

4. Research Reports

4.1. GCOE Program Members

The GCOE has been organized by the program members of 26 professors of Tohoku University in 2012 fiscal year. Their research fields are in Physics, Astronomy, Mathematics and Philosophy. The list of members and their research titles is as follows. Then, their research reports are the following.

- **Kunio Inoue** (Physics, Professor, Program Leader)
Search for Neutrino-less Double-Beta-Decay with KamLAND-Zen

- **Ken-ichi Hikasa** (Physics, Professor)
Theoretical High Energy Physics

- **Yoshio Kuramoto** (Physics, Professor)
Theory of strongly correlated electrons and topological insulators

- **Yoshiro Hirayama** (Physics, Professor)
Transport characteristics of semiconductor quantum systems,
Hyperfine interactions and novel NMR (NER),
NMR (NER) studies of semiconductor quantum systems,
Nanoprobng of semiconductor quantum systems,
Transport characteristics of nano-materials

- **Hirokazu Tamura** (Physics, Professor)
Hypernuclear Physics

- **Masahiro Yamaguchi** (Physics, Professor)
Particle theory and cosmology

- **Riichiro Saito** (Physics, Professor)
Optical properties of carbon nanotubes and graphene

- **Hitoshi Yamamoto** (Physics, Professor)
Electron-positron colliders

- **Toshihiro Kawakatsu** (Physics, Professor)

Study on structure and dynamics of soft matter

- **Teruya Ishihara** (Physics, Professor)
Light-Matter interaction in metallic photonic crystals and metamaterials
- **Toshio Kobayashia** (Physics, Professor)
Study on Unstable Nuclides
- **Hajime Shimizu** (Physics, Professor)
Quark Nuclear Physics with a Photon Beam
- **Yasuhiro Sakemi** (Physics, Professor)
Study of the violation of time reversal invariance with the search for electron electric dipole moment.
- **Takashi Takahashi** (Physics, Professor)
Ultrahigh-resolution photoemission study of topological insulators, graphene, and novel superconductors
- **Katsumi Tanigaki** (Physics, Professor)
 1. Materials with regulated nano spaces: Ubiquitous-element strategy
 2. Carbon materials
 3. Dirac-cone quantum states on topology and geometrical symmetry
 4. Molecular semiconductors: Fundamentals in device physics
- **Motoko Kotani** (Mathematics, Professor)
Mathematical challenge to a new phase of materials science
- **Reiko Miyaoka** (Mathematics, Professor)
Differential Geometry
- **Takashi Shioya** (Mathematics, Professor)
Geometry
- **Takyoshi Ogawa** (Mathematics, Professor)
Real and Harmonic Analysis on Nonlinear PDE
- **Kazuhihiro Ishige** (Mathematics, Professor)

Asymptotic profiles of the solutions for nonlinear parabolic equations

- **Toshifumi Futamase** (Astronomy, Professor)
General Relativity, Cosmology

- **Takashi Ichikawa** (Astronomy, Professor)
Study of galaxy evolution at high redshift universe and new instruments for infrared astronomy in Antarctica

- **Toru Yamada** (Astronomy, Professor)
Galaxy Formation and Evolution

- **Makoto Hattori** (Astronomy, Professor)
Construction of high accuracy components separation scheme for dramatic improvement of detection limit of primordial gravity wave origin cosmic microwave background polarization B-mode signal

- **Keiichi Noe** (Philosophy, Professor)
Science and Technology after the Great East-Japan Earthquake
Narratology of Historiography

- **Kiyotaka Naoe** (Philosophy, Associate Professor)
Study of Philosophy and Ethics of Technology

Name	Kunio Inoue
Department	Research Center for Neutrino Science
Position	Professor
Research Title	Search for Neutrino-less Double-Beta-Decay with KamLAND-Zen

I. Summary of Research

1. The world most sensitive search for neutrino-less double beta decay has been performed using ^{136}Xe in KamLAND-Zen. The obtained lower limit of the half-life of neutrino-less mode, 1.9×10^{25} years at 90% confidence level, can be translated to the upper limit of effective Majorana neutrino mass of 160-330 meV depending on various calculations of the nuclear matrix element.
2. Combined with the EXO-200 (the second most sensitive) result using the same ^{136}Xe atoms, limits are improved to 3.4×10^{25} years and 120-250 meV. The limit refutes the positive claim once made using ^{76}Ge under the common assumption of light Majorana neutrino exchange and with up-to-date calculations of nuclear matrix elements. This is the first milestone toward resolving neutrino mass structure and neutrino-antineutrino equality.

II. Publications

1. "Measurement of the Double-Beta Decay Half-life of ^{136}Xe in KamLAND-Zen", KamLAND-Zen Collaboration, Physical Review C85, 045504 (2012)
2. "Limits on Majoron-Emitting Double-Beta Decays of ^{136}Xe in KamLAND-Zen", KamLAND-Zen Collaboration, Physical Review C86, 021601(R) (2012)
3. "Limits on Neutrinoless Double-Beta Decay of ^{136}Xe from the First Phase of KamLAND-Zen and Comparison with the Positive Claim in ^{76}Ge ", KamLAND-Zen Collaboration, Physical Review Letters 110, 062502 (2013)

III. Presentations

1. "Results from KamLAND-Zen", K.Inoue for the KamLAND-Zen collaboration, The 25th International Conference on Neutrino Physics and Astrophysics, June 3-9 (6), 2012, Kyoto, Japan
2. "Status of KamLAND-Zen", K.Inoue for the KamLAND-Zen collaboration, Neutrinos and Dark Matter in Nuclear Physics, June 11-15 (11), 2012, Nara, Japan
3. "KamLAND2-Zen", K.Inoue, 5th CRC future plans town meeting –Underground non-accelerator experiment-, July 22, 2012, Ookayama, Japan

IV. Prizes (Awards)

1. Nishina Memorial Prize for the study on "Observation of geologically produced antineutrinos", Nishina memorial foundation, (Nov. 9, 2012)
2. Yoji Totsuka Memorial Prize for "Neutrino research with liquid scintillator, observation of geologically produced anti-neutrinos", Heisei Foundation for Basic Science, (February 12, 2013)

Members of Neutrino Science Group:

1. Azusa Gando (Physics, D3), Department Director's Award of Physics for the doctoral thesis of "First Results of Neutrinoless Double Beta Decay Search with KamLAND-Zen", (March, 2013)

Name	Ken-ichi Hikasa
Department	Physics
Position	Professor
Research Title	Theoretical High Energy Physics

I. Summary of Research

1. We set up a formalism to calculate helicity amplitudes for up to two-body processes including high spin particles with spin $3/2$ and 2 which appear in models for physics beyond the Standard Model such as supersymmetry and extra dimensions. Use of spherical vector basis enables an efficient way of evaluating the amplitudes with clearcut derivation of angular distributions.
2. We reevaluate the lepton-flavor violating decay $\mu \rightarrow e\gamma$ which can arise via renormalization effect of neutrino Yukawa couplings in supersymmetric models using the recent measurement of the neutrino mixing angle θ_{13} . Excluded region of the model parameter space is derived from the recent upper limit on the decay from MEG experiment.

II. Publications

1. "Review of Particle Physics",
J. Beringer et al., Physical Review D 86, 010001 (2012).

III. Presentations

1. "Helicity amplitudes and new physics",
K. Hikasa, Hokkaido University seminar (September 25, 2012, Hokkaido University, Sapporo, Japan)
2. "Helicity amplitudes and new physics",
K. Hikasa, Toyama University seminar (October 31, 2012, Toyama University, Toyama, Japan)

IV. Prizes (Awards)

Members of Particle Theory and Cosmology Group:

1. Fuminobu Takahashi (Associate Prof.), Inoue Research Award for the study on "Beginning and ending of the universe: research of inflation and dark universe from CMB - cosmic microwave background", (Feb. 4, 2013)

Name	Yoshio Kuramoto
Department	Physics
Position	Professor
Research Title	Theory of strongly correlated electrons and topological insulators

I. Summary of Research

1. A disordered topological insulator is studied theoretically for two-dimensional cases. The phase diagram is derived in the plane of disorder strength and location of the Fermi level. By detailed scaling analysis of the metal-insulator transition, it is shown that the transition to the so-called "topological Anderson insulator" belongs to the symplectic universality class. This finding puts an end to the confusion whether the transition provides a new universality class.
2. We study a ring-shaped disordered system of topological insulator theoretically, with possible application to nanostructured devices. With three leads A, B and C attached to the system, injected electron current from A comes out from B and C with different spin polarizations. Hence the system can be used to filter the spin of electrons from unpolarized current. The numerical calculation is performed by taking a lattice model with long-range hopping so as to simulate the continuum model obtained by the effective-mass approximation.
3. The distinction between the localized and itinerant behaviors of electrons in solids is a longstanding problem. We have shown for the Kondo lattice that the antiferromagnetic order occurs in the itinerant regime, but that the itinerant-localized change occurs inside the antiferromagnetic state. The change can either be a first-order transition with topological change of the Fermi surface, or a quantum phase transition. In the latter case, the energy bands should be completely flat, namely, should disappear at the transition.

II. Publications

1. "Interference effects of helical current: Geometry-dependent spin polarization of transmitted electrons"
S. Masuda, and Y. Kuramoto: Phys. Rev. B 85 (2012) 195327-1 -- 195327-8
2. "Z₂ Topological Anderson Insulator"
Ai Yamakage, Kentaro Nomura, Ken-Ichiro Imura and Yoshio Kuramoto: J. Phys.: Conf. Ser. 400 (2012) 042070-1 - 042070-4
3. "Z₂-Classification of Localization Properties in Graphene"
Ken-Ichiro Imura, Yoshio Kuramoto and Kentaro Nomura: AIP Conf. Proc. 1504 (2012) 871-874
4. "Spin-Orbit Effects in Graphene p-n Junction"
A. Yamakage, K.-I. Imura, J. Cayssol and Y. Kuramoto: AIP Conf. Proc. 1504 (2012) 867-870

5. "Theoretical aspects of heavy electrons"
Yoshio Kuramoto: Solid State Physics 47 (2012) 199-206 (in Japanese)

III. Presentations

1. "New kinds of orders in heavy electron systems"
Y. Kuramoto: The 440th Condensed-matter colloquium, 27 April 2012, Hiroshima University, Japan
2. "Exotic orders in heavy electron systems"
Yoshio Kuramoto: 18 May 2012, University of Cologne, Germany.
3. "Exotic orders in heavy electron systems"
Yoshio Kuramoto: International WORKSHOP on Strongly Correlated Electron systems in high magnetic Fields (SCEF), 20-25 May 2012, talk on 23 May, Ecole de Physique des Houches, France
4. "Exotic orders in heavy electron systems"
Y. Kuramoto: The Fourth International Workshop on Dual Nature of f-Electrons, July 4-6, 2012, talk on 5 July, Himeji, Jibasan Center, Japan
5. "Unconventional electronic orders in non-Kramers electron systems"
Y. Kuramoto: 12th Japan-German Symposium on Emergent phenomena in novel quantum phases of condensed matter, 14-17 July 2012, talk on 15 July, Hotel Laforet Shuzenji, Izu, Japan
6. "Energy spectrum and effective g-factor in Bi₂Se₃-type topological insulators in magnetic field"
S. Masuda and Y. Kuramoto: Divisional Meeting of the Physical Society of Japan, 18-21 September 2012, Yokohama, Japan
7. "Dynamical susceptibility of URu₂Si₂ by a CEF model -- test of doublet and singlet models for the multipole order"
T. Kikuchi, S. Hoshino and Y. Kuramoto: Divisional Meeting of the Physical Society of Japan, 18-21 September 2012, Yokohama, Japan
8. "Formation of heavy electrons by competition between Kondo singlet and CEF singlet and the high-field phase of PrFe₄P₁₂"
S. Hoshino and Y. Kuramoto: Divisional Meeting of the Physical Society of Japan, 18-21 September 2012, Yokohama, Japan
9. "Study of strong-coupling superconductivity in the Holstein-Hubbard model by means of quantum Monte Carlo"
S. Yamazaki, S. Hoshino and Y. Kuramoto: Divisional Meeting of the Physical Society of

Japan, 18-21 September 2012, Yokohama, Japan

10. "Kondo and Mott insulators: aspect of itinerant and localized dichotomy of electrons in solids"
Y. Kuramoto: Toyota Physical and Chemical Research Institute Colloquim, 18 January 2013,
Nagoya University
11. "Antiferromagnetic order of heavy electrons induced by magnetic fields"
T. Kikuchi, S. Hoshino and Y. Kuramoto: Divisional Meeting of the Physical Society of Japan,
26-29 March 2013, Hiroshima, Japan
12. "Itinerant-localized transition within the antiferromagnetically ordered phase of the Kondo
lattice"
S. Hoshino and Y. Kuramoto: Divisional Meeting of the Physical Society of Japan, 26-29
March 2013, Hiroshima, Japan

Name	Yoshiro Hirayama
Department	Department of Physics, Graduate School of Science
Position	Professor
Research Titles	1. Transport characteristics of semiconductor quantum systems, 2. Hyperfine interactions and novel NMR (NER), 3. NMR (NER) studies of semiconductor quantum systems, 4. Nanoprobng of semiconductor quantum systems, 5. Transport characteristics of nano-materials

I. Summary of Research

1. Nuclear spin systems are exposed to electron spin environment in quantum Hall regime. The change in nuclear spin system is probed by using $\nu = 2/3$ spin phase transition. We found that the spin phase transition (SPT) from spin-polarized to spin unpolarized $\nu=2/3$ gives us a very sensitive measure of the background nuclear polarization. The less than 1% nuclear polarization can be detected as a shift of the SPT peak position. By using the characteristics of the SPT, we confirmed that the spin-unpolarized (spin-polarized) domain mainly mediates the up-directed (down-directed) nuclear spin polarization. The unique and strong many-body interaction appears between electron and nuclear spin systems when nuclear spins are exposed to $\nu = 2$ canted spin state in bilayer GaAs quantum wells.
2. The noise spectrum influencing nuclear spin decoherence can be determined by using a multiple π -pulse sequence. It is theoretically confirmed that signal relaxation rate of 2τ -interval π -pulse sequence in a long time limit reflects noise spectrum, $S(1/4\tau)$. This multiple π -pulse technique is applied in conventional NMR to measure noise spectra of nuclear spins in GaAs and Si.
3. The successful gate control of InSb two-dimensional systems is essential to extend our RD-NMR and spin-susceptibility studies to the wider-range pump-and-probe experiments. To achieve this goal, high-quality Al_2O_3 dielectrics were grown by atomic layer deposition (ALD) on InSb quantum wells. Magnetotransport measurements were carried out to clarify the characteristics of a gated InSb quantum wells. When we deposited Al_2O_3 dielectrics on InSb top layer, the magnetoresistance data demonstrate a parallel conduction channel at zero gate voltage (V_g). A good interface between Al_2O_3 and the top InSb layer ensures that the parallel channel is depleted at negative V_g , and the density of two-dimensional electrons in the QW is tuned by V_g with a large ratio of $6.5 \times 10^{14} \text{ m}^{-2}\text{V}^{-1}$, but saturates at more negative V_g . These findings are closely related to layer structures of the quantum wells.

4. Using scanning tunneling spectroscopy at low temperature and high magnetic fields, we have directly probed real-space local density of states of a two-dimensional electron system in a high magnetic field, in particular within higher Landau levels. By Fourier transforming the local density of states, we find a set of n radial minima at fixed momenta for the n th Landau levels. Our findings demonstrate that Landau quantization implies disorder independent universal features on the microscopic scale. Recently, we have completed a setup of a nanoprobe system operating at dilution temperatures so that we will extend these measurements to fractional quantum Hall effects and nuclear-spin-related phenomena.
5. A vertically π -coupled quantum point contact was successfully fabricated in bilayer two-dimensional system. The coupling characteristics between two point contacts can be tuned by electrical method.
6. A micro-scale Hall bar was fabricated on CVD-grown graphene. We confirmed quantum Hall effects down to 3 T, reflecting a high-quality of the CVD-grown graphene.
7. We are collaborating with many outside organizations. We work together with researchers from ERATO Nuclear Spin Electronics Project (ERATO-NSEP). In this frame, we are collaborating with NTT, Oklahoma Univ., Univ. of Tokyo, and Niigata Univ. We are also collaborating with Paul-Drude-Institute (PDI) (Germany), Bath University (England), Tsukuba University and Chiba University. Especially, we would like to thank NTT, PDI, and Oklahoma University for providing us high quality heterostructures.

II. Publications

1. "Resistively detected nuclear magnetic resonance: recent developments",
H. W. Liu, K. F. Yang, T. D. Mishima, M. B. Santos, K. Nagase, and Y. Hirayama, *Acta Phys. Sin.* 61, 147302 (2012) (invited).
2. "All Electrical Probe of Nuclear Spin Polarization and Relaxation by Spin Phase Transition Peaks of the Filling Fraction $\nu = 2/3$ Quantum Hall Effect",
M. H. Fauzi, S. Watanabe, and Y. Hirayama, *J. Korean Phys. Soc.*, 60, 1676 (2012).
3. "Robust Nodal Structure of Landau Level Wave Functions Revealed by Fourier Transform Scanning Tunneling Spectroscopy",
K. Hashimoto, T. Champel, S. Florens, C. Sohrmann, J. Wiebe, Y. Hirayama, R. A. Römer, R. Wiesendanger, and M. Morgenstern, *Phys. Rev. Lett.* 109, 116805 (2012).
4. "Microscopic Characteristics of Dynamic Nuclear Polarization and Selective Nuclear Depolarization at the $\nu=2/3$ Spin Phase Transition",
M. H. Fauzi, S. Watanabe, and Y. Hirayama, *Appl. Phys. Lett.* 101, 162105 (2012).
5. "Characterization of InSb quantum wells with atomic layer deposited gate dielectrics",

M. M. Uddin, H. W. Liu, K. F. Yang, K. Nagase, T. D. Mishima, M. B. Santos, and Y. Hirayama, *Appl. Phys. Lett.* 101, 233503 (2012).

6. "Exchange energy enhanced g-factors obtained from Landau fan diagrams at low magnetic fields",
S. Nomura, H. Tamura, M. Yamaguchi, T. Akazaki, and Y. Hirayama, *Phys. Rev. B* (to be published).

III. Presentations

1. "Spin-phase transition spectroscopy to probe spin dynamics in quantum Hall systems",
M. H. Fauzi, S. Watanabe, and Y. Hirayama, 20th Int. Conf. on High Magnetic Fields in Semiconductor Physics (HMF-20), (Chamonix Mont-Blanc, France, July 22 – July 27, 2012).
2. "Localized Nuclear Spin Resonance Mediated by Electrical-Field-Induced Domain Oscillation",
Satoru Miyamoto, Tomonori Miura, Shinji Watanabe, Katsumi Nagase, and Yoshiro Hirayama, 31st Int. Conf on Physics Semicond. (ICPS2012), (Zurich, July 29- August 3, 2012).
3. "Fine structures in photoluminescence in the fractional quantum Hall regime in low magnetic field",
Shintaro Nomura, Masumi Yamaguchi, Hiroyuki Tamura, Tatsushi Akazaki, Yoshiro Hirayama, Marek Korkusinski, and Pawel Hawrylak, 31st Int. Conf on Physics Semicond. (ICPS2012), (Zurich, July 29- August 3, 2012).
4. "Electron gyroscope with high-mobility electrons on a cylindrical surface",
Klaus-Juergen Friedland, Duncan K. Maude, Hajime Okamoto, Hiroshi Yamaguchi, Mohammad Hanzah Fauzi, and Yoshiro Hirayama, 31st Int. Conf on Physics Semicond. (ICPS2012), (Zurich, July 29- August 3, 2012).
5. "Spin and Valley Polarization Dependence of Resistivity in Two Dimensions",
Kei Takashina, Yoshitaka Niida, Vincent Renard, Benjamin Piot, David Tregurtha, Akira Fujiwara, and Yoshiro Hirayama, 31st Int. Conf on Physics Semicond. (ICPS2012), (Zurich, July 29- August 3, 2012).
6. "Nuclear-Spin Observation of Noise Spectra in Semiconductors",
Susumu Sasaki, Tatsuro Yuge, Masashi Nishimori, Takashi Kawanago, and Yoshiro Hirayama, 31st Int. Conf on Physics Semicond. (ICPS2012), (Zurich, July 29- August 3, 2012).
7. "Effect of Gate Dielectric on Transport Properties of InSb Two-Dimensional Electron Gas",
M. M. Uddin, H. W. Liu, K. F. Yang, T. D. Mishima, M. B. Santos, K. Nagase, and Y. Hirayama, 39th Int. Symp. on Compound Semiconductors (ISCS2012), (Santa Barbara, USA, August 27-30, 2012).
8. "Electronic transport properties in vertically coupled quantum point contacts",

- S. Ichinokura, T. Hatano, W. Izumida, K. Nagase, and Y. Hirayama, 39th Int. Symp. on Compound Semiconductors (ISCS2012), (Santa Barbara, USA, August 27-30, 2012).
9. "Evidence of Strong Coupling Between Electron and Nuclear Spin Systems in Two-dimensional Quantum Wells",
Mohammad H. Fauzi and Yoshiro Hirayama, 2012 Workshop on Innovative Nanoscale Devices and Systems (WINDS), (Kona, USA, December 2-7, 2012).
 10. "Gate control of InSb two-dimensional systems and its application to resistively-detected NMR",
Yoshiro Hirayama, The 11th Sweden- Japan Workshop on Quantum Nanophysics and Nanoelectronics (QNANO) (Tokyo, Japan, January 13-14, 2013) (invited).
 11. "Electron spin and nuclear spin interactions in GaAs quantum structures",
Yoshiro Hirayama, Tohoku – Harvard Joint Workshop; New Directions in Materials for Nanoelectronics, Spintronics and Photonics (10th RIEC International Workshop on Spintronics) (Sendai, Japan, January 16, 2013) (invited).
 12. "Nuclear Magnetometry, Domain Walls, and Electron-Nuclear Spin Dynamics in the Quantum Hall Regime",
M. H. Fauzi, S. Watanabe, and Y. Hirayama, Tohoku – Harvard Joint Workshop; New Directions in Materials for Nanoelectronics, Spintronics and Photonics (10th RIEC International Workshop on Spintronics) (Sendai, Japan, January 16, 2013) .
 13. "InSb Quantum Wells with Atomic Layer Deposited Gate Dielectrics",
M. M. Uddin, H. W. Liu, K. F. Yang, T. D. Mishima, M. B. Santos, K. Nagase, and Y. Hirayama, Tohoku – Harvard Joint Workshop; New Directions in Materials for Nanoelectronics, Spintronics and Photonics (10th RIEC International Workshop on Spintronics) (Sendai, Japan, January 16, 2013).
 14. "Nuclear spin - environmental interactions in semiconductor systems",
Yoshiro Hirayama, 3rd Japan-Israel Binational Workshop on Quantum Phenomena (2013. 3.10-13) (Okinawa, Japan, March 10-13) (invited) .

Name	Hirokazu Tamura
Department	Physics
Position	Professor
Research Title	Hypernuclear Physics

I. Summary of Research

1. An elaborated reanalysis of the $^{12}_{\Lambda}\text{C}$ γ -ray spectroscopy data taken in 2005 at KEK-PS was carried out. A new γ -ray peak was observed at 6048 keV and assigned to be the $M1(1_3^- \rightarrow 1_1^-)$ transition in $^{12}_{\Lambda}\text{C}$.
2. Using the SKS spectrometer system which we constructed at the K1.8 beam line in the J-PARC hadron hall, we investigated the neutron-rich Λ hypernucleus, $^6_{\Lambda}\text{H}$, via the (π^-, K^+) reaction. The data analysis is in progress.
3. We have constructed a new Ge detector array, Hyperball-J, which are characterized by a new type of low-temperature mechanically-cooled Ge detectors and fast background suppression counters using PWO scintillator. The frame of the Hyperball-J array was installed at the target area of the K1.8 beam line at J-PARC, and the Ge detectors and the PWO counters were mounted on it for the coming E13 experiment.
4. We have just started a set of hypernuclear γ -ray spectroscopy experiments (E13) at the K1.8 beam line of J-PARC. For this experiment, we modified the detectors of the SKS spectrometer for the (K^-, π^-) reaction and installed the Hyperball-J array.

II. Publications

1. "Search for the Θ^+ pentaquark via the $\pi^- p \rightarrow \text{K}^- X$ reaction at 1.92 GeV/c".
K. Shirotori et al., Phys. Rev. Lett. 109, 132002 (2012).
2. "Study of Λ hypernuclei using hadron beams and γ -ray spectroscopy at J-PARC",
H. Tamura, M. Ukai, T.O. Yamamoto, T. Koike, Nucl. Phys. A 881, 310-321 (2012).
3. "Production of hypernuclei in peripheral HI collisions: The HypHI project at GSI"
T. R. Saito et al., Nucl. Phys. A 881, 218-227 (2012).
4. "Experimental plan of Sigma p scatterings at J-PARC",
K. Miwa et al., EPJ Web Conf. 20, 05001 (2012).
5. "Strangeness nuclear physics experiments at J-PARC",
H. Tamura, Prog. Theor. Exp. Phys. 2012, 02B012 (2012).
6. "Beam and SKS spectrometers at the K1.8 beam line"
T. Takahashi et al., Prog. Theor. Exp. Phys. 2012, 02B010 (2012).
7. "Three-body $\Lambda\text{NN} \rightarrow \text{nNN}$ nonmesonic weak decay process of Λ hypernuclei",

- H. Bhang et al., *Few Body Syst.* 54, 103-110 (2013).
8. "Gamma-Ray Spectroscopy of Hypernuclei –Present and Future–",
H. Tamura, K. Hosomi, S. Buffalino, N. Chiga, P. Evtoukhovitch, A. Feliciello, R. Honda, T. Koike, Y. Ma, K. Miwa, A. Sasaki, Y. Sasaki, K. Shirotori, K. Tanida, Z. Tsamalaidze, M. Ukai, T. O. Yamamoto, S. B. Yang, *Nucl. Phys. A* (2013), in press.
 9. "Gamma-ray spectroscopy of $^{12}_{\Lambda}\text{C}$ via the (π^+, K^+) reaction",
K. Hosomi, et al., *Nucl. Phys. A* (2013), in press.

III. Presentations

1. "Gamma-ray spectroscopy in hypernuclei", H. Tamura, 10th International Conference on Clustering Aspects of Nuclear Structure and Dynamics, September 24-28, 2012, Debrecen, Hungary, (invited talk).
2. "Gamma-ray spectroscopy of hypernuclei", H. Tamura, 11th International Conference On Hypernuclear and Strange Particle Physics (HYP2012), October 1–5, 2012, Barcelona, Spain (invited talk).
3. "Hypernuclear Physics at J-PARC and Study of Neutron Stars with Strangeness", H. Tamura, The 8th JSPS Core-to-Core Symposium, October 5-6, 2012, Barcelona, Spain (invited talk).
4. "Hypernuclear Studies using HI Beams", H. Tamura, SuperFRS Collaboration Meeting, November 14-16, 2012, Frankfurt, Germany (Invited talk).
5. "Strangeness Nuclear Physics", H. Tamura, Int. Symposium on "Quarks to Universe in Computational Science", December 13-16, 2012, Nara (Invited talk).

IV. Prizes (Awards)

Members of Nuclear Physics Group:

1. M. Ukai (Assistant Prof.), 4th Senshu-kai shoreishou Award for "Development of gamma-ray spectroscopy and the research for fine structure in hypernuclear", Senshu-kai, (Oct. 27, 2012).

Name	Masahiro Yamaguchi
Department	Physics
Position	Professor
Research Title	Particle theory and cosmology

I. Summary of Research

1. We study the implications of the LHC Higgs signals on the Higgs mixing in the next-to-minimal supersymmetric standard model (NMSSM). The Higgs couplings can depart from their values in the standard model (SM) due to mixing effects. However the Higgs signal rate in the WW and ZZ channels can remain close to the SM values, as observed at the LHC, even if the SM-like Higgs boson with a mass near 125 GeV has a large singlet component. This allows to get a sizable enhancement in the Higgs to diphoton rate through the charged-higgsino loop contribution, as well as a sizable reduction of the Higgs to bb and $\tau\tau$ rates through the mixing effects, with little deviation in the WW and ZZ signal rates from the SM prediction. We find that an enhancement of diphoton signals by a factor of 1.5 or more, and also a reduction of bb and $\tau\tau$ signals by a factor of 0.5, can be obtained in the region of parameter space consistent with the constraints on the higgsino mass parameter and the singlet coupling to the Higgs doublets, which determine the Higgs mixing.
2. We examine the implications of singlet-doublet Higgs mixing on the properties of a Standard Model (SM)-like Higgs boson within the Peccei-Quinn invariant extension of the NMSSM (PQ-NMSSM). The SM singlet added to the Higgs sector connects the PQ and visible sectors through a PQ-invariant non-renormalizable Kaehler potential term, making the model free from the tadpole and domain-wall problems. For the case that the lightest Higgs boson is dominated by the singlet scalar, the Higgs mixing increases the mass of a SM-like Higgs boson while reducing its signal rate at collider experiments compared to the SM case. The Higgs mixing is important also in the region of parameter space where the NMSSM contribution to the Higgs mass is small, but its size is limited by the experimental constraints on the singlet-like Higgs boson and on the lightest neutralino constituted mainly by the singlino whose Majorana mass term is forbidden by the PQ symmetry. Nonetheless the Higgs mixing can increase the SM-like Higgs boson mass by a few GeV or more even when the Higgs signal rate is close to the SM prediction, and thus may be crucial for achieving a 125 GeV Higgs mass, as hinted by the recent ATLAS and CMS data. Such an effect can reduce the role of stop mixing.

II. Publications

1. "Higgs mixing and diphoton rate enhancement in NMSSM",
K. Choi, S.H. Im, K.S. Jeong, M. Yamaguchi, JHEP 1302, 090 (2013)
2. "Singlet-Doublet Higgs Mixing and Its Implications on the Higgs mass in the PQ-NMSSM",
K.S. Jeong, S. Shoji and M. Yamaguchi, JHEP 1209, 007 (2012)

Name	Riichiro Saito
Department	Physics
Position	Professor
Research Title	Optical properties of carbon nanotubes and graphene

I. Summary of Research

1. Coherent phonon spectroscopy of carbon nanotubes has been investigated especially for considering the localized force of the exciton (photo excited electron hole pair.).
2. Gate modulated Raman spectra of single, bilayer and triple layer graphene are calculated and compared with experimental results.

II. Publications

1. "Unraveling the interlayer-related phonon self-energy renormalization in bilayer grapheme", P. T. Araujo, D. L. Mafra, K. Sato, R. Saito, J. Kong, M. S. Dresselhaus, Scientific Reports 2, 1017-1-6, (2012).
2. "Using gate-modulated Raman scattering and electron-phonon interactions to probe single-layer graphene: A different approach to assign phonon combination modes", D. L. Mafra, J. Kong, K. Sato, R. Saito, M. S. Dresselhaus, P. T. Araujo, Phys. Rev. B 86, 195434-1-9, (2012).
3. "Effect of Domain Boundaries on the Raman Spectra of Mechanically Strained Graphene", M. A. Bissett, W. Izumida, R. Saito, H. Ago, ACS Nano 6, 10229-10238, (2012).
4. "Observation of layer-breathing mode vibration in few-layer graphene through combination Raman scattering", C. H. Lui, L. M. Malard, S. H. Kim, G. Lantz, F. E. Laverge, R. Saito, T. F. Heinz, Nano Lett. 12, 5539-5544, (2012).
5. "Reversible formation of ammonium persulfate/sulfuric acid graphite intercalation compounds and their peculiar Raman spectra", A. M. Dimiev, S. M. Bachilo, R. Saito, J. M. Tour, ACS Nano 6, 7842-7849, (2012).
6. "Zone folding effect in Raman G-band intensity of twisted bilayer grapheme", K. Sato, R. Saito, C. Cong, T. Yu, M. S. Dresselhaus, Phys. Rev. B 86, 125414-1-6, (2012).
7. "Raman spectroscopy of boron-doped single-layer grapheme", Y. A. Kim, K. Fujisawa, H. Muramatsu, T. Hayashi, M. Endo, T. Fujimori, K. Kaneko, M. Terrones, J. Behrends, A. Eckmann, C. Casiraghi, K. S. Novoselov, R. Saito, M. S. Dresselhaus, ACS Nano 6, 6293-6300, (2012).
8. "Phonon self-energy corrections to nonzero wave-vector phonon modes in single-layer grapheme", P. T. Araujo, D. L. Mafra, K. Sato, R. Saito, J. Kong, and M. S. Dresselhaus,

- Phys. Rev. Lett. 109, 046801-1-5, (2012).
9. "Effect of ^{13}C isotope doping on the optical phonon modes in graphene: Localization and Raman spectroscopy", J. F. Rodriguez-Nieva, R. Saito, S. D. Costa, M. S. Dresselhaus, Phys. Rev. B 85, 245406-1-8, (2012).
 10. "Using the G' Raman cross-section to understand the phonon dynamics in bilayer graphene systems", D. L. Mafra, P. T. Araujo, K. Sato, R. Saito, M. S. Dresselhaus, J. Kong, Nano Lett. 12, 2883-2887, (2012).
 11. "Coherent radial-breathing-like phonons in graphene nanoribbons", G. D. Sanders, A. R. T. Nugraha, R. Saito, C. J. Stanton, Phys. Rev. B 85, 205401-1-17, (2012).
 12. "Asymmetric velocities of Dirac particles and Vernier spectrum in metallic single-wall carbon nanotubes", W. Izumida, A. Vikstrom, R. Saito, Phys. Rev. B 85, 165430-1-8, (2012).
 13. "Luminescence properties of individual empty and water-filled single-walled carbon nanotubes, S. Cambre", S. M. Santos, W. Wenseleers, A. R. T. Nugraha, R. Saito, L. Cognet, B. Lounis, ACS Nano 6, 2649-2655, (2012).
 14. "Polarization dependence of x-ray absorption spectra in grapheme", M. T. Chowdhury, R. Saito, and M. S. Dresselhaus, Phys. Rev. B 85, 115410, (2012).

III. Presentations

1. "Raman spectroscopy of double and triple layer graphene(invited)" R. Saito, 2012 Material Research Society Spring meeting, (Aoril 9-13, 2012, Moscone West Convention Center, San Francisco, USA)
2. "Welcome to Nanotube World(invited)",R. Saito, NSF Nano Japan Program, (May 29, 2012, Sanuki Club, Tokyo, Japan).
3. "Raman spectroscopy of nanotube and graphene (invited talk)" R. Saito, Department Seminar of Applied Physics, (June 7, 2012, Aalto University, Nanotalo, Puumiehenkuja 2, Finland)
4. "Opposite behavior of the Kohn anomaly effect in double resonance Raman spectroscopy of metallic carbon nanotube and graphene", R. Saito, K. Sato, P. Araujo, D. Mafra, M. Dresselhaus, Conference on the Science and Application of Nanotubes 13th International Conference on the Science and Application of Nanotubes (NT12), (June 23-29, 2012, Brisbane Convention and Exhibition Centre, Australia)
5. "G band Raman intensity of twisted bilayer graphene", K. Sato, Chunxiao Cong, Ting Yu, R. Saito, Conference on the Science and Application of Nanotubes 13th International Conference on the Science and Application of Nanotubes (NT12), (June 23-29, 2012, Brisbane Convention and Exhibition Centre, Australia)
6. "Raman Characterization of ABA- and ABC- Stacked Trilayer Graphene", C. Cong, Y. Ting,

- K. Sato, J Shang, R. Saito, G. Dresselhaus, M. S. Dresselhaus, the International Conference of Young Researchers on Advanced Materials (ICYRAM2012), (July 1-6, 2012, MATRIX Building, Biopolis Shared Facilities, Singapore).
7. "Optical characterization of nanotube and graphene (invited)", R. Saito, The 2nd Workshop on Nanoscience in Taiwan, (July 4-7, 2012, Cheng Kung University, Tainan, Taiwan)
 8. "Raman and coherent phonon spectroscopy of nanotube and graphene(invited)", R. Saito, A. R. T. Nugraha, K. Sato, G. Sandaers, C. Stanton C. Conxiao, Y. Ting, G. Dresselhaus, M. S. Dresselhaus, The Third International Workshop on Nanocarbon Photonics and Optoelectronics, (July 29-August 4, 2012, Huhmari, Polvijarvi, North Karelia, Finland).
 9. "G band intensity and joint density of states of twisted bilayer graphene" K. Sato, R. Saito C. Cong, T. Yu, M. S. Dresselhaus, The 43th Fullerenes-Nanotubes-Graphene General Symposium, (September 5-7,2012, Tohoku Univ. Sendai, Japan)
 10. "Theory of electronic Raman scattering in metallic single-walled carbon nanotube", E. H. Hasdeo, A. R. T. Nugraha, K. Sato, R. Saito, The 43th Fullerenes-Nanotubes-Graphene General Symposium, (September 5-7,2012, Tohoku Univ. Sendai, Japan)
 11. "Effect of Mechanical Strain on Polycrystalline Graphene" M. Bissett, W. Izumida, R. Saito, H. Ago, The 43th Fullerenes-Nanotubes-Graphene General Symposium, (September 5-7,2012, Tohoku Univ. Sendai, Japan)
 12. "Excitonic effects on coherent phonons in single wall carbon nanotubes" A. R. T. Nugraha, G. D. Sanders, C. J. Stanton, R. Saito The 43th Fullerenes-Nanotubes- Graphene General Symposium, (September 5-7,2012, Tohoku Univ. Sendai, Japan).
 13. "Optical properties of nanotubes and graphene (invited)", R. Saito, K. Sato, A. R. T. Nugraha, 2012 A3 Symposium of Emerging Materials: Nanomaterials for Energy and Environments - ATI International Forum, (October 29-31, 2012, Tohoku University, Sendai, Japan)
 14. "Tilting of Dirac cones and vernier spectrum in finite-length metallic single wall carbon nanotubes" W. Izumida, Y. Tatsumi, R. Saito, 2012 A3 Symposium of Emerging Materials: Nanomaterials for Energy and Environments - ATI International Forum, (October 29-31, 2012, Tohoku University, Sendai, Japan)
 15. "Raman spectra and enhancement of twisted bilayer graphene" K. Sato, R. Saito, 2012 A3 Symposium of Emerging Materials: Nanomaterials for Energy and Environments - ATI International Forum, (October 29-31, 2012, Tohoku University, Sendai, Japan)
 16. "Exciton effects on coherent phonons in single wall carbon nanotubes" A. R. T. Nugraha, E. Rosenthal, E. H. Hasdeo, R. Saito, 2012 A3 Symposium of Emerging Materials: Nanomaterials for Energy and Environments - ATI International Forum, (October 29-31, 2012, Tohoku University, Sendai, Japan)

17. "Theory of electronic Raman scattering in metallic single wall carbon nanotubes" E. H. Hasdeo, A. R. T. Nugraha, K. Sato, R. Saito, 2012 A3 Symposium of Emerging Materials: Nanomaterials for Energy and Environments - ATI International Forum, (October 29-31, 2012, Tohoku University, Sendai, Japan)
18. "Optical properties of carbon nanotubes and graphene (invited)" R. Saito, 2012 MRS Fall meeting, (November 25-30, 2012, Hynes Convention Center, Boston, USA).
19. "Real-time monitoring of stage transitions in graphite intercalation compounds on micro-scale level" A. Dimiev, G. Ceriotti, N. Behabtu, M. Pasquali, R. Saito, J. M. Tour 2012 MRS Fall meeting, (November 25-30, 2012, Hynes Convention Center, Boston, USA)
20. "Anomalous Raman behavior of CVD grown graphene under strain" M. A. Bissett, W. Izumida, R. Saito, H. Ago, 2012 MRS Fall meeting, (November 25-30, 2012, Hynes Convention Center, Boston, USA)
21. "D-band Raman spectra for several types of defects in graphene", J. F. Rodriguez- Nieva, R. Saito, M. S. Dresselhaus, 2012 MRS Fall meeting, (November 25-30, 2012, Hynes Convention Center, Boston, USA)
22. "Using the G' Raman cross-section to understand the phonon dynamics in bilayer graphene systems" D. L. Mafra, J. Kong, K. Sato, R. Saito, 2012 MRS Fall meeting (November 25-30, 2012, Hynes Convention Center, Boston, USA)
23. "Using gate-modulated Raman scattering and electron-phonon interactions to probe single layer graphene: a new technique to assign phonon combination modes" D. L. Mafra, J. Kong, K. Sato, R. Saito, M. S. Dresselhaus, P. T. Araujo, 2012 MRS Fall meeting, (November 25-30, 2012, Hynes Convention Center, Boston, USA)
24. "Gate Modulated Raman spectroscopy of graphene", R. Saito, The 44th Fullerenes-Nanotubes-Graphene General Symposium, (March 11-13, 2012 Ito International Research center, The University of Tokyo, Tokyo, Japan).
25. "Raman spectroscopy of graphene and its analysis", R. Saito, Japan Phys. Society meeting, 68th annual meeting, (March 26-29, 2012, Hiroshima Univ., Hiroshima, Japan).

Name	Toshihiro Kawakatsu
Department	Physics
Position	Professor
Research Title	Study on structure and dynamics of soft matter

I. Summary of Research

1. Deformation of polymer-containing membranes under flow field

We extended the field-theoretic approach for polymer-containing membranes we developed in 2011 to flow-induced deformation phenomena under an external flow field. Our model is based on a phase field description for the membrane and a self-consistent field description for the enclosed polymers. We coupled this model of polymer-containing membrane with an external flow field described by Navier-Stokes equation. By simulating this model, we observed an effect of the enclosed polymers on the deformation of the membrane [Publication 1].

2. Dynamics of structural phase transition of block copolymer induced by external electric field

Using dynamic self-consistent field simulations, we studied the kinetic pathway of the transition from cubic phase to hexagonal phase of a diblock copolymer induced by an external DC electric field. By changing the direction of the electric field, we found several typical kinetic pathways that have not been observed before [Publication 2].

3. Development of hybrid particle-field simulation methods for bio-membranes and drug delivery system

Combining self-consistent field theory with molecular dynamics simulation technique, we developed a simulation program for polymer mesophases. By tuning this program for parallelized computers, we achieved a high performance of the simulation efficiency (10-30 times speed-up) [Publication 3]. Using this parallelized program, we simulated a variety of mesophases that DPPC lipid molecules show in an aqueous solution [Publication 4].

4. 2- and 3-dimensional simulations on string phases of hard sphere particles with a step-repulsive potential

Monte Carlo simulation method was applied to 2- and 3-dimensional systems of hard spheres with a step-repulsive potential. For both of 2 and 3 dimensions, we observed "string phases" where the particles align in a string-like assembly. We determined the phase diagram of these model systems and identified the region where the string phase emerges.

II. Publications

1. "Field theoretical approach for a polymer-containing vesicle", Y.Oya and T.Kawakatsu; Adv.

- Nat. Sci.: Nanosci. Nanotechnol. **4** 015010-1-4 (2013).
2. "Kinetic pathways of sphere-to-cylinder transition in diblock copolymer melt under electric field", D.Ly, M.Pinna, T.Honda, T.Kawakatsu, and A.Zvelindovsky; J. Chem. Phys. **138** (No.7) 074904-1-9 (2013).
 3. "Hybrid Particle-Field Molecular Dynamics Simulations: Parallelization and Benchmarks", Y.Zhao, A.De Nicola, T.Kawakatsu and G.Milano; J. Comput. Chem., **33** (No.8) 868-880 (2012).
 4. "Validation of a Hybrid MD-SCF Coarse-Grained Model for DPPC in Non-Lamellar Phases", A.De Nicola, Y.Zhao^a, T.Kawakatsu, D.Roccatano and G.Milano; Theoretical Chemistry Accounts, **131**(No.3) 1167-1-16 (2012).
 5. "Particle Monte Carlo simulation of string-like colloidal assembly in 2 and 3 dimensions", Y.Norizoe, T.Kawakatsu; J. Chem. Phys., **137** (No.2) 024904-1-16 (2012).
 6. "Diffusion of surfactant micelles in fluid and crystal phases", M. Imai, M. Kurimoto, F. Matsuura, Y. Sakuma, and T. Kawakatsu; Soft Matter, **8** (No.38) 9829-9905 (2012).

III. Presentations

1. "Dynamics of complex domains in polymer-surfactant systems", T.Kawakatsu; The 6th International Workshop on Advanced Materials Science and Nanotechnology (IWAMSN) 2012, 30 Oct. - 2 Nov., 2012, Halong City, Vietnam.
2. "Field Theoretical Approach for Polymer Containing Vesicle", Y.Oya and T.Kawakatsu; The 6th International Workshop on Advanced Materials Science and Nanotechnology (IWAMSN) 2012, 30 Oct. - 2 Nov., 2012, Halong City, Vietnam.
3. "Simple crack propagation model of pressure-sensitive adhesives", S.Sekine and T.Kawakatsu; The 6th International Workshop on Advanced Materials Science and Nanotechnology (IWAMSN) 2012, 30 Oct. - 2 Nov., 2012, Halong City, Vietnam.
4. "Dynamics of complex domains in polymer-surfactant systems", T.Kawakatsu; Random Media II (CREST Workshop), Sep. 3 - 6, 2012, WPI-AIMR, Tohoku University, Sendai, Japan,

Name	Teruya Ishihara
Department	Physics
Position	Professor
Research Title	Light-Matter interaction in metallic photonic crystals and metamaterials

I. Summary of Research

1. Optical rectification effect at normal incidence in non-diffraction regime has been investigated, which is not expected from simple momentum conservation between light and free carriers in 1D grating slab. It is clarified that the optical rectification signal is due to the asymmetric excitation of a surface plasmon polariton.
2. Magnetic response of stratified metal dielectric multi-layers has been investigated. Especially large magnetic response is found to be ascribed to the inhomogenous distribution of magnetic field in a photonic unit cell. The origin of pseudo-resonance due to thickness fluctuation was ascribed to the non-equivalent unit cells.
3. "Split-tube" metamaterials in THz regime were fabricated with a maskless exposure technique combined with oblique metal sputtering. Transmission spectra obtained by THz time domain spectroscopy is readily reproduced by Finite Difference Time Domain numerical calculation.
4. Radiative life-time of CdSe based quantum dots on a metal dielectric multilayer structures was investigated. When the structure has Fibonacci sequence, the lifetime is expected to have considerably shorter lifetime compared to the case of simple periodic structure. The effect was observed experimentally in time-resolved spectroscopy using a streak camera.
5. Four-detector ellipsometry setup has been developed for real-time monitor of multi-layer film growth with ion-beam sputtering technique. We found that the insertion of quarterwave plates was essential for accurate measurement.
6. Nano-porous gold was investigated as a novel type of plasmonic material. The material is prepared by etching a leaf of 50:50 alloy of Au and Ag. Numerical simulation shows considerable red shift of plasmon edge, which has been confirmed by optical measurement.

II. Publications

1. "Permeability enhancement of stratified metal dielectric metamaterial in optical regime," Aunuddin Syabba Vioktalamo, Ryosuke Watanabe and Teruya Ishihara, *Photonics and Nanostructures - Fundamentals and Applications*, Volume 10, pp. 325–328 (2012).
2. "Optical rectification effect due to surface plasmon polaritons at normal incidence in a

- nondiffraction regime," Hiroyuki Kurosawa, Teruya Ishihara, Naoki Ikeda, Daiju Tsuya, Masayuki Ochiai, and Yoshimasa Sugimoto, *Optics Letters*, Vol. 37, pp. 2793-2795 (2012).
3. "Transverse voltage induced by circularly polarized obliquely incident light in plasmonic crystals," T. Ishihara, T. Hatano, H. Kurosawa, Y. Kurami and N. Nishimura, *Proceedings of SPIE conference* doi:10.1117/12.933279 (2012)
 4. *Metamaterials II*, eds, Teruya Ishihara, Atsushi Sanada and Kotaro Kajikawa, CMC publication, pp. 1-278, (2012).

III. Presentations

1. "Transverse voltage induced by circularly polarized obliquely incident light in plasmonic crystals," T. Ishihara, T. Hatano, H. Kurosawa, Y. Kurami and N. Nishimura, *SPIE Optics and Photonics* (August 11-16, 2012, San Diego, CA, USA)
2. "Optical Properties of Chemically Prepared Metamaterials," *Asian Conference on Nanoscience and Nanotechnology 2012*. (September 7-10 , 2012. Lijiang, China)
3. "Optical rectification effect at normal incidence in asymmetric metamaterial," Hiroyuki Kurosawa, Takafumi Hatano, Teruya Ishihara, Naoki Ikeda, Daiju Tsuya, Masayuki Ochiai, Yoshimasa Sugimoto, *Metamaterials 2012* (September 17-22, 2012, St. Petersburg, Russia)
4. "Nano-porous gold as a metamaterial," Teruya Ishihara, *Physical Society of Japan Autumn Meeting* (September 18-21, 2012, Yokohama, Japan)
5. "Photo-rectification effect in deformed metal-dielectric photonic crystal slabs," Hiroyuki Kurosawa, Kei Sawada, Seigo Ohno, Kazuyuki Nakayama and Teruya Ishihara, *Physical Society of Japan Annual Meeting* (Mar. 26-29, 2013, Hiroshima University, Japan)
6. "Fabrication of sub-wavelength structure by utilizing sub-wavelength structure," Kanta Kusaka, Yosaburo Sakaki, Hiroyuki Kurosawa, Seigo Ohno, Kazuyuki Nakayama and Teruya Ishihara, *Physical Society of Japan Annual Meeting* (Mar. 26-29, 2013, Hiroshima University, Japan)
7. "Control of luminescence with quasi-periodic metamaterials," Kazuyuki Nakayama, Yuto Moritake, Teruya Ishihara, *Physical Society of Japan Annual Meeting* (Mar. 26-29, 2013, Hiroshima University, Japan)
8. "Spontaneous emission enhancement using sub-wavelength Fibonacci structure," Yuto Moritake, Kazuyuki Nakayama, Toshihiro Suzuki, Hiroyuki Kurosawa, Seigo Ohno, Toshiyuki Kodama, Satoshi Tomita, Hisao Yanagi and Teruya Ishihara, *Physical Society of Japan Annual Meeting* (Mar. 26-29, 2013, Hiroshima University, Japan)

Name	Hajime Shimizu
Department	Research Center for Electron Photon Science
Position	Professor
Research Title	Quark Nuclear Physics with a Photon Beam

I. Summary of Research

1. We became able to restart analyses at long last for the data obtained in the FOREST experiment that had been performed before the 3.11 disaster. The total cross section has been obtained for single η photoproduction on the deuteron as well as on the proton at an energy region about 1 GeV. A clear bump is observed at $E \approx 1670$ MeV in the total cross section for the η -n channel in which outgoing neutrons are detected with a time of flight method. For the η -p channel, on the other hand, no such bump has been observed. We have been working on this research to search for anti-decuplet members of pentaquark baryons with hidden strangeness. The data analysis is now going on to the final stage.
2. A research on multi-meson photoproduction processes has proceeded to provide a new data set to be employed in a recently developed coupled-channel analysis of nucleon resonances. A preliminary result is now available for the total cross sections in $\pi^+\pi^0$ and $\pi^-\pi^0$ photoproduction on the deuteron and proton. The final result will be the first data that are obtainable with a photon beam of the energy greater than 800 MeV.
3. We have finally completed mechanical part of BGOegg, a brand new 4π electro-magnetic calorimeter, to be used in quark nuclear physics experiments. The BGOegg calorimeter consists of 22 different-size BGO crystals of tapered shape, which gives position-dependent light output due to a focusing effect if all sides of each crystal are polished. A surface-treatment technique was employed to make the light output uniform. All of the 1320 BGO crystals, about 2 ton in weight, have been successfully installed so as to be an egg-shape calorimeter. The overall energy resolution at 1 GeV was found to be 1.3%, which was obtained in a test experiment for a part of BGOegg, a 5×5 matrix, with a positron beam at ELPH before the disaster.
4. The BGOegg calorimeter system moved to SPring-8 in Dec. 15, 2012 without any trouble and was placed on the LEPS2 beamline, which was commissioned for use on Jan. 27, 2013. We observed a clear π^0 peak in a $\gamma\gamma$ invariant mass spectrum which was obtained with BGOegg for the first time at the LEPS2 beam line.

II. Publications

1. "A detailed test of a BSO calorimeter with 100-800 MeV positrons",
T. Ishikawa, H. Fujimura, R. Hashimoto, S. Kaida, J. Kasagi, R. Kitazawa, S. Kuwasaki,

A. Nakamura, K. Nawa, Y. Okada, M. Sato, H. Shimizu, K. Suzuki, Y. Tajima, S. Takahashi, Y. Tsuchikawa, H. Yamazaki, and H.Y. Yoshida,
Nucl. Instr. and Meth. A694 (2012) 348-360.

III. Presentations

1. "Recent Progress and Results of LEPS, LEPS2, and ELPH", N. Muramatsu, The 20th International IUPAP Conference on Few-Body Problems in Physics, August 20-25, 2012, Fukuoka, Japan (invited talk).
2. " π^0 and η photoproduction on the deuteron at ELPH", T. Ishikawa, The 20th International IUPAP Conference on Few-Body Problems in Physics, August 20-25, 2012, Fukuoka, Japan.
3. "Recent results from LEPS and ELPH", M. Miyabe, The 8th China-Japan Joint Nuclear Physics Symposium, October 15-19, 2012, Beijing, China.
4. "Physics Programs at ELPH-Tohoku", H. Shimizu, The 2nd International School for Strangeness Nuclear Physics, February 14-20, 2013, J-PARC and Sendai, Japan (invited lecture).

Name	Yasuhiro Sakemi
Department	Physics (Cyclotron and Radioisotope Center)
Position	Professor
Research Title	Study of the violation of time reversal invariance with the search for electron electric dipole moment measurements

I. Summary of Research

1. The development of the experimental apparatus to search for the electric dipole moment (EDM) of the Francium (Fr), which is the radioactive element and produced with the nuclear fusion reaction with the AVF cyclotron at CYRIC, is in progress. We already have succeeded to produce the Fr with about 10^6 Fr⁺/sec by newly developed thermal ionizer, which is sufficient for the EDM measurement with the accuracy of 10^{-28} e cm. Also the neutralizer to convert the Fr ions into the neutral atoms, which is needed to cool and trap the Fr with laser cooling technique, was successfully developed, and the neutralization efficiency with about 5% is achieved. The Fr ion beam is transported to neutralizer with 10 m beam line successfully for the first time.
2. The EDM measurement system is also developed. It consists of the magneto-optical trap (MOT) to cool and trap the Fr, optical trap system for the measurement of EDM, EDM cell to accumulate the Fr and apply the high voltage, co-magnetometer to monitor the magnetic field, and the magnetic field shielding. Two MOTs are ready for the Fr trapping and cooling. We already tested them with Rb and this double MOT system worked well. Also the change of the magnetic field in the experimental area was measured accurately with/without the prototype of the magnetic field shield. The change of the magnetic field was reduced by the shield with about nT level, but we need to control it to pT level at least. So the development of the magnetometer is started.

II. Publications

1. T.Adachi et al. (Y.Sakemi), "High-resolution study of Gamow-Teller transitions via the Fe-54 (He-3, t) Co-54 reaction.", Phys.Rev. C85 (2012) 024308
2. I. Poltoratska et al. (Y.Sakemi)." Pygmy dipole resonance in 208Pb.", Phys.Rev. C85 (2012) 041304
3. T. Wakasa, M. Okamoto (Kyushu U.) , M. Dozono (Nishina Ctr., RIKEN & Wako, RIKEN) , K. Hatanaka (Osaka U.) , M. Ichimura (Nishina Ctr., RIKEN & Wako, RIKEN) , S. Kuroita (Kyushu U.) , Y. Maeda, H. Miyasako (Miyazaki U.) , T. Noro (Kyushu U.) , T. Saito (Miyazaki U.) Y. Sakemi (Tohoku U.) , T. Yabe (Kyushu U.) , K. Yako (Tokyo U.), "Complete sets of

- polarization transfer observables for the Pb-208 ($p^{\vec{r}}, n^{\vec{r}}$) reaction at 296 MeV and Gamow-Teller and spin-dipole strengths for Pb-208", Phys.Rev. C85 (2012) 064606
4. Y. Shimbara (Osaka U. & Niigata U.) , Y. Fujita, T. Adachi, G.P.A. Berg, H. Fujimura, H. Fujita, K. Fujita, K. Hara (Osaka U.) , K.Y. Hara (Konan U.) , K. Hatanaka J. Kamiya, K. Katori, T. Kawabata, K. Nakanishi (Osaka U.) , G. Martinez-Pinedo (Darmstadt, GSI) , N. Sakamoto, Y. Sakemi, Y. Shimizu, Y. Tameshige (Osaka U.) , M. Uchida (Kyoto U.) , M. Yoshifuku (Osaka U.) , M. Yosoi (Kyoto U.), "High-resolution study of Gamow-Teller transitions with the Cl-37 (He-3, t) Ar-37 reaction", Phys.Rev. C86 (2012) 024312
 5. S. Almaraz-Calderon, W.P. Tan, A. Aprahamian, M. Beard, G.P.A. Berg, B. Bucher, M. Couder, J. Gorres, S. O'Brien, D. Patel A. Roberts, K. Sault, M. Wiescher (Notre Dame U.) , C.R. Brune, T.N. Massey (Ohio U.) , K. Fujita, K. Hatanaka, D. Ishiwaka, H. Matsubara, H. Okamura, H.J. Ong, Y. Sakemi, Y. Shimizu, T. Suzuki, Y. Tameshige, A. Tamii, J. Zenihiro (Osaka U.) , T. Kubo, Y. Namiki, Y. Ohkuma, Y. Shimbara, S. Suzuki, R. Watanabe, R. Yamada (Osaka U. & Niigata U.) , T. Adachi, Y. Fujita (Osaka U.) , H. Fujita (Witwatersrand U.) , M. Dozono, T. Wakasa (Kyushu U.), "Level structure of S-30 and its importance in the Si-26 (alpha, p) P-29 and P-29 (p, gamma) S-30 reaction rates", Phys.Rev. C86 (2012) 065805

III. Presentations

1. "Laser cooled radioactive francium factory at CYRIC",
H.Kawamura et al. (Y.Sakemi), International Conference on Electromagnetic Isotope Separators and Techniques related their applications: EMIS2012, Dev.02-07 2012, Matue, Shimane, Japan
2. "Search for electron EDM with laser cooled radioactive atom",
T. Inoue et al. (Y.Sakemi), The 8th China-Japan joint nuclear physics symposium: CJJNP2012, Oct. 15-19 2012, Beijing, China
3. "Status report on the development of magneto-optical trap systems for Fr towards the electron EDM search",
K. Harada et al. (Y.Sakemi), Fundamental Physics using Atoms 2012: FPUA2012, Sep. 28-30 2012, Sendai, Miyagi, Japan
4. "Current status of Fr EDM enhancement factor calculations",
H.S. Nataraj et al. (Y.Sakemi), Fundamental Physics using Atoms 2012: FPUA2012, Sep. 28-30 2012, Sendai, Miyagi, Japan
5. "Development of a double MOT system and spectroscopy of iodine molecule at 718 nm toward the electron EDM measurement",
K. Harada et al. (Y. Sakemi), The 23rd international conference on atomic physics : ICAP2012,

Jul. 23-27 2012, Ecole Polytechnique, Palaiseau, France

6. "Development of Fr ion source with melting Au target for electron EDM search",
T. Hayamizu et al. (Y. Sakemi), The 23rd international conference on atomic physics :
ICAP2012, Jul. 23-27 2012, Ecole Polytechnique, Palaiseau, France
7. "EDM Project with radioactive paramagnetic Fr atoms",
T. Sato et al. (Y. Sakemi), Spin-Praha-2012, Jul. 1-8 2012, Praha
8. "Search for electron EDM in laser-cooled francium factory",
H. Kawamura et al. (Y.Sakemi), 5th international symposium on symmetry in subatomic
physics: SSP2012, June 18-22 2012, Groningen, The Netherlands

Name	Takashi Takahashi
Department	Physics, and WPI-AIMR
Position	Professor
Research Title	Ultrahigh-resolution photoemission study of topological insulators, graphene, and novel superconductors

I. Summary of Research

1. We have performed high-resolution angle-resolved photoemission spectroscopy (ARPES) on a IV-VI semiconductor SnTe, and found a pair of metallic Dirac-cone surface states in the (110) mirror plane. The present observation provides the first experimental evidence for the topological-crystalline-insulator phase in which the metallic surface state is protected by the mirror symmetry of the crystal.
2. We have successfully fabricated calcium-intercalated bilayer graphene C_6CaC_6 which is a 2D limit of superconducting C_6Ca . Our high-resolution ARPES indicated the existence of a free-electron-like interlayer band, which is thought to be responsible for the superconductivity in C_6Ca . The present results open a promising route to search for novel 2D superconductors as well as to realize novel graphene-based devices.
3. By performing spin-resolved ARPES of $TiBi(S_{1-x}Se_x)_2$ which undergoes a topological phase transition, we have revealed a helical spin texture in the massive Dirac phase as well as unusual reduction of spin polarization with approaching the phase transition. The present results unambiguously indicate the topological origin of the massive Dirac states, and also impose a constraint on models to explain the origin of mass acquisition of Dirac fermions.

II. Publications

1. "Experimental realization of a topological crystalline insulator in SnTe",
Y. Tanaka, Z. Ren, T. Sato, K. Nakayama, S. Souma, T. Takahashi, K. Segawa, and Y. Ando,
Nature Phys., 8, 800, (2012).
2. "Ca intercalated bilayer graphene as a thinnest limit of superconducting C_6Ca ",
K. Kanetani, K. Sugawara, T. Sato, R. Shimizu, K. Iwaya, T. Hitosugi, and T. Takahashi, Proc.
Natl. Acad. Sci., 109, 19610, (2012).
3. "Observation of momentum space semi-localization in Si-doped \hat{a} - Ga_2O_3 ",
P. Richard, T. Sato, S. Souma, K. Nakayama, H. W. Liu, K. Iwaya, T. Hitosugi, H. Aida, H.
Ding, and T. Takahashi, Appl. Phys. Lett., 101, 232105, (2012).
4. "Manipulation of topological states and the bulk band gap using natural heterostructures of a topological insulator",

- K. Nakayama, K. Eto, Y. Tanaka, T. Sato, S. Souma, T. Takahashi, K. Segawa, and Y. Ando, *Phys. Rev. Lett.*, 109, 236804, (2012).
5. "Real-Space Coexistence of Melted Mott phase and Superconductivity in Fe-Substituted $1T\text{-TaS}_2$ ",
R. Ang, Y. Tanaka, E. Ieki, K. Nakayama, T. Sato, L. J. Li, W. J. Lu, Y. P. Sun, and T. Takahashi, *Phys. Rev. Lett.*, 109, 176403, (2012).
 6. "Spin Polarization of Gapped Dirac Surface States Near the Topological Phase Transition in $\text{TlBi}(\text{S}_{1-x}\text{Se}_x)_2$ ",
S. Souma, M. Komatsu, M. Nomura, T. Sato, A. Takayama, T. Takahashi, K. Eto, K. Segawa, and Y. Ando, *Phys. Rev. Lett.*, 109, 186804, (2012).
 7. "Angle-resolved photoemission spectroscopy of Co-based boride superconductor LaCo_2B_2 ",
K. Nakayama, E. Ieki, Y. Tanaka, T. Sato, T. Takahashi, T. Kuroda, H. Mizoguchi, S. W. Kim, and H. Hosono, *Phys. Rev. B*, 86, 014503, (2012).
 8. "Anomalous Rashba effect of Bi(111) thin film studied by high-resolution spin-resolved ARPES",
A. Takayama, T. Sato, S. Souma, and T. Takahashi, *J. Vac. Sci. Tech.*, 30, 04E107, (2012).

III. Presentations

1. "ARPES studies of novel topological materials" (invited),
Takafumi Sato, JPS the 68th annual meeting (March 26-29, 2013, Hiroshima University, Hiroshima, Japan)
2. "Quasiparticle states in ultrathin films" (invited),
Katsuaki Sugawara, JPS the 68th annual meeting (March 26-29, 2013, Hiroshima University, Hiroshima, Japan)
3. "Intercalated bilayer graphene studied by high-resolution ARPES" (invited),
Katsuaki Sugawara, Graphene Workshop (February 7, 2013, Tohoku University, Sendai, Japan)
4. "Dirac fermions systems studied by spin-resolved ARPES" (invited),
Seigo Souma, IMR-CMRI Symposium, (January 21-22, 2013, Sendai, Japan)
5. "Spin-Resolved ARPES Study of Graphene and Topological Insulators" (invited),
Takashi Takahashi, 10th RIEC International Workshop on Spintronics: New Directions in Materials for Nanoelectronics, Spintronics and Photonics, (January 15-16, 2013, Tohoku University, Sendai, Japan)
6. "High-resolution ARPES of Topological insulator with using synchrotron radiation light source" (invited),
Seigo Souma, CMRC Workshop "Recent progress in correlated electron systems using ARPES,

- neutron scattering, and μ SR", (December 6-7, 2012, KEK, Tsukuba, Japan)
7. "Spin-resolved ARPES on topological insulators" (invited),
Seigo Souma, WPI-AIMR workshop "Topological functional materials and devices",
(November 30 - December 1, 2012, Tohoku university, Sendai, Japan)
 8. "Electronic structure of topological insulator studied by spin-resolved ARPES" (invited),
Seigo Souma, Workshop on the occasion of the establishment of Laser and Synchrotron
Research Center, (November 29, 2012, ISSP, Kashiwa, Japan)
 9. "Graphene intercalation compounds studied by high-resolution ARPES" (invited),
Katsuaki Sugawara, International Conference on Emerging Advanced Nanomaterials (October
22-25, 2012, Mercure Hotel, Brisbane, Australia)
 10. "ARPES studies of Dirac-cone surface states in topological insulators" (invited),
Takafumi Sato, 5th Indo-Japan Conference on New functionalities in Electronic and Magnetic
Materials (October 18-20, 2012, Bangalore, India)
 11. "Graphene and intercalation compounds studied by high-resolution ARPES" (invited),
Katsuaki Sugawara, Graphene Workshop (October 4, 2012, Tokyo University of Science,
Tokyo, Japan)
 12. "New frontier in spintronics developed by high-resolution spin-resolved ARPES" (invited),
Seigo Souma, JPS 2012 autumn meeting, (September 24-27, 2012, Yokohama National
University, Yokohama, Japan)
 13. "Low-energy electronic excitations in iron-based superconductors studied by ARPES" (invited),
Kosuke Nakayama, WPI mini workshop "A route to high T_c superconductivity", (September 3,
2012, Tohoku University, Sendai, Japan)
 14. "Rashba effect of Bi(111) thin film studied by high-resolution spin-resolved ARPES" (invited),
Akari Takayama, The 4th synchrotron radiation symposium for young scientist (August 29-30,
2012, Tokyo University, Tokyo, Japan)
 15. "Direct observation of anisotropic SC gaps in LiFeAs by high-resolution ARPES" (invited),
Kosuke Nakayama, Materials and Mechanisms of Superconductivity (M^2S) Conference 2012,
(July 29 – August 3, 2012, Omni Shoreham Hotel, Washington, D. C., USA)
 16. "ARPES studies of novel topological materials" (invited),
Takafumi Sato, JPS the 68th annual meeting (March 26-29, 2013, Hiroshima University,
Hiroshima, Japan)
 17. "Novel electronic states of topological insulators studied by ARPES" (invited),
Takafumi Sato, Low-Energy Electrodynamics of Solids conference (LEES2012) (July 23-27,
2012, Napa, USA)
 18. "Fermi surface topology and superconducting gap symmetry in Fe-based superconductors

studied by high-resolution ARPES" (invited),

Kosuke Nakayama, 2012 EMN meeting (April 16-20, 2012, Orland, Florida, USA)

IV. Prizes (Awards)

Members of Photoemission solid-state physics Lab.

1. Akari Takayama (Physics, D3), Presidential Prize (Tohoku University) for the study on "Construction of spin-resolved photoemission spectrometer and the study of Rashba effect in bismuth thin films", Tohoku University, (March 27, 2013)
2. Akari Takayama (Physics, D3), JSPS Ikushi Prize for the study on "Ultrahigh-resolution spin-resolved ARPES study of two-dimensional Rashba electron system", Japan Society for the Promotion of Science, (March 4, 2013)
3. Kosuke Nakayama (Physics/WPI, Assistant prof.), Inoue Research Award for Young Scientist for the study on "Bulk electronic structure of cuprate high- T_c superconductors studied by angle-resolved photoemission spectroscopy", Inoue Foundation for Science, (February 4, 2013)
4. Katsuaki Sugawara (Physics/WPI, Assistant Prof.), Harada Research Award for Young Scientists (2012) for the study on "graphite and related materials studied by high-resolution ARPES", The Honda Memorial Foundation (July 6, 2012)

Name	Katsumi Tanigaki
Department	Physics, and WPI-AIMR
Position	Professor
Research Titles	1. Materials with regulated nano spaces: Ubiquitous-element strategy 2. Carbon materials 3. Dirac-cone quantum states on topology and geometrical symmetry 4. Molecular semiconductors: Fundamentals in device physics

I. Summary of Research

We have been currently exploring materials targeting on innovative materials in nano scale for future technology. By employing nano structure, intriguing physical properties such as high transport mobility, high temperature superconductivity and high efficient photo/thermoelectricity can be anticipated. A new paradigm of new materials science and technology will open a new route to develop various materials, based on which we can construct new devices and new scientific concept.

1. Materials with regulated nano spaces: Strategy on ubiquitous element

Nano materials with inner space become excellent thermoelectric materials for converting heat into electricity. This comes from the large suppression in heat conductivity without losing high electric conductivity. This contradictory relationship necessary for thermoelectrics cannot be realized in standard materials, as is known by Wiedemann-Franz Law. Anharmonic phonons created by anomalous motions of endohedral atoms inside the cage greatly scatter acoustic phonons to reduce the thermal conductivity in a similar fashion observed in amorphous materials, while electric conductivity is less influenced because the Fermi surface can mainly be constructed by the wave functions of elements residing on the cage. This concept was proposed by Sales et al. in 2001 and now is one of the promising methodologies for making high efficient thermoelectric compounds. Another intriguing issue on anharmonic phonons is how greatly they can strengthen electron-phonon coupling interactions. We have made a new approach for making accurate determination of the coupling strength by separating the two parts between the itinerant electrons and the phonons via the tunneling process. The finding is very important for understanding the mechanism of superconductivity mediated by anharmonic phonons as well as for designing new thermoelectric materials.

2. Carbon materials

Carbon materials are scientifically and technologically very important. We have been resurveying the structure and the physical properties of alkali metal or alkaline-earth metal

doped polycyclic analogues, with various stoichiometries and study whether the half-filled states of this system is indeed a Mott state or another localized one. Ever since many studies have been made in the past decades, the answer to this fundamental reply has yet been clarified. Antimagnetic interactions have been confirmed in the case of anthracene. We expect that further studies will provide useful information on the nature of these doped systems.

3. Dirac-cone quantum states on topology and geometrical symmetry

Topology in materials is of large scientific interest after the discovery of intriguing quantum states of graphene, to which the 2010 Nobel Prize in physics was awarded. The quantum states of the Dirac-cone fermions as well as the topological insulators showing nontrivial metallic surface states have become one of priority research areas in materials science to date. Dirac-cone electronic states originally discussed in graphene are now popular also in other materials, such as some of Bi compounds, organic conductors as well as Fe pnictides. We have demonstrated experimentally in the first time that a linear evolution of magneto-resistance as a function of magnetic is observed in a Fe pnictide multiband system via electric transport, which was predicted by Abricosov for the Dirac-cone states in the past. The multiband Dirac-cone quantum states are scientifically very intriguing, and further experimental and theoretical studies are presently in progress.

4. Molecular semiconductors: Fundamentals in device physics

Metal-semiconductor contact between the active layer and the electrodes has been one of the very important scientific issues in the field of semiconductor technology. Two extreme limits, the Schottky limit and the Bardeen one, are generally known. The Schottky barrier height depends on the workfunction of the metal electrodes (ϕ_m) in the former case, while it is nearly independent in the latter case. The metal-semiconductor contact becomes important when one thinks about organic light-emitting field effect transistors (OLETs). Different from inorganic semiconducting materials, ambipolar carrier injection of electrons and holes has recently been known to be possible in organic semiconducting materials most likely due to their non-dangling bonding characters stemming from π -conjugated interfacial states. However, the contact of the metal-semiconductor interface of organic semiconductors can in general be classified to the Schottky limit and the conduction band minima (CBM) is apart from the Fermi level (E_F) of the conventional electrode metals, such as gold and copper. As a consequence, metals with low workfunctions must be used as an electrode in order to inject electron carriers. We found that the metal-semiconductor contact can be changed from the Schottky limit to the Bardeen one without large reduction in carrier mobility. The almost equal injection of electrons and holes with holding high mobilities was achieved regardless of the fact that the Fermi level of Au is very different from that of CBM and nearly the same as that of VBM, being in good

correspondence with the concept of the Bardeen limit.

II. Publications

1. Y. Tanabe, K. K. Huynh, T. Urata, S. Heguri, G. Mu, J. T. Xu, R. Nouchi, and K. Tanigaki, "Suppression of backward scattering of Dirac fermions in iron pnictides $\text{Ba}(\text{Fe}_{1-x}\text{Ru}_x\text{As})_2$ ", *Physical Review B* 86, 094510 (2012).
2. K. Hara, S. Matsuda, E. Matsuoka, K. Tanigaki, and A. Ochiai, S. Nakamura, T. Nojima, K. Kato, "Quantum spin state in the rare-earth compound YbAl_3C_3 ", *Phys. Rev. B* 85, 144416 (2012).
3. Akihiko Fujiwara, Kunihisa Sugimoto, Che-Hsiu Shih, Hiroshi Tanaka, Jun Tang, Yoichi Tanabe, Jingtao Xu, Satoshi Heguri, Katsumi Tanigaki, Masaki Takata, "Quantitative relation between structure and thermal conductivity in type-I clathrates $\text{X}_8\text{Ga}_{16}\text{Ge}_{30}$ ($\text{X} = \text{Sr}, \text{Ba}$) based on electrostatic-potential analysis", *Phys. Rev. B* 85, 144305 (2012).
4. S. Michimura, T. Inami, E. Matsuoka, M. Watahiki, K. Tanigaki, H. Onodera, "Resonant X-Ray Diffraction Study of Multipole Ordering in the Ferromagnetic Compound CePd_3S_4 ", *J. Phys. Soc. Jpn* 81, 044711 (2012).
5. Jingtao Xu, Satoshi Heguri, Yoichi Tanabe, Gang Mu, Jiazhen Wu, Katsumi Tanigaki, "Heat capacity studies on rattling vibrations in Ba-TM-Ge type I clathrates", *J. Phys. Chem. Solid*, 73, 1521-1523 (2012).
6. Jingtao Xu, Jiazhen Wu, Satoshi Heguri, Gang Mu, Yoichi Tanabe, and Katsumi Tanigaki, *J. Elect. Mater.* 41, 1177-1180 (2012).
7. Ryo Nouchi, Tatsuya Saito, Katsumi Tanigaki, "Observation of negative contact resistances in graphene field-effect transistors", *J. Appl. Phys.* 111 084314-1_7 (2012).

III. Presentations aaaaaaa

1. K. Tanigaki, Electron correlation and transport in organic semiconductors, International School & Symposium on Molecular Materials and Devices, Durham, UK, 23-29 September, 2012. (Invited Keynote Lecture)
2. K. Tanigaki, Intercalation of Polyacenes and Their Physical Properties: Present status and future possibility, LEMSUPER Workshop, October 12 - 14, 2012, MaxPlanck Institute, Dresden, Germany (Invited Lecture).
3. K. Tanigaki, Rattlers in clathrates: superconductivity and thermoelectrics, Japan-France Joint Seminar 2012, Physics and Control of Clustering Solids, Awaji, November 6, 2012. (Invited)
4. K. Tanigaki, Clathrates: Present status and the future direction: from view point of quasicrystals, December 19-21, Kiniki University. (Special invited lecture)

5. Hui Shang, Susumu Ikeda, Kanagasekaran Thangavel, Hidekazu Shimotani, Kazuaki Oniwa, Tienan Jin, Naoki Asao, Yoshinori Yamamoto, Hiroyuki Tamura, Ikutaro Hamada, Kenta Abe, Masayuki Yoshizawa, Katsumi Tanigaki, Investigation on Gain Properties of Organic Single Crystals towards Electrically Driven Lasers, OIST International Symposium on Organic Electronics 2012, Okinawa Science and Technology University, December 3, 2012.
6. Quynh Phan T. N., Satoshi Heguri, Yoichi Tanabe, Hidekazu Shimotani, and Katsumi Tanigaki, Determination of ground state in potassium intercalated polyacenes, ISSMMD2012, Durham University, Durham, UK, September 28, 2012.
7. Satoshi Heguri, Yoichi Tanabe, Jingtao Xu, Gan Mu, Hidekazu Shimotani, Katsumi Tanigaki, ISSMMD2012, "Static Eu atoms endohedral type-1 clathrate, Durham University, Durham, UK, September 25, 2011.
8. Hui Shang, Susumu Ikeda, Kanagasekaran Thangavel, Hidekazu Shimotani, Kazuaki Oniwa, Tienan Jin, Naoki Asao, Yoshinori Yamamoto, Hiroyuki Tamura, Ikutaro Hamada, Kenta Abe, Masayuki Yoshizawa, Katsumi Tanigaki, Amplified Spontaneous Emission in Newly Synthesized Furan/Phenylene Co-oligomer Single Crystal, Physical Society Meeting of Japan, Yokohama, September 20, 2012.
9. Katsumi Tanigaki, Jingtao Xu, Jiazhen Wu, Gang Mu, Dwi Prananto, Correlations of Electronic states and anharmonic phonons in clathrates, Hidekazu Shimotani, Yoichi Tanabe, Satoshi Heguri, Physical Society Meeting of Japan, Yokohama, September 19, 2012.
10. Quynh Phan T. N., Satoshi Heguri, Yoichi Tanabe, and Katsumi Tanigaki, Magnetic properties of potassium intercalated several varieties of polyacene, Physical Society Meeting of Japan, Yokohama, September 19, 2012.
11. Khuong Huynh, Y. Tanabe, T. Urata, S. Heguri, K. Tanigaki, T. Kida, M. Hagiwara, Five-band model analysis of transport properties of Ba(FeAs)₂, Physical Society Meeting of Japan, Yokohama, September 19, 2012.
12. Carrier Control using organic-inorganic interface control in Topological Insulators of Bi_{2-x}Sb_xTe_{3-y}Se_y, Yoichi Tanabe, Huynh Kim Khuong, Satoshi Heguri, Ryo Nouchi, Mu Gang, Xu Jingtao, Katsumi Tanigaki, Physical Society Meeting of Japan, Yokohama, September 19, 2012.
13. Jiazhen Wu, Jingtao Xu, Gang Mu, Dwi Prananto, Hidekazu Shimotani, Yoichi Tanabe, Satoshi Heguri, Katsumi Tanigaki, Low Temperature Specific Heat Study on Type I Clathrates, Physical Society Meeting of Japan, Yokohama, September 18, 2012.
14. Nobuhiko Mitoma, Ryo Nouchi, Katsumi Tanigaki, Chemical Modification of Graphene with Water under Light Irradiation, MRS Spring Meeting & Exhibit, Moscone West, San Francisco, USA, April 13, 2012.

15. Ryo Nouchi, Masanori Shigeno, Nao Yamada, Katsumi Tanigaki, Masahiko Yamaguchi, Reversible Schottky-Ohmic Switching at Interfaces between SAM-Modified Metals and Organic Semiconductors, MRS Spring Meeting & Exhibit , Marriott, San Francisco, USA, April 12, 2012.
16. Hui Shang, Susumu Ikeda, Kanagasekara Thangavel, Hidekazu Shimotani, Kazuaki Oniwa, Tienan Jin, Uzzaman M. Akhtar, Naoki Asao, Yoshinori Yamamoto, Hiroyuki Tamura, Ikutaro Hamada, Katsumi Tanigaki, Optoelectronic Properties of Newly Synthesized Furan/Phenylene Co-oligomer Single Crystal, 2012 MRS Spring Meeting & Exhibit, Moscone West, San Francisco, USA, April 11, 2012.
17. Thangavel Kanagasekaran, Susumu Ikeda, Ryotaro Kumashir, Hidekazu Shimotani, Katsumi Tanigaki, Air Stable Organic Light Emitting Field Effect Transistor with Gold Electrodes, MRS Spring Meeting & Exhibit , Moscone West, San Francisco, USA, April 10, 2012.
18. Ryo Nouchi, Tatsuya Saito, Nobuhiko Mitoma, Katsumi Tanigaki, Negative Contact Resistances Apparently-appeared at Graphene/Metal Contacts, MRS Spring Meeting & Exhibit , Moscone West, San Francisco, USA, April 10, 2012.
19. Quynh Phan, Satoshi Heguri, Yoichi Tanabe, Junichi Ikeda, Katsumi Tanigaki, "ESR study in potassium doped anthracene" Physical Society Meeting of Japan, Kansei Gakuin University, Kobe, March 26, 2012.
20. Junichi Ikeda, Yoichi Tanabe, Ryo Nouchi, Hidekazu Shimotani, Katsumi Tanigaki, Anomaly in contact resistance in organic double layer transistors, Physical Society Meeting of Japan, Kansei Gakuin University, Kobe, March 25, 2012.
21. Hui Shang, Susumu Ikeda, Thangavel Kanagasekaran, Hidekazu Shimotani, Kazuaki Oniwa, Tienan Jin, Uzzaman Md. Akhtar, Naoki Asao, Yoshinori Yamamoto, Hiroyuki Tamura, Ikutaro Hamada, Katsumi Tanigaki, Optoelectronic Properties of Newly Synthesized Furan/Phenylene Co-oligomer Single Crystal, Physical Society Meeting of Japan, Kansei Gakuin University, Kobe, March 24, 2012.
22. T. Kanagasekaran, S. Ikeda, H. Shang, R. Kumashiro, H. Shimotani, K. Tanigaki, Air stable organic ambipolar field effect transistor with gold electrodes, Physical Society Meeting of Japan, Kansei Gakuin University, Kobe, March 24, 2012.
23. Jiazhen Wu, Jingtao Xu, Satoshi Heguri, Gang Mu, Katsumi Tanigaki, Discussion of magnetism in type 1 clathrate compounds, Physical Society Meeting of Japan, Kansei Gakuin University, Kobe, March 24, 2012.
24. Jingtao Xu, Jiazhen Wu, Satoshi Heguri, Yoichi Tanabe, Gang Mu, Jun Tang, Katsumi Tanigaki, Low temperature heat capacity study on type I clathrates, Physical Society Meeting of Japan, Kansei Gakuin University, Kobe, March 24, 2012.

25. Gang Mu, Jun Tang, Yoichi Tanabe, Jingtao Xu, Satoshi Heguri, Katsumi Tanigaki, A directional specific heat study on an overdoped iron-pnictide superconductor $\text{Ba}(\text{Fe}_{1-x}\text{Co}_x)_2\text{As}_2$, Physical Society Meeting of Japan, Kansei Gakuin University, Kobe, March 24, 2012.
26. Measurements of electric resistivity of $\text{EuxSr}_{8-x}\text{Ga}_{16}\text{Ge}_{30}$, Satoshi Heguri, Yoichi Tanabe, Jingtao Xu, Gang Mu, Jiazhen Wu, Katsumi Tanigaki, Physical Society Meeting of Japan, Kansei Gakuin University, Kobe, March 24, 2012.
27. Ryo Nouchi, Nobushiko Mitoma, Yan Fanxiao, Katsumi Tanigaki, Electric transport in Surface modified Graphene, Physical Society Meeting of Japan, Kansei Gakuin University, Kobe, March 24, 2012.
28. Takahiro Urata, Yoichi Tanabe, Huynh Kim Khuong, Satoshi Heguri, Gang Mu, Jingtao Xu, Katsumi Tanigaki, Influences of Mn Impurity on Dirac-cone of $\text{Ba}(\text{Fe}_{1-x}\text{Mn}_x\text{As})_2$, Physical Society Meeting of Japan, Kansei Gakuin University, Kobe, March 24, 2012.
29. Katsumi Tanigaki, Properties of potassium doped organic semiconductors: anthracene, tetracene and pentacene, Special Meeting of New Materials Science using Regulated Nano Space: Ubiquitous Element Strategy, The 3rd meeting, Tokyo Institute of Technology, March 23, 2012.
30. Hidekazu Shimotani, Elucidation of Meta-Organic Interfaces in Electric Double Layer Transistors, Special Meeting of New Materials Science using Regulated Nano Space: Ubiquitous Element Strategy, The 3rd meeting, Tokyo Institute of Technology, March 23, 2012.
31. Gang Mu, Jun Tang, Yoichi Tanabe, Jingtao Xu, Satoshi Heguri, Yoichi Tanab, Katsumi Tanigaki, Evidence for line nodes in the energy gap of overdoped $\text{Ba}(\text{Fe}_{1-x}\text{Co}_x)_2\text{As}_2$: A low-temperature specific heat study, APS March Meeting 2012, Boston Convention Center, Boston, USA, February 28, 2012.

Name Reiko Miyaoka
Department Mathematics
Position Professor
Research Title Differential Geometry

I. Summary of Research

1. I completed the classification of isoparametric hypersurfaces with six principal curvatures, which gives a solution to Yau's problem and Dorfmeister-Neher's conjecture.
2. I gave an expression of the Cartan-Munzner polynomial of degree four in terms of the moment map of certain group actions including the spin action.
3. I characterized the transnormal functions in relation with isoparametric functions. Although the former is weaker than the latter, they play a more essential role.

II. Publications

1. "Isoparametric hypersurfaces with $(g,m)=(6,2)$ ", R. Miyaoka, Annals of Math., 177, No.1, (2013), 53–110.
2. "Moment maps of the spin action and the Cartan-Munzner polynomials of degree four", R. Miyaoka, Math. Ann. to appear (2012), DOI: 10.1007/s00208-012-0819-8
3. "Transnormal functions on a Riemannian manifold", R. Miyaoka, Differential Geometry and its Applications, 31 (2013), 130–139
4. "Isoparametric hypersurfaces and moment map", R. Miyaoka, Proceedings of the 16th International Workshop on Diff. Geom. 16, (2012), 11–23.
5. Geometry of G_2 orbits and isoparametric hypersurfaces", R. Miyaoka, Nagoya Math. J. Vol. 203, (2011, not yet reported), 695—715.

III. Presentations

1. "Hypersurface geometry and moment map", R. Miyaoka, The 9th KWMS International Conference (June 22, 2012), Ehwa Womans Univ., Seoul, Korea.
2. "Hypersurface geometry and moment map", R. Miyaoka, UK-Japan Mathematical Forum (July 17, 2012), Keio Univ., Tokyo, Japan.
3. "Isoparametric hypersurfaces and moment map", R. Miyaoka, The 58th Geometry Symposium, (Aug. 27, 2012), Kyushu Univ., Fukuoka, Japan.
4. "Hypersurfaces with the spin action and moment map", R. Miyaoka, Submanifold Geometry and Lie Group Action, (Sept. 4, 2012), Tokyo Univ. of Science, Tokyo, Japan.

5. "Expression of Cartan-Munzner polynomials via moment map of the spin action", R. Miyaoka, The 8th Geometry Conference for Friendship between China and Japan, (Sept. 8 2012), Sichuan Univ. Chendu, China.
6. "Theory of isoparametric hypersurfaces and related topics", R. Miyaoka, International Conference on Differential Geometry in Memory of Su Buqing (Sept. 22, 2012), Fudan Univ., Shanghai, China.
7. "Isoparametric hypersurfaces and moment map", R. Miyaoka, 16th International Workshop on Differential Geometry, (Nov. 2, 2012) , Kyungpook National Univ., Teagu, Korea.
8. "Hypersurface geometry, classical and modern" (four lectures), R. Miyaoka, KIAS Winter School (Jan.21-25, 2013), Highone and Seoul, Korea.

Organization:

2nd Geometry Workshop, "Symplectic Geometry and Mean Curvature Flow", (Mar. 16 - 18, 2013), KKR Hakugin-so, Zao.

Name	Takashi Shioya
Department	Mathematics
Position	Professor
Research Title	Geometry

I. Summary of Research

Gromov constructed a theory of metric measure geometry, based on the idea of concentration of measure phenomenon. However, the theory is very difficult and many proofs are incomplete. In these years, I complete the details of the proof of Gromov's claims and developed the theory further.

II. Publications

1. K. Funano and T. Shioya, Concentration, Ricci curvature, and the eigenvalues of Laplacian, to appear in Geometric and Functional Analysis.

III. Presentations

1. "Concentration, Ricci curvature, and the eigenvalues of Laplacian",
T. Shioya, The 8th China-Japan friendship conference of differential geometry (September 7-13, 2012, Sichuan University, Chengdu, China)
2. "Concentration, Ricci curvature, and the eigenvalues of Laplacian",
T. Shioya, The forth geometry meeting (August 20-24, 2012, Euler Institute, Saint-Petersburg, Russia)
3. "Concentration of metric measure spaces",
T. Shioya, ERC Summer School "Analysis and geometry in metric measure spaces" (May 7-12, 2012, Centro De Giorgi, Pisa, Italy)

Name	Takayoshi Ogawa
Department	Mathematics
Position	Professor
Research Title	Real and Harmonic Analysis on Nonlinear PDE

I. Summary of Research

1. Compressible Navier-Stokes-Poisson system is a model for the fluid mechanical approximation for the astronomical matter under the gravitational potential and the local and global well-posedness of the system is one of the big program in the mathematical research on the fluid dynamics. The closely related model is given by the compressible Navier-Stokes equation has the scaling invariant property so that the time local well-posedness of the system in the scaling critical space is possible to obtain. According to the hyperbolic structure of the density equation, the system is only possible to show the well-posedness not in the standard Sobolev type space but the real interpolation space of the Besov type. If the external force is driven by the potential induced by the Poisson equation modifies the low frequency structure and it is required to consider the low and high frequency separately. We introduce the hybrid Besov space and show the time local well-posedness in the scaling critical Besov space.
2. In the theory of the linear parabolic equations, maximal L^p regularity for the solution is one of the most important tool and it has been developed for wide functional space, especially L^p space or such a reflexible Banach space. However, if we require the time integrability by the limiting case L^1 , then the general theory fails and it is required to show maximal regularity by independent way. We consider time L^1 maximal regularity in terms of the initial and external force and proved that the time L^1 maximal regularity is possible if and only if the initial data is belonging to the end-point homogeneous Besov space. This result can be possible to apply the well-posedness issue for the density dependent Navier-Stokes system.
3. The wellposedness issue on the nonlinear partial differential equation is the main problem in the field of the partial differential equations. We continue to research the time local well-posedness issue for drift-diffusion system of bipolar type. It then turns out that the critical situation can be separated by the Besov space and there appears a difference of two type of the system, the mono polar type and bipolar type has different critical space for the largest well-posed class. We also investigate the similar case may happen to the system of the NLS.

II. Publications

Book

1. T. Ogawa, "*Real Analytic Method for Nonlinear Evolution Equations*" (in Japanese), Springer-Japan, pp 420, 2013. Paper

Paper

2. T. Kobayashi, T. Ogawa, *Fluid mechanical approximation to the degenerated drift-diffusion and chemotaxis equations in barotropic model*, Indiana Univ. Math. J., to appear.
3. T. Iwabuchi, T. Ogawa, *Ill-posedness issue for nonlinear Schrödinger equation with the quadratic nonlinearity for low dimensions*, Trans. Amer. Math. Soc., to appear.

III. Presentations

1. 5th Euro-Japanese Workshop Blow-up in CIRM,
" L^p Dissipative Estimate for the Schrödinger Semigroup with critical singular potential", Feb. 15-16, 2012, CIRM, Marseille-Luminy, France.
2. MathFlow 2012
"Existence of solution to the compressible Navier-Stokes-Poisson system and the relation with the drift-diffusion system", Oct. 22-26, 2012, Porquerolles, France.
3. CAU-Kyoto workshop for PDE.
"Local existence result for the compressible Navier-Stokes-Poisson system in a critical case", Feb. 15-16, 2013, Chung-Ang University, Seoul, Korea.

Workshop, Seminar, Colloquium

4. Applied Mathematics Seminar,
"*Ill-posedness problem for quadratic nonlinear Schrödinger equation in two space dimensions*", Tohoku Univ. April, 26, 2012.
5. Colloquium in Math, Muroran Inst. Tech.,
"*Asymptotic behavior of solution of various nonlinear partial differential equations in two dimensions*", Mathematical Institute, Tohoku University, May, 21, 2012.
6. "*Asymptotic behavior of solutions and mass resonance for the system of nonlinear Schrödinger equations*"
Colloquium, Muroran Inst. Tech. Aug. 3, 2012.
7. Department of Mathematics Colloquium,
"*Ill-posedness for quadratic nonlinear Schrödinger equation in two dimensions*", Department of Mathematics, Ehime University Sept. 28, 2012.
8. Workshop for Partial Differential Equations in North Kyushu

- “Existence of critical strong solution for compressible Navier-Stokes-Poisson system in three dimensions”*, Resent Hotel Kokura, Kitakyushu, Nov. 23, 2012.
9. 6th PDE seminar via the method of real and functional analysis,
“Meyer’s inequality in “Besov space $\dot{B}_{\infty,\infty}^0$ and bi-linear estimates”, Sanhills Yamagata, Yamagata, December, 21-23, 2012.
10. PDE. seminar, *“Ill-posedness for quadratic nonlinear Schrödinger equation in two dimensions”*, University of California Santa Barbara, March 15, 2013

Name	Kazuhiro Ishige
Department	Mathematics
Position	Professor
Research Title	Asymptotic profiles of the solutions for nonlinear parabolic equations

I. Summary of Research

1. We studied the large time behavior of positive solutions for the Laplace equation on the half-space with a nonlinear dynamical boundary condition. We showed the convergence of the solutions to the Poisson kernel in a suitable sense provided initial data are sufficiently small.
2. We considered the Cauchy problem for the heat equation with a smooth, nonpositive, and radially symmetric potential, and gave the exact power decay rates of L^q -norm of the corresponding solution. Furthermore, we investigated the large time behavior of the solution and its hot spots.
3. We considered the heat equation in the half-space with the singular potential function on the boundary, and found the threshold number on the existence and the nonexistence of positive solutions. The threshold number is characterized as the best constant of the Kato inequality in the half-space.

II. Publications

1. "Refined asymptotic profiles for a semilinear heat equation",
K. Ishige and T. Kawakami,
Math. Ann. 353 (No. 1) 161—192, (2012).
2. "Global solutions for a semilinear heat equation in the exterior domain of a compact set",
K. Ishige and M. Ishiwata,
Discrete Contin. Dyn. Syst. 32 (No. 3) 847—865, (2012).
3. "Blow-up for a semilinear parabolic equation with large diffusion on \mathbb{R}^N . II",
Y. Fujishima and K. Ishige,
J. Differential Equations 252 (No. 2) 1835—1861, (2012).
4. "Convergence to the Poisson kernel for the Laplace equation with a nonlinear dynamical boundary condition",
M. Fila, K. Ishige, and T. Kawakami,
Commun. Pure Appl. Anal. 11 (No. 3) 1285—1301, (2012).
5. " L^p norms of nonnegative Schrödinger heat semigroup and the large time behavior of hot spots",

K. Ishige and Y. Kabeya,

J. Funct. Anal. 262 (No. 6) 2695—2733, (2012).

6. “Heat equation with a singular potential on the boundary and the Kato inequality”,

K. Ishige and M. Ishiwata,

J. Anal. Math. 118 (2012), 161--176.

III. Presentations

1. “Sharp decay estimates of L^q -norms for nonnegative Schrödinger heat semigroups”,

K. Ishige,

Tohoku-Fudan workshop on the occasion of centennial of the Faculty of Science of Tohoku University, (May. 18, Tohoku University, Japan).

2. “Sharp decay estimates of L^q -norms for nonnegative Schrödinger heat semigroups”,

K. Ishige,

9th AIMS International Conference on Dynamical Systems and Differential Equations, (July. 2, Orland, USA).

3. “Blow-up set for type I blowing up solutions for a semilinear heat equation”,

K. Ishige,

5th Euro-Japanese Workshop on Blow-up, (Sep. 12, Luminy, France).

4. “Blow-up set for type I blowing up solutions for a semilinear heat equation”,

K. Ishige,

The 30th Kyusyu Symposium on Partial Differential Equations (Jan. 30, Kyusyu University, Japan).

Name Toshifumi Futamase
Department Astronomy
Position Professor
Research Title General Relativity, Cosmology

I. Summary of Research

1. We have studied non-linear gravitational evolution of Dark matter density fluctuation using Wiener-Hermite expansion technique and obtained very good agreement with N-body simulation up to a small scale and low redshifts
2. We have found a new series of solutions of Einstein equations representing charged black holes without no singularity by matching interior de Sitter solution with outside Reissner-Nordstrom solutions.
3. We have calculated an effective action for Bianchi type I anisotropic universe in loop quantum cosmology and found that the initial singularity is replaced by bounce.

II. Publications

1. "An Application of Wiener-Hermite Expansion to Non-Linear Evolution of Dark Matter", N.S. Sugiyama, T. Futamase, *Astrophysical Journal* 760, 114, (2012)
2. "New solution of charged regular black holes and their stability", N. Uchikata, S. Yoshida, T. Futamase, *Physical Review D*, 86, 084025, (2012)
3. "Behavior of Bianchi type I spacetime by path integral approach in LQC", K. Fujio, T. Futamase, *Physical Review D*, 85, 124002, (2012)

III. Presentations

1. "GR in the observational Cosmology", RESCEU Symposium on General Relativity and Gravitation, (November, 12- 16, 2012, Tokyo University, Tokyo, Japan)
2. "Weak Lensing Study on Substructure in Coma Cluster", 13th Marcel Grossmann Meeting, (July 1-7, 2013, Stockholm, Sweden)
3. "WH expansion applied for non-linear density perturbation", Relativity and Gravitation, 100 years after Einstein in Prague, (June 25-29, 2012, Prague, Czech)

Name	Takashi Ichikawa
Department	Astronomy
Position	Professor
Research Title	Study of galaxy evolution at high redshift universe and new instruments for infrared astronomy in Antarctica

I. Summary of Research

1. We analyze the recent released *HST*/WFC3 IR images to study the size-stellar mass relations of galaxies at high-redshift. We compared the results from traditional two-dimensional parameter fitting with those from newly invented non-parametric methods. Both results are in good agreement and show that very compact and normal massive galaxies coalesce at high-redshift. Our findings suggest that no significant size evolution is always necessary for massive quiescent galaxies.
2. New small telescopes were set at Dome Fuji station at Antarctica. The telescopes are being operated from Japan and sending astronomical site evaluation data. We obtained the smallest atmospheric turbulence (called "seeing") than ever taken at best sites for astronomy. The new data suggest Dome Fuji station to be the best site for the astronomy observations.

II. Publications

1. "Assembly of Massive Galaxies in a High-z Protocluster",
Uchimoto, Y. et al. *ApJ*, 750, 116-132 (2012)
2. "A universal stellar-mass and size relation] {A universal stellar-mass and size relation of galaxies in GOODS-N region",
Ichikawa, T. et al. *MNRAS*, 422, 1014-1027 (2012)
3. "The SCAR Astronomy & Astrophysics from Antarctica Scientific Research Programme",
Storey, J., *Astrophysics from Antarctica*, Proceedings of the International Astronomical Union, IAU Symposium, Volume 288, pp. 275-295 (2013)
4. "Dome Fuji in Antarctica as a Site for Infrared and Terahertz Astronomy",
Seta, N. et al. *Astrophysics from Antarctica*, Proceedings of the International Astronomical Union, IAU Symposium, Volume 288, pp. 251-255 (2013)
5. "Dome Fuji Seeing -the Summer Results and the Future Winter-over Observations",
Okita, H. et al. *Astrophysics from Antarctica*, Proceedings of the International Astronomical Union, IAU Symposium, Volume 288, pp. 25-28 (2013)

III. Presentations

1. "Test of Significant Size Evolution in Quiescent Galaxies: A Novel Approach",
Akhlaghi, Mohammad; Ichikawa, T. American Astronomical Society, AAS Meeting #221,
#418.03, USA

Name	Makoto Hattori
Department	Astronomy
Position	Associate Professor
Research Title	Construction of high accuracy components separation scheme for dramatic improvement of detection limit of primordial gravity wave origin cosmic microwave background polarization B-mode signal

I. Summary of Research

Main goal of my research team is a construction of high accuracy components separation scheme for dramatic improvement of detection limit of primordial gravity wave origin cosmic microwave background polarization B-mode signal. It is known that improvement of accuracies of the separation of emission from Galactic interstellar matters from the cosmic microwave background polarization data is crucial to achieve the aim. We have been trying to improve accuracies of the models of Galactic emission using brand new observational data and theoretical studies. My team has been working along following four theme during 2012 fiscal year.

The first one is finishing science grade all sky far infrared maps based on all sky survey data obtained by Japanese Infrared Satellite Akari. We have been working on improving map making tools to reduce systemetic errors appeared in the map. Significant improvement of the tools has been achieved. One of main contribution of Tohoku University team is improvement of accuracy for subtraction of zodiacal light. Related works on this task are published in the refereed journals. However, we have not yet reached a satisfactory level to open the final scientific grade map. My team has taken part in map making team for 7 years as one of main contributors. The map making process has been done by our high performance computer in Sendai. Obtained maps are expected to improve the Galactic dust emission model which is one of the key foreground components to improve the accuracy of the component separation.

The second one is construction of more accurate and realistic Galactic magnetic field model since Galactic polarized microwave emissions are controlled by the Galactic magnetic field structure. We have examined the effect of the existence of Galactic spiral gravitational potential and radiative cooling energy loss on the evolution of the magnetized Galactic thin gas disk which is hydrostatic equilibrium state when the spiral potential does not exist, by using numerical magneto hydrodynamical simulation at the first time. We found that isothermal spiral shock appeared around the spiral gravitational potential and magnetic field strength is amplified up to energy equipartition with thermal energy of the thin gas disk. Preliminary results were reported at the work shop held in Sapporo. We have been constructing the scheme to test the numerically obtained

Galactic magnetic field model with all sky distribution of polarization angle of synchrotron emission and dust emission. Further, stability of the plasma which is fulfilled by temperature fluctuation with back ground magnetic field is examined by using plasma kinetic theory. We have deduced an emission formula from relativistic electron when they travel through the turbulent magnetic field excited by the instability, and showed that a Jitter radiation is generated. We have shown that the expected Jitter radiation could be an origin of the Galactic microwave haze emission when the Galactic warm gas halo is fulfilled by significant amount of temperature fluctuation. The results were reported at the conference held in Muechen, the seminar at CfA in Cambridge, USA and annual meeting of physical society of Japan held in Saitama.

The third one is construction of original component separation code based on hierarchical Bayesian method. To test the performance of the code, we have started to construct theoretical Galactic polarization emission models in microwave wave bands using our original Galactic magnetic field models, Galactic dust distribution and Galactic relativistic electron distribution. Preliminary results were reported at the conference held in Muenchen and annual meeting of physical society of Japan held in Saitama.

The fourth one is studying the possibility of proposing original cosmic microwave B-mode polarization experiment as one of experiment of international space station.

Additional to above mentioned research activities, I have been doing following two activities. One is organizing a summer school for high school students to experience research activities as astronomer. In this fiscal year, 7 high school students participate in a 7 days camp. Another is organizing a brain circulation program in which 4 young researchers in our institute have been sent to institutes in US and AU. Two volumes of news letters to introduce our brain circulation activities are published with a help of cartoon writer. Following is URL for these activities;

<https://www.astr.tohoku.ac.jp/~hken/MosiTen>

<https://www.astr.tohoku.ac.jp/~hken/us.tohoku.abc/> .

II. Publications

1. AKARI Near-infrared Spectroscopic Survey for CO₂ in 18 Comets, T.Ootsubo et al., ApJ, 752 id.15, 12pp, (2012)
2. AKARI/AcuA Physical Studies of the Cybele Asteroid Family, T.Kasuga, et al., AJ, 143, id.141 11pp, (2012)
3. Albedo Properties of Main Belt Asteroids Based on the All-Sky Survey of the Infrared Astronomical Satellite AKARI, F.Usui, et al., ApJ, 762, id.56 14pp, (2013)
4. AKARI/IRC 18 μ m survey of warm debris disks, H.Fujiwara, A&A, 550, id.A45 15p, (2013)

III. Presentations

1. Development of component separation scheme based on hierarchical Bayes, T.Morishima, M.Hattori, Polarized Foreground for Cosmic Microwave Background, Nov.27, 2012, MPA, Munic, Germany
2. Proposal of new Galactic magnetic field models and their observational test, M.Hattori, T.Morishima, S.Nakamura, K.Fujiki, Polarized Foreground for Cosmic Microwave Background, Nov.27, 2012, MPA, Munic, Germany
3. Numerical examination of the evolution of the Galactic magnetic field structure, S.Nakamura, M.Hattori, T.Morishima, Structure formation theory in ALMA era, Jan.26-28, Hokkaido University, Sapporo, Japan
4. Origin of Galactic turbulent magnetic field by plasma kinetic instability and possible origin of Galactic microwave Haze, M.Hattori, K.Fujiki, Structure formation theory in ALMA era, Jan.26-28, Hokkaido University, Sapporo, Japan
5. Origin of Galactic turbulent magnetic field by plasma kinetic instability and possible origin of Galactic microwave Haze, M.Hattori, K.Fujiki, Private discussion with Drs. Finkbeiner and Medvedev at CfA, Feb.25, 2013, Havard University, Cambridge, USA
6. Origin of Galactic turbulent magnetic field by plasma kinetic instability and possible origin of Galactic microwave Haze, M.Hattori, K.Fujiki, The Annual meeting of the Physical Society of Japan, Mar.29, 2013, Hiroshima University, Hiroshima, Japan
7. Development of component separation scheme based on hierarchical Bayes, T.Morishima et al., The Annual meeting of the Astronomical Society of Japan, Mar.22, 2013, Saitama University, Saitama, Japan
8. Fine structure found in the zodiacal light obtained by AKARI far infrared all sky map, T.Ootsubo et al., The Annual meeting of the Astronomical Society of Japan, Mar.20, 2013, Saitama University, Saitama, Japan
9. AKARI far infrared diffuse light all sky mapping XI (Detail estimation of quality of the obtained map), Y.Doii et al., The Annual meeting of the Astronomical Society of Japan, Mar.23, 2013, Saitama University, Saitama, Japan

Name	Keiichi Noe
Department	Philosophy
Position	Professor
Research Title	1. Trans-science and Risk Society. 2. Poiesis of the self by way of narratology

I. Summary of Research

1. The severe accident of Fukushima Daiichi nuclear power plant raises a typical trans-scientific question, which can be asked of science and yet which cannot be answered by science. On the other hand, contemporary society is characterized as the so-called risk society, where the distribution of risks becomes serious problem. Both are two sides of the same coin. In such a situation, the social responsibility of scientists must be asked from the new point of view. So far, the Merton's norm (CUDOS) and Ziman's PLACE has been well known. Instead of them, I propose a new norm for scientists RISK in the age of trans-science and the risk society
2. Since Descartes' famous proposition "cogito ergo sum", the concept of self has been a central problem of the modern philosophy. Through the criticism of Cartesian self by Hume and Mach, the self is gradually grasped not as a substance but as relations. I develop this line of thought by way of narratology, and introduce the concept of "narrative identity". From such viewpoint, the I is not "being" self but "becoming" self. In this sense, the self is none other than a kind of "unfinished narrative".

II. Publications

1. "For the sake of 'Fruitful Disagreement'." (in Japanese), K. Noe, *Trends in the Sciences*, Vol. 17 No. 5, pp.46-50 (May 2012)
2. "The Great Earthquake Disaster and Japanese View of Nature", K. Noe, *Proceedings of the International Conference: Japanese Philosophy in the East Asian Perspective*, Institute for the Advanced Studies in Humanities and Social Sciences, Taiwan National University, pp.1-9. (Sept. 2012)
3. "Narrating Self / Narrated Self" (in Japanese), K. Noe, in B. Kimura and K. Noe (eds.) *The Self and the Other*, Kawai Publishing, pp.133-150. (Jan. 2013)
4. "Bioethics Concerning iPS cells", (in Japanese), K. Noe, *Trends in the Sciences*, Vol.18 No.2, pp.26-29. (Feb. 2013)

III. Presentations

1. "Science, Technology and Human Being after 3.11", K. Noe, Japan Association of Synthetic Anthropology 2012 Annual Meeting (May 26-27, 2012, Nihon University, Tokyo, Japan)
2. "The Great Earthquake and the Integration of Knowledge", K. Noe, Science Council of Japan symposium on "The Integration of Knowledge", (July 27, 2012, Tokyo University, Tokyo, Japan)
3. "The Great Earthquake Disaster and Japanese View of Nature", K. Noe, International Conference: Japanese Philosophy in the East Asian Perspective (September 1-2, 2012, Institute for the Advanced Studies in Humanities and Social Sciences, National Taiwan University, Taipei, Taiwan)
4. "Conservation from the viewpoint of philosophy: the meaning and the objective of 'conservation'", K. Noe, World Heritage Convention 40th Anniversary Celebrations, Expert Meeting in Himeji (November 3-5, 2012, Center for the study of castle, Himeji, Hyogo, Japan)
5. "Technology and the Institutional Body", K. Noe, The Phenomenological Association of Japan 2012 Annual Meeting, Symposium on "the Phenomenology of Technology" (November 17-18, Tohoku University, Sendai, Japan)
6. "Science, Technology and Society after 3.11", K. Noe, The Northern Japan Philosophical Conference 2012 Annual Meeting (January 13, 2013, Hokkaido University, Sapporo, Japan)

Name	Kiyotaka Naoe
Department	Philosophy
Position	Associate Professor
Research Title	Study of Philosophy and Ethics of Technology

I. Summary of Research

1. I investigate Japanese philosophy of technology from a contemporary perspective. Theories of technological mediation developed by some pre- and postwar Japanese philosophers (ex. K.Miki, H.Saegusa) gave a comprehensive understanding to the technological process as a whole. Through a critical examination, I argue that these theories can contribute to mediate subdivisions of this field (philosophy of design, philosophy of engineering science, ontology of artifacts etc.) and thus to reconstruct an integrated view of technology.
2. Brain-machine interface is a direct communication pathway between a neural system and an external device (computer system etc.). This technology can be used, for example, for neuroprosthesis that aims to restore human functions, but there are debates about its ethical implications, especially about human enhancement. Based on philosophical considerations about this new technology, I evaluate the main arguments against the human enhancement and propose a common platform for further ethical discussions.

II. Publications

1. "Karl Löwith revisited", Kiyotaka Naoe,
Annual review of the Tohoku Philosophical Association(Tohoku-Tetsugakukai-Nenpo), No.27,
pp.63-77, 2011.
2. "From Engineering Ethics to the Ethics of Technology", Kiyotaka Naoe,
Engineering Ethics and the Society(Gijutsu rinri to Shakai), vo.6, pp.105-115, 2011.
3. "Artifacts and technological Knowledge", Kiyotaka Naoe, *Shisaku(Meditations)*,
vol.44,pp.1-30, 2011.
4. "Philosophy of Science and Philosophy of Technology today", Kiyotaka Naoe,
Kunitsugu Kosaka, Hitoshi Hongo(ed), *Contemporary Philosophy*, Minerva Shobo, 2012(in
printing).

III. Presentations

1. "What is the Functions of Artifacts?", Kiyotaka Naoe,
3rd Annual Meeting of the Japanese Association for the Contemporary and Applied
Philosophy, April 24, Chiba University, Chiba, Japan.

2. "How to Discuss the Risk of the Atomic Power Plants", Kiyotaka Naoe,
Symposium "How can Sciences deal with the problem of the diffused radioactive materials" (The Japan Society of Applied Physics Tohoku Chapter), September 23, AER Hall Sendai, Sendai, Japan.
3. "Functions of Artifacts", Kiyotaka Naoe,
Special Meeting of the Japanese Association for the Contemporary and Applied Philosophy, September 24, Kyoto University, Kyoto, Japan.
4. "How can Philosopher tackle the big Disaster - Giant Earthquake, Tsunami, and the Nuclear Accident", Kiyotaka Naoe,
Symposium of the Japanese Society for Ethics, September 30, Toyama University, Toyama, Japan.
5. "Cummunication on Nuclear Energy after Fukushima", Kiyotaka Naoe,
Workshop on the Discourse Ethics and Science, October 10, Tohoku University, Sendai, Japan.
6. "Engineering Judgment and Exterpise", Mariko Nihei, Kiyotaka Naoe,
10th Annual Meeting of the Japanese Society for Science and Technology Studies, December 4, 2011, Kyoto University, Kyoto, Japan
7. "Philosophy of Design" Kiyotaka Naoe,
Workshop on Ecological Psychology and Technology, December 26, 2011, Rissho University, Tokyo, Japan
8. "Philosophy of Technology : Historical Perspectives", Kiyotaka Naoe,
Workshop on the Philosophy of Technology, February 21, Tohoku University, Sendai, Japan.
9. "Nuclear Accident and the Transformation of Value System", Kiyotaka Naoe,
International Conference:Disaster and the Creation of Value System, March 10, 2012, Tohoku University, Sendai, Japan