model Theory, in particular Stability Theory.

(Note)

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- Applicants are requested to discuss their research plan, prior to application, with the faculty member by whom they would like to be supervised.

For inquiries about the entrance examination, please contact:

Prof. Kazuhiro Kawamura, Chair, Doctoral Program in Mathematics
Email：kawamura#@#math.tsukuba.ac.jp (Remove "#")
Telephone: +81-29-853-4375

Website of Doctoral Program in Mathematics： https://nc.math.tsukuba.ac.jp

Doctoral Program in Physics

Field of Research		Faculty	Detailed Description of Research Field
Particle physics	Theory	ISHIBASHI Nobuyuki KURAMASHI Yoshinobu ISHIKI Goro ISHIZUKA Naruhito YAMAZAKI Takeshi 〔AKIYAMA Shinichiro〕 〔ASANO Yuhma〕 〔MOHRI Kenji〕 〔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) Theoretical studies related to string theory and quantum field theory (nonperturbative formulation of string theory such as string field theory and the matrix model, noncommutative geometry, gauge/gravity correspondence).
	Experiment	※UKEGAWA Fumihiko TAKEUCHI Yuji 〔SATO Koji〕 〔IIDA Takashi〕 〔HIROSE Shigeki〕	(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) Searches for neutrino decays and the determination of their masses using the cosmic neutrino background. (3) Development of new particle detectors for the LHC accelerator luminosity upgrade, linear electron-positron colliders, and other future experiments.
Astrophysics	Theory	OHSUGA Ken MORI Masao YAJIMA Hidenobu YOSHIKAWA Kohji 〔WAGNER Alexander〕 〔FUKUSHIMA Hajime〕	(1) Formation of Cosmic Structure and Observational Cosmology (2) Formation of the First Generation Objects (3) Formation and Evolution of Galaxies (4) Black Holes (5) Evolution of Planetary Systems and Astrobiology Theoretical researches on these issues by using simulations with supercomputers and by analytic methodology.
	Observation	KUNO Nario 〔HASHIMOTO Takuya〕 〔HONDA Shunsuke〕	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 SHIMIZU Noritaka	(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
		HINOHARA Nobuo 〔SATO Shunsuke〕	synthesis in the universe, large-scale nuclear structure calculation for interdisciplinary applications, etc. (2) Computational approaches to interaction between ultra-short laser pulse and material.
	Experiment	OZAWA Akira ESUMI Shinichi SASA Kimikazu CHUJO Tatsuya 〔MORIGUCHI Tetsuaki〕 〔NONAKA Toshihiro〕 〔NIIDA Takafumi〕 〔PARK Jonghan〕	(1) Experimental Study of Nuclear physics using relativistic heavy ion collider (Quark Gluon Plasma, Big Bang Cosmology, Reaction mechanism of high energy nuclear collision) (2) Evolution of Nucleosynthesis using RI beam (Nucleosynthesis, Unstable nuclei, Precise mass spectroscopy of rare nuclei) (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 (4) R&D of new experimental devices (Accelerator, detector, new application of accelerator beam)
Condensed matter physics	Theory	OTANI Minoru OKADA Susumu ※TOKURA Yasuhiro HATSUGAI Yasuhiro 〔TANIGUCHI Nobuhiko〕 〔YOSHIDA Kyo〕 〔MIZOGUCHI Tomonari〕 〔MARUYAMA Mina〕 〔GAO Yanlin〕 〔HAGIWARA Satoshi〕	(1) Computational material sciences (Otani, Okada, Maruyama, Gao, Hagiwara): 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. (2) Quantum transport (Tokura, Yoshida): 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. (3) Quantum theory of matter (Y. Hatsugai, T. Mizoguchi): 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.) (4) 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.

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	Experiment	KANDA Akinobu NISHIBORI Eiji MORITOMO Yutaka IKEZAWA Michio NOMURA Shintaro 〔MORISHITA Masashi〕 *〔HIGASHIYAMA Kazuyuki〕 〔KUBO Atsushi〕 〔TOMIMOTO Shinichi〕 〔KASAI Hidetaka〕 〔KOBAYASHI Wataru〕 〔NIWA Hideharu〕	(1) Low temperature physics (Kanda, Morishita) Mesoscopic electron transport in nanoscale systems: quantum effects in graphene and other atomic layer 2D materials, observation and manipulation of quantum states in mesoscopic superconductors. Low dimensional quantum properties in quantum fluids and quantum solids (helium) which appear with structural control. (2) Energy materials science (Y. Moritomo, W. Kobayashi, H. Niwa, and K. Higashiyama) Research of the energy materials and devices, such as, tertiary battery (energy harvesting), secondary battery, perovskite solar cell, thermoelectrics, and so on with use of Synchrotron-radiation X-ray (SPring-8, PF) and nano probes (NIMS). (3) Structural Materials Science (Nishibori, Kasai): 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. Advanced Structural research using X-ray free electron laser. (4) 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. (5) Optical nanoscience (Nomura): Studies on optical and spin properties of semiconductor nanostructures by advanced optical techniques. Studies on quantum spin systems in diamond NV centers, electron systems such as in heterostructures, and atomic layered compounds.
Biophysics	Theory	SHOJI Mitsuo 〔HORI Yuta〕	Simulation researches on biological macromolecules (proteins, nucleic acids and sugars) and supercomplexes. Development of computational

Field of Research		Faculty	Detailed Description of Research Field
			methods to reveal the structure-function relationship, enzymatic catalytic reaction and origin of life.
Plasma Physics	Experiment	SAKAMOTO Mizuki ※KARIYA Tsuyoshi MINAMI Ryutaro YOSHIKAWA Masayuki 〔KOHAGURA Junko〕 〔HIRATA Mafumi〕 〔NUMAKURA Tomoharu〕 〔HWANGBO Dogyun〕 〔EMOTO Kazuma〕	(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 and radio frequency wave, 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 plasma thruster. (5) Study on plasma-material interaction.

【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) (Nishimura)
Nuclear Fusion and Plasma Physics	※IDE Shunsuke SAKAMOTO Yoshiteru NAKANO Tomohide (QST)	(1) Study on integrated scenario of a large nuclear fusion device. (2) Study on core-boundary plasma physics for a large nuclear fusion device. (3) Study on plasma control scenario for a nuclear fusion reactor.
Frontier Materials Science	YAMAMOTO Tsuyoshi (NEC) Work location is AIST	Research on superconducting devices for quantum information processing application. Circuit-based quantum electronics is explored with technologies such as nano-fabrication and microwave engineering.

Field of Research	Faculty	Detailed Description of Research Field
	YUGE Ryota (NEC) Work location is AIST	Research on devices with carbon nanotubes and carbon nanobrushes. They contain the material preparation, characterization, and sensing and energy device applications.
	SASAKI Ken-ichi (NTT)	We study the electronic properties of graphene, graphite, and carbon nanotube using the method of condensed matter physics. We aim for theoretical proposal of new and versatile ideas.
	SHINYA Akihiko (NTT)	Research on ultra-compact and ultra-low power photonic devices and circuits, novel photonic phenomena in nanostructures.
	OGURI Katsuya (NTT)	Research on ultrafast optical physics, in particular, attosecond physics. We are investigating lightwave-matter interaction dynamics on extreme short time scale by developing various attosecond time-resolved spectroscopic techniques.

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(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. Yasuhiro Tokura, Chair, Doctoral Program in Physics
Email：tokura.yasuhiro.ft#@#u.tsukuba.ac.jp (Remove "#" before sending an email)
Telephone: +81-29-853-4277
Website of Doctoral Program in Physics： https://grad.physics.tsukuba.ac.jp/

(Remarks) The 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

(NEC)＝NEC Corporation
(NTT)＝NTT Basic Research Laboratories

Doctoral Program in Chemistry

Field of Research	Faculty	Detailed Description of Research Field
Inorganic and Analytical Chemistry	KOJIMA Takahiko 〔ISHIZUKA Tomoya〕 〔KOTANI Hiroaki〕	Synthesis of transition-metal complexes and their reactivity in various redox and catalytic reactions; Development of photo- and redox-functionality of non-planar and fused porphyrins.
	※NAKATANI Kiyoharu 〔NAGATOMO Shigenori〕 〔MIYAGAWA Akihisa〕	Studies on physical and chemical processes of microdroplet, microparticle, and biopolymer using spectroscopic and electrochemical techniques.
	NIHEI Masayuki 〔SHIGA Takuya〕 〔MIHARA Nozomi〕	Chemistry of multi-nuclear metal clusters with controlled structures and electronic states; Creation of ultra-small metal/metal oxide nano-particles.
	SAKAGUCHI Aya 〔YAMASAKI Shinya〕	Studies on naturally-occurring/anthropogenic radionuclides in the environment; Study on radioactive wastes for their volume reduction.
Physical Chemistry	ISHIBASHI Taka-aki 〔SATO Tomoo〕 〔KONDOH Masato〕	Studies on interfaces and condensed phases by linear and nonlinear molecular spectroscopy (Ishibashi, Kondoh); Studies on photofunctions and photochemical properties of newly fabricated molecular assemblies and inorganic particles in mesoscopic scale (Sato)
	ENAMI Shinichi	Atmospheric multiphase chemistry, interface chemistry and physics, biosurface chemistry, and molecular-level inhomogeneity on/in liquid phases.
	NISHIMURA Yoshinobu	Synthesis of emissive compounds and kinetic analyses of formation and deactivation processes of the emissive state by TCSPC.
	MATSUI Toru	Material design and bio-molecular modeling based on computational chemistry.
	MOMOTAKE Atsuya	Development of useful molecules for photodynamic therapy and elucidation of reaction mechanisms, and development of nucleic acid adjuvants.
	YAMAMURA Yasuhisa	Structure and property of soft molecular systems, and dynamics and phase transitions in them.

Field of Research	Faculty	Detailed Description of Research Field
Organic Chemistry	SASAMORI Takahiro 〔ICHINOHE Masatoshi〕 〔OHYOSHI Takayuki〕	Studies on synthesis of novel main-group-element compounds with unusual chemical bonds and elucidation of their chemical and physical properties. Creation of the novel species of main-group-element compounds in pursuit of unique organic reactions and functions utilizing main group elements. (Sasamori, Ichionohe); Isolation, structural elucidation, synthesis, and bioorganic studies of bioactive natural products. Design, synthesis and biological evaluation of novel biologically active molecules. (Ohyoshi)
	FUCHIBE Kouhei	Development of synthetic reactions using organofluorine and organometallic compounds.
	YOSHIDA Masahito	Bioorganic studies on bioactive natural products and related analogs based on isolation and total synthesis.
	NAKAMURA Takashi	Precise construction of functional molecules based on supramolecular chemistry, and exploration of their properties such as molecular recognition and selective reaction. Studies on supramolecular metal complexes utilizing organic ligands and metal ions.
Interdisciplinary Chemistry	IWASAKI Kenji 〔YOSHIDA Hisashi〕 〔HARADA Ayaka〕	Study of proteins in soft-tissue sarcoma, chromatin remodeling factors and a photosensing flavoprotein. Structural biology and chemistry using single-particle cryo-EM and its development.
	KUTSUMURA Noriki 〔SUGAI Tomoya〕	Design and synthesis of protein kinase ligands regulating sleep/wakefulness, Synthesis of biologically active nitrogen–containing heterocycles, Studies on chemoselective reaction useful for drug discovery.

【Cooperative Graduate School System】

Field of Research	Faculty	Detailed Description of Research Field
Materials Inorganic Chemistry	AKIMOTO Junji （ＡＩＳＴ）	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).
High-pressure Organic Chemistry	KAWANAMI Hajime （ＡＩＳＴ）	Studies in Organic Chemistry with High-pressure and Supercritical Fluids includes High-pressure Hydrogen Production, Carbon Dioxide Utilization Chemistry, Biomass Conversion, etc.

Field of Research	Faculty	Detailed Description of Research Field
Surface Electrochemistry	SATO Yukari （ＡＩＳＴ）	Functionalization of solid and electrode surfaces. Redox flow battery for renewable energy introduction. Construction of micro multi sensing devices for marine environment.
Organic Electronics Chemistry	YOSHIDA Yuji （ＡＩＳＴ）	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).
Nano-Carbon Materials Chemistry	OKAZAKI Toshiya （ＡＩＳＴ）	Development of functional nano-carbon materials and characterizations of their physical properties.
Photofunctional Materials Chemistry	NORIKANE Yasuo （ＡＩＳＴ）	Photofunctional organic molecules especially showing photo-induced solid-liquid phase transitions and lightdriven mechanical motion.
Functional Polymer Gel Chemistry	HARA Yusuke （ＡＩＳＴ）	Research and development of functional polymers and polymer gels for application to soft actuators, soft robots, micro fluidic devices.
Organic Reaction Chemistry	MINAMI Yasunori （ＡＩＳＴ）	Research and development of organic reactions and catalysts for precise organic transformations of stable chemicals including polymers

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Prof. Masayuki Nihei, Chair, Doctoral Program in Chemistry/
Prof. Takahiro Sasamori, Member of the Academic Committee Doctoral Program in Chemistry
Telephone: +81-29-853-4238・4412
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(AIST)＝The National Institute of Advanced Industrial Science and Technology

Doctoral Program in Engineering Sciences
Subprogram in Applied Physics

Field of Research	Faculty	Detailed Description of Research Field
Optical and Quantum Engineering	ITOH Masahide	(1) Optical Information processing and optical metrology. Development of optical instrumentation and devices.
	YASUNO Yoshiaki	(2) Fundamental, instrumentation, application research on optical tomographic imaging for medical and lifescience applications. It includes optical coherence tomography and quantitative three-dimensional functional microscopy.
	HADA Masaki	(3) Femtosecond time-resolved electron diffraction measurements: filming “molecular movies” of photo-reactive or responsive materials, Terahertz-wave engineering.
	WATANABE Norio	(4) Development of X-ray imaging optics and its application to X-ray microtomography.
Instrumentation Physics	*SASAKI Masahiro	(5) Observations and controls of surface/interface properties by using supersonic molecular/atomic beams, scanning probe microscopes and other spectroscopic and microscopic techniques
	SHIRAKI Kentaro	(6) Technology of protein folding and application of biomaterials
	※FUJITA Jun-ichi	(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
	SEKIGUCHI Takashi	(8) Basics and application of scanning electron microscope (SEM). Electron and material interactions and physics of secondary and reflective electron. New measurement method by the electron beam.
	SOHDA Yasunari	(9) Basic and application of scanning electron microscope (SEM). Electron optics and measurement of electron beam. Enhancement of SEM system and proposal new system.
	ITO Yoshikazu	(10) Synthesis, characterizations and fabrication of 3D materials using graphene and two dimensional materials for developments of catalysts, device applications and energy harvesting devices with renewable energy sources

Field of Research	Faculty	Detailed Description of Research Field
	KOBAYASHI Nobuhiko	(11) Condensed matter theory. Computational materials science. Density functional theory for nonequilibrium systems. Theory of charge, heat and spin transport in nanoscale systems.
	TERADA Yasuhiko	(12) Development of new imaging methods based on NMR and MRI
	YAMADA Yoichi	(13) Surface and molecular sciences on the structure-property relationships of the self-organized organic semiconductors.
Quantum Beam and Plasma Engineering	EZUMI Naomichi	(14) 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 plasma measurement systems.
	TOMITA Shigeo	(15) Experimental studies on advanced atomic physics and atomospheric science using charged particle beams from accelerators
Nano-Technology	HASE Muneaki	(16) Ultrafast laser spectroscopy on semiconductors and dielectric materials using femtosecond laser and application to optical devise and controlling phase transitions
	UMEDA Takahide	(17) Electron-spin-resonance(ESR)-based characterization on nano-electronics devices and power-electronics devices
	TAKEUCHI Osamu	(18) 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
	MAKIMURA Tetsuya	(19) Nano- and Micro-machining and materials synthesis using laser produced plasma EUV light and laser light
	YOSHIDA Shoji	(20) 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

Field of Research	Faculty	Detailed Description of Research Field
		develop new microscopy techniques based on scanning probe microscopy and advanced laser technologies, which, for example, enable ultimate spatial and temporal resolutions, simultaneously.
	OIGAWA Haruhiro	(21) Experimental study on nano physics and spectroscopy
	ARASHIDA Yusuke	(22) Optical control of electrons in solids and molecules in femtosecond temporal regime and Developing atomic scale imaging of the ultrafast phenomena.
Semiconductor Electronics (Power Electronics)	UEDONO Akira	(23) Study of defects in materials using positron annihilation and developments of positron annihilation spectroscopy.
	*SANO Nobuyuki	(24) Simulation and theoretical studies of Electron transport phenomena under nanoscale semiconductor structures, and device modeling and simulation of device characteristics.
	SUEMASU Takashi	(25) High-efficiency thin-film solar cells, thermoelectric devices, and spintronics materials using safe, stable, and abundant elements.
	HASUNUMA Ryu	(26) Development of highly reliable gate dielectric films for future LSI.
	TOKO Kaoru	(27) Research on materials and processes for highly functional thin films for flexible energy devices.
	OKUMURA Hironori	(28) Crystal growth of wide bandgap semiconductors and development of their optical and electrical devices.
	SELVAKUMAR Sellayan	(29) Defect studies on Fe based alloys and nanostructured materials by positron annihilation spectroscopy.
Optoelectronics and Spintronics (Power Electronics)	OHNO Yuzo	(30) Research on electronic, optical, and spin properties of semiconductor nanostructures, and spin injection and control which are the basis of spin lasers for ultra-high-speed and low-power consumption technologies
	SAKURAI Takeaki	(31) Development of highly efficient organic and inorganic thin-film solar cells. Characterization of defects in power semiconductor devices.
	YANAGIHARA Hideto	(32) Thin film growth of advanced magnetic oxides for spintronics devices.
	ISLAM Muhammad Monirul	(33) Growth and characterization of thin-film semiconductors for application in energy devices, such as solar cells and photocatalyst. Study of

Field of Research	Faculty	Detailed Description of Research Field
		nanostructured semiconductors for battery application.
	SHARMIN Sonia	(34) Using machine learning to analyze light emission spectra during sputtering
	TRAORE Aboulaye	(35) Ultra-wide bandgap semiconductors electron devices: development of device technologies for power-electronics and quantum sensing, investigation and modelling of electron transport mechanisms, defects characterizations.
Power Electronics	IWAMURO Noriyuki	(36) Research on improvement of power semiconductor devices characteristics for achieving a low loss and high withstand capability.
	ISOBE Takanori	(37) Study on circuit topologies and control for efficiency and power density improvement in power converters, and its emerging applications.
	YANO Hiroshi	(38) 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)	(39) Diamond growth, and electronic device fabrication using unique properties.
Optoelectronics and Spintronics	YUASA Shinji (AIST)	(40) Research and development of magnetic tunnel junctions, magnetoresistive random access memory MRAM and other spintronic devices.
Surface Science	MIYAKE Koji (AIST)	(41) Surface functionalization by nano-/micro-structures and surface modifications.
Power Electronics	KOJIMA Kazutoshi (AIST)	(42) 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.

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Inquiries about the entrance examination should be sent to:

Prof. SUEMASU TAKASHI, Chair, Subprogram in Applied Physics
Email：suemasu.takashi.gu#@#u.tsukuba.ac.jp (Remove "#" before sending an email)
Telephone: +81-29-853-4966

For more information, please refer to the following websites:

Website of the Degree Programs in Pure and Applied Sciences: http://www.pas.tsukuba.ac.jp/
Website of Doctoral Program in Engineering Sciences Subprogram in Applied Physics：
https://applphys.bk.tsukuba.ac.jp/

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

Doctoral Program in Engineering Sciences
Subprogram in Materials Science

Field of Research	Faculty	Detailed Description of Research Field
Quantum Physics of Solid State	KURODA Shinji	(1) 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.
	MATSUISHI Kiyoto	(2) Study on optical properties and high-pressure physics of nanostructured semiconductors, such as quantum dots, organic-inorganic complexes, nano-carbon hybrids, and perovskites for search of new optically-functionalized materials.
	FUJIOKA Jun	(3) 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.
	MARUMOTO Kazuhiro	(4) 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.
	JUNG Min-Cherl	(5) Understanding of defect, phonon-dispersion, and electronic structures in organic-inorganic hybrid perovskite materials and new applications such as THz-wave sensing, modulating, and imaging devices.
	KASHIWAGI Takanari	(6) Development of terahertz-waves emitters, detectors and applications based on single crystals of high temperature superconductors. Study of material characteristics of single crystals of high-temperature superconductors.
	MORI Tatsuya	(7) Fundamental research and application development on universal excitations appearing in disordered systems. We aim to understand the dynamics of glasses and proteins using terahertz spectroscopy and molecular dynamics simulation, and to develop novel applications of terahertz light.

Field of Research	Faculty	Detailed Description of Research Field
Theoretical Quantum Physics	KOIZUMI Hiroyasu	(8) Theoretical study of superconductivity in strongly-correlated materials and topological materials, and their application to fault-tolerant quantum computers.
	SUZUKI Shugo	(9) First-principles study of structural and electronic properties of materials
	TONG Xiao-Min	(10) 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.
	MAESHIMA Nobuya	(11) Theoretical study of photo-induced phenomena in strongly correlated electron systems and topological materials
Materials Physics and Engineering	KIZUKA Tokushi	(12) Development of heat resistance materials and carbon fiber-reinforced composites for aircrafts and jet engines, nanowires, nanocontacts devices, and mechanical and friction nanostructures for nanodevices by electron microscopy.
	KIM Hee Young	(13) Development and characterization of novel functional alloys and biomaterials including biomedical superelastic alloy, high temperature shape memory alloy, high entropy alloy and gum metal
	TOKORO Hiroko	(14) 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	(15) 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	(16) Development of new inorganic materials for energy and environmental applications such as solar cells and environmental purification filters
	TANIMOTO Hisanori	(17) Research on characteristic properties and application of nanostructured materials (amorphous alloys and metallic nanoparticles etc.) and high-entropy alloys.

Field of Research	Faculty	Detailed Description of Research Field
	TAKAHASHI Miwako	(18) Phase transitions and structural fluctuations in magnetic alloys and compounds studied by diffraction techniques using quantum beams (neutron beams and X-rays)
Materials Chemistry and Biotechnology	KANBARA Takaki	(19) Development and characterization of novel functional polymers and organometallic compounds directed toward organic devices and catalysts
	*NAGASAKI Yukio	(20) Design of functional polymer materials for biomaterials and environmental friendly materials (Drug delivery systems, nanomedicines, biosensing, biodegradable polymers)
	YAMAMOTO Yohei	(21) Self-assembly of π-conjugated molecules, polymers, and biomolecules to construct electronic, optical, and energy conversion devices.
	OISHI Motoi	(22) Development and design of novel point of care testing (POCT) devices and nano-machines based on DNA nano-system.
	KUWABARA Junpei	(23) Development of new molecular catalysts, facile synthetic methodology for conjugated molecules, and luminescent metal complexes.
	*KOBAYASHI Masami	(24) Photosynthesis (pigment analysis). Photodynamic Therapy by Chlorophylls. Algae and algal oil.
	GOTO Hiromasa	(25) Synthesis and properties of low-molecular mass compounds and polymeric materials having magnetism, electrical conductivity, photo-isomerization, optical rotation, and circular dichroism
	KONDO Takahiro	(26) Creating new materials contributing to the carbon neutrality, surface physics and chemistry at atomic scale, surface reaction dynamics, and creating new materials composed of boron.
	TSUJIMURA Seiya	(27) Electrochemistry of redox enzymes and its application to biosensors and biofuel cells
	TAKEYASU Kotaro	(28) Elucidation of the mechanism of electrocatalytic reactions and development of catalysts. We study the mechanisms of biological reactions and design CO_2 conversion reactions based on the mechanisms.

【Cooperative Graduate School System】

Field of Research	Faculty	Detailed Description of Research Field
Materials Chemistry and Biotechnology	CHOI Jun-Chul (AIST)	We aim at the development of high efficiency catalyst for green synthetic processes and material design of highly dispersed metal catalyst.
	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, 2025. Only application of Ph.D. candidates for the Early Completion Program will be accepted. Applicants who wish to conduct research under their supervision should consult the faculty adequately prior to the application.
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- Applicants should have a thorough discussion with a professor of their research field about your research plan in advance.

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

Doctoral Program in Engineering Sciences
Subprogram in Materials Science and Engineering

Field of Research	Faculty	Detailed Description of Research Field
Metals and ceramics	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	Our lab is developing high-Tc superconductors and functional materials. Using machine learning and first-principles calculation, we search for candidate materials, and synthesize and evaluate them by newly developed diamond anvil cell that can measure physical properties multimodally under high pressure. Our ultimate goal is to discover room-temperature superconductivity, a dream of humankind.
	MORI Takao	We focus on developing highly functional energy environment materials, such as, thermoelectric and thermal management 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.
	UCHIDA Ken-ichi	Development of novel science and technology of "Spin caloritronics", an interdisciplinary field between spintronics physics and thermal energy engineering. Spin caloritronics enables unconventional thermoelectric generation and thermal energy control, which are investigated by cutting-edge heat and spin detection techniques.
	SHIBATA Akinobu	Main our research target is structural metallic materials (particularly, steel). We are investigating microstructure evolution by phase transformation, relationship between deformation / fracture behavior (mainly brittle fracture, such as hydrogen embrittlement) and microstructure. We try to propose novel alloy design and microstructure design concepts for developing advanced steels from theoretical background.

Field of Research	Faculty	Detailed Description of Research Field
Nanomaterials	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	Research and development of olfactory sensors, the last frontier of the five senses. Based on various basic sciences such as structural mechanics, materials science, fluid mechanics, system engineering, and informatics, we will conduct comprehensive research and development of novel hardware and software with unprecedented performance, aiming for social implementation through industry-academia-government collaboration.
	ISHII Satoshi	Studies on developing novel photonic nanostructures for extraordinary optical properties and photoelectric/photothermal conversions. Includes both numerical and experimental works to develop, for examples, optical metamaterials and photonic nanostructures to harvest sunlight as well as solar heat.
	KAWAI Shigeki	Single molecular chemistry with high-resolution atomic force microscopy/scanning tunneling microscopy. Development of local probe chemistry. Functionalized nano-carbon materials synthesized by on-surface chemical reaction.
	SODEYAMA Keitaro	The working mechanism of energy-related materials such as lithium-ion batteries will be clarified by first-principles molecular dynamics simulations using a supercomputer. We also use the machine learning techniques to find new feasible materials with experimentalists.
	SAKURABA Yuya	Focusing on special transport and thermoelectric effects derived from magnetism and spin, we studied new magnetic thin film materials and multilayer nanostructures. In addition to the fundamental research, we are also conducting research for practical devices such as next-generation data storage, ultra-sensitive magnetic sensors, and novel thermoelectric power generation applications.

Field of Research	Faculty	Detailed Description of Research Field
Organic-and Bio-Materials	TAKEUCHI Masayuki	Creation of new organic nanochemistry thorough 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.
	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	Basic research on polymer-based medical materials for minimally invasive treatment and tissue regeneration. By synthesizing polymeric materials that change from sol to gel in the in vivo environment and combining these materials with cells and drugs, we will develop tissue adhesive materials, anti-adhesive materials, injectable materials for localized cancer treatment, and other applications.
	NAITO Masanobu	We aim to research and develop functional materials that contribute to the circular economy, such as self-healing materials, adhesives, coatings, and superhydrophobic materials, through data-driven research using state-of-the-art autonomous smart lab systems and materials informatics.
	KAWAKAMI Kohsaku	Development of pharmaceutical/cosmetic materials are of our research interests, where self-assembly phenomena of organic molecules are utilized to add novel functions. Also focused is regulation of non-equilibrium behaviors of soft materials, which is important for maximizing function of drug products.
Condensed Matter Physics	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.

Field of Research	Faculty	Detailed Description of Research Field
	YAMAGUCHI Takahide	Research on fundamental properties and device applications of diamond as an electronic material for power electronics, quantum information processing, and sensing. Development of quantum devices based on heterostructures consisting of diamond and two-dimensional materials such as graphene and h-BN.
	SAKAUSHI Ken	We conduct our research to solve modern energy issues through unveiling basic principles and synthesis of materials of electrochemistry towards fuel-cells and rechargeable batteries. We put special emphasis on researches in collaboration with experiments, theoretical calculations, and data science, focusing on the following two points: (1) uncovering reaction mechanisms by using model electrodes, and (2) design and synthesis of novel electrode materials.
Semiconducting Materials	FUKATA Naoki	The basic and applied research of next generation semiconductor transistor materials and new environment and energy related materials, which are characterized by high speed and low power consumption by compounding semiconductor nanomaterials of different dimensions and material types, is comprehensively carried out.

(Note)

- Applicants should discuss with a professor of their research field in advance.

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Relevant Homepages: https://www.nims.go.jp/tsukuba/en/

Doctoral Program in Materials Innovation

Field of Research	Faculty	Detailed Description of Research Field
Energy Materials Engineering	SUEMASU Takashi	High-efficiency thin-film solar cells, thermoelectric devices, and spintronics materials using safe, stable, and abundant elements.
	NISHIBORI Eiji	Structural Materials Science: 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.
	MORITOMO Yutaka	Energy materials science: Research of the energy materials and devices, such as, sodium-ion secondary battery, perovskite 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.
	SAKURAI Takeaki	Development of highly efficient organic and inorganic thin-film solar cells. Characterization of defects in power semiconductor devices.
	TOKORO Hiroko	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
	SUZUKI Yoshikazu	Development of new inorganic materials for energy and environmental applications such as solar cells and environmental purification filters
	HADA Masaki	Femtosecond time-resolved electron diffraction measurements: filming “molecular movies” of photo reactive or responsive materials, Terahertz-wave engineering.
	MORI Takao (NIMS)	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.

Field of Research	Faculty	Detailed Description of Research Field
	INOUE Isao (AIST)	Ultra-low-power IT is an urgent necessity, and we challenge the problem by mimicking the brain. Artificial neurons/synapses and their circuits are in development with new materials and physics POV.
	YU Denis Y. W. (NIMS)	Synthesis and characterizations of battery materials: study the effect of surface chemistry and structure on electrochemical performance, long-term stability and safety
	SEPEHRI AMIN Hossein (NIMS)	Studies on high-performance magnetic materials for green energy conversions and data storage applications using a combinatorial research approach, i. e. multi-scale microstructure characterizations, micromagnetic simulations, data science, and materials processing.
Environment-friendly Materials	YAMAMOTO Yohei	Self-assembly of π-conjugated molecules, polymers, and biomolecules to construct electronic, optical, and energy conversion devices.
	SHIRAKI Kentaro	Technology of protein folding and application of biomaterials
	KONDO Takahiro	Formation and application of new two-dimensional material of boron, development of a substitute material of Pt at the Fuel Cell electrode using nitrogen-doped carbon, and reaction dynamics at surface based on the fine e xperimental measurements.
	SASAMORI Takahiro	Main group element chemistry. Creation of novel compounds with unique chemical bondings by utilizing element properties. Development of unique organic reactions with main group element compounds.
	TSUJIMURA Seiya	Electrochemistry of redox enzymes and its application to biosensors and biofuel cells
	TAKEYASU Kotaro	Elucidation of the mechanism of electrocatalytic reactions and development of catalysts. We study the mechanisms of biological reactions and design CO_2 conversion reactions based on the mechanisms
	YAMAGISHI Hiroshi	We develop novel molecular crystals with distinct structural flexibility by assembling the constituent molecules via extremely weak intermolecular interactions in a programmable manner.

Field of Research	Faculty	Detailed Description of Research Field
	NAKAMURA Takashi	Precise construction of functional molecules based on supramolecular chemistry, and exploration of their properties such as molecular recognition and selective reaction. Studies on supramolecular metal complexes utilizing organic ligands and metal ions.
	TAKEUCHI Masayuki (NIMS)	Creation of new organic nanochemistry thorough the design, synthesis, and characterization of organic, macromolecular, and supramolecular materials with photo- and electro-active components, chemosensing functions, dynamic mechanical characters.
	NAITO Masanobu (NIMS)	Development of functional polymer materials using machine learning and smart labs. In particular, we will create innovative composite materials that support people's safety and security through the development of bonding and coating materials with different materials, antibacterial, antiviral, and superhydrophobic materials.
	HIMEDA Yuichiro (AIST)	Design and development of organometallic catalysts for carbon dioxide conversion and hydrogen storage. Methanol synthesis at low temperature from carbon dioxide. Hydrogen production from formic acid.
	NORIKANE Yasuo (AIST)	Photofunctional organic molecules especially showing photo-induced solid-liquid phase transitions and lightdriven mechanical motion.
	Lok Kumar Shrestha (NIMS)	Fabrication of fullerene-based new functional nanomaterials using nanoarchitectonics concept. We produce ultra-high surface area nanoporous fullerene crystals, and convert them into hierarchically porous carbon materials by high temperature heat treatment for the high-performance supercapacitor and vapor sensing applications.
	KATSURA Yukari (NIMS)	Design of inorganic functional materials database for experimental materials informatics. Searches for new inorganic crystals and new thermoelectric materials by data science, first-principles calculation and experiments.
	WEI Qingshuo (AIST)	We aim to understand the doping mechanisms of organic semiconductors, develop new materials and design devices based on them, and to commercialize organic thermoelectric devices and thermoelectrochemical cells.

Field of Research	Faculty	Detailed Description of Research Field
Electronic Materials	HASE Muneaki	Ultrafast laser spectroscopy on semiconductors and dielectric materials using femtosecond laser and application to optical devise and controlling phase transitions
	YANAGIHARA Hideto	Thin film growth of advanced magnetic oxides for spintronics devices
	OKADA Susumu	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.
	OHNO Yuzo	Studies of electronic, optical, and spin properties of semiconductor nanostructures, and spin coherence for quantum information and low-power 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.
	TAKEUCHI Osamu	Development of new microscopy techniques by combining nanometer-resolving scanning probe microscopy and optical measurement techniques, in order to reveal nanometer-scale optoelectronicprocesses in solar cells, light emitting diodes, and spintronics devices and to improve their device performance
	JUNG Min-Cherl	Understanding of defect, phonon-dispersion, and electronic structures in organic-inorganic hybrid perovskite materials and new applications such as THz-wave sensing, modulating, and imaging devices.
	TONG Xiao-Min	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.
	FUJIOKA Jun	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.

Field of Research	Faculty	Detailed Description of Research Field
	OISHI Motoi	Development and design of novel point of care testing (POCT) devices and nano-machines based on DNA nano-system.
	KUWABARA Junpei	Development of new molecular catalysts, facile synthetic methodology for conjugated molecules, and luminescent metal complexes.
	YUASA Shinji (AIST)	Research and development of magnetic tunnel junctions, magnetoresistive random access memory MRAM and other spintronic devices.
	TAKANO Yoshihiko (NIMS)	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.
	MITANI Seiji (NIMS)	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.
	SANG Liwen (NIMS)	Development on the optical, electronic and mechanical devices based on polarization field in III-V nitride semiconductors. Physical properties engineering at semiconductor nanointerfaces.
Synchrotron-Radiation Materials Engineering	AMEMIYA Kenta (KEK)	Elucidation of the function expression mechanism by operando observation of surface and interface using quantum beams.
	KUMAI Reiji (KEK)	Study using quantum beams such as synchrotron radiation to reveal the origin of macroscopic physical properties from the microstructure inside materials in condensed matter.
	YOKOO Tetsuya (KEK)	The dynamics in functional materials, in particular high-Tc superconductors and quantum spin systems are the target of research. Neutron scattering technique is utilized as a probe, also physical thermodynamic quantities will be measured to elucidate the mechanism in materials.

(Note)

- Applicants should have a thorough discussion with a professor of their research field about your research plan in advance.

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