YITP Annual Report

Yukawa Institute For
Theoretical Physics
Kyoto University

2013

Foreword

We present here an annual report of the scientific activities of Yukawa Institute for Theoretical Physics during the academic year 2013.

From the year 2007 we started our new project of “Yukawa International program of Quark-Hadron Sciences (YIPQS)" funded by Japan Ministry of Education, Culture, Sports, Science and Technology. In this project we select a few research topics each year for long-term workshops and invite leading experts from abroad to stimulate discussions and foster collaborations among workshop participants. In the year 2013 we held three long-term workshops on "Gravitational Waves and Numerical Relativity", "Supernovae and Gamma-Ray Bursts 2013" and on "New Frontiers in QCD 2013" and extensive discussions have been exchanged. Our report contains some of the results obtained during these workshops.

Director
Misao Sasaki

Contents

Chapter 1

People

1.1 Regular Staff and Guest Professors (2013 April – 2014 March)

Regular Staff

Misao Sasaki
Professor (A)

Hisao Hayakawa
Professor (C)

Takami Tohyama
Professor (C) [– 2014.3.31]

Takahiro Tanaka
Professor (A) [– 2014.3.31]

Akira Ohnishi
Professor (N)

Masaru Shibata
Professor (A)

Tadashi Takayanagi
Professor (E)

Sinya Aoki
Professor (E) [2013.4.1 –]

Masatoshi Murase
Associate Professor (C)

Hiroshi Kunitomo
Associate Professor (E)

Naoki Sasakura
Associate Professor (E)

Keisuke Totsuka
Associate Professor (C)

Ken-Iti Izawa
Associate Professor (E)

Naoyuki Itagaki
Associate Professor (N)

Fumihiro Takayama
Associate Professor (E)

Yoshitaka Hatta
Associate Professor (N) [2013.4.1 –]

Atsushi Taruya
Associate Professor (A) [2013.8.16 –]

Kazuo Hosomichi
Associate Professor (E)

Yudai Suwa
Associate Professor (A)

Antonio De Felice
Associate Professor (A) [2013.12.1 –]

Seiji Terashima
Assistant Professor (E)

Yu Watanabe
Assistant Professor (C)

Ippei Danshita
Assistant Professor (C)

Tetsuo Hyodo
Assistant Professor (N) [2013.8.1 –]

Takayuki Muranushi
Assistant Professor (A)

Yuko Fujita
Project Manager

In this list, the symbols A, C, E and N in the parenthesis are the following abbreviations of research fields:

A: Astrophysics and Cosmology
C: Condensed Matter and Statistical Physics
E: Elementary Particle Theory
N: Nuclear Physics Theory

Visiting Professors

Prof. Meheboob ALAM
(Jawaharlal Nehru Centre for Advanced Scientific Research)
2013.5.1 — 2013.7.31.
Theory of granular flow

Prof. Vladimir KAZAKOV
(Universite de Paris VI)
2013.9.21 — 2013.12.20
String Theory and Integrability

Prof. Patrick BRADY
(University of Wisconsin-Milwaukee)
2014.1.1 — 2014.3.31
Gravitational waves from compact binaries and data analysis

Prof. James Michael LATTIMER
(State University of New York)
2014.1.1 — 2014.3.31
Nuclear equation of state and compact stars

1.2 Research Fellows and Graduate Students (2013 April – 2014 March)

Research Fellows

Yu-ichiro Sekiguchi (A)

Kenta Kiuchi (A)

Takashi Hiramatsu (A)

Takatoshi Ichikawa (N)

Hiroki Nagakura (A)

Naoki Yoshioka (C) [2011.4.1 – 2014.3.31]

Ryo Saito (A) [2011.4.1 – 2014.3.31]

Masashi Kimura (A) [2011.4.1 – 2014.3.31]

Andrea Prudenzia (E)

Ryosuke Yoshii (C) [2012.4.1 – 2014.3.31]

Yuichi Takamizu (A)

Hirotaka Irie (E)

Naoki Yamamoto (N) [2012.4.1 – 2013.8.31]

Satoshi Nakamura (N) [2012.5.1 – 2013.9.30]

Norihiro Iizuka (E)

Hajime Sotani (N)

Hiroyuki Nakano (A) [2012.11.1 – 2014.3.31]

Toshiya Namikawa (A) [2013.4.1 –]

Hayato Motohashi (A) [2013.4.1 – 2013.9.15]

Dong-han Yeom (A) [2013.4.1 – 2014.3.31]

Wakana Iwakami (A) [2013.4.1 –]

Keiko Murano (E) [2013.7.1 –]

Noburo Shiba (E) [2013.9.26 –]

Ying-li Zhang (A) [2013.10.1 –]

Daisuke Nomura (E) [2013.10.16 –]

Dong-han Yeom (A) [2013.4.1 – 2014.3.31]

Bernard Raffaelli (E) [2013.10.1 – 2014.1.31]

Pawel Pitor Caputa (E) [2014.2.1 –]

Song He (E) [2013.11.1 –]

Takashi Okada (E) [2013.4.1 – 2014.3.31]

Graduate Students

Masahiro Ikeda (C) [2009.4.1 –]

Koki Nakata (C) [2009.4.1 –]

Soichiro Isoyama (A) [2009.4.1 –]

Yuusuke Kourai (A) [2009.4.1 –]

Kazuyuki Sugimura (A) [2009.4.1 –]

Sugure Tanzawa (A) [2005.4.1 –]

Masahiro Nozaki (E) [2010.4.1 –]

Naofumi Hama (E) [2010.4.1 –]

Kiyoshi Kanazawa (C) [2010.4.1 –]

Koudai Sugimoto (C) [2010.4.1 –]

Zhang Yingli (A) [2010.10.1 – 2013.9.30]

Ryo Murakami (C) [2011.4.1 –]

White Jonathan (A) [2011.4.1 –]

Kazuya Shinjo (C) [2011.4.1 –]

Yasunori Matsui (C) [2011.4.1 –]

Tomohiko Sano (C) [2011.4.1 –]

Satoshi Takada (C) [2011.4.1 –]

Takumi Imai (E) [2011.4.1 –]

Tomoki Nosaka (E) [2011.4.1 –]

Noritoshi Hashiba (E) [2011.4.1 –]

Yusuke Kimura (E) [2011.10.1 –]

Hiroshi Ueda (N) [2012.4.1 –]

Terukazu Ichihara (N) [2012.4.1 –]

Kyohei Kawaguchi (A) [2012.4.1 –]

Tokiro Numasawa (E) [2012.4.1 –]

Yasuho Yamashita (A) [2012.4.1 –]

Yuta Yoshida (N) [2012.4.1 –]

Kota Watanabe (C) [2012.4.1 –]

Yuri Ichioka (C) [2012.4.1 –]

Kazuhiko Tanimoto (C) [2012.4.1 –]

Takumi Ohta (C) [2013.4.1 –]

Ryosuke Hara (C) [2013.4.1 –]

Tomohisa Okazaki (A) [2013.4.1 –]

Hidekazu Tsukiji (N) [2013.4.1 –]

Ichihiko Hashimoto (A) [2013.4.1 –]

Kento Watanabe (E) [2013.4.1 –]

Minkyu Park (E) [2013.4.1 –]

Choi Jaewang (E) [2013.4.1 –]

Ph.D Awarded

Soichiro Isoyama
Radiation reaction to the motion of a point particle in Kerr spcetime (A)
(supervisor: Misao Sasaki)

Koki Nakata
Non-Equilibrium Quantum Spin Transport Theory Based on Schwinger-Keldysh Formalism (C)
(supervisor: Keisuke Totsuka)

Kazuyuki Sugimura
Quantum Tunneling During Inflation: Non-linear Analysis of the Quantum fluctuations (A)
(supervisor: Misao Sasaki)

Jonathan White
Non-minimal coupling in the context of multi-field inflation (A)
(supervisor: Misao Sasaki)

Chapter 2

Research Activities

2.1 Research Summary

Astrophysics and Cosmology Group

Inflation and Early Universe

A. Naruko, C. Pitrou, K. Koyama & M. Sasaki formulated the second-order Boltzmann equation for photons in the context of cosmological perturbation theory without a specific choice of gauge, and showed explicitly its properties under the coordinate gauge transformation. The result forms a theoretical basis for the interpretation of high precision CMB data to be obtained in the coming years.

X. Chen, H. Firouzjahi, M. H. Namjoo & M. Sasaki proposed an inflationary mechanism based on fluid dynamics. It is shown that a perfect barotropic fluid naturally gives rise to a non-attractor inflationary universe in which curvature perturbation is not frozen on super-horizon scales. It produces a scale-invariant power spectrum with the local non-Gaussianity parameter $f_{NL} = 5/2$. Then X. Chen, H. Firouzjahi, E. Komatsu, M. H. Namjoo & M. Sasaki studied general non-attractor single-field inflation models that produce a scale-invariant power spectrum. It is found that they give $f_{NL} = 5(1+c_s^2)/(4c_s^2)$ for arbitrary values of the sound speed c_s.

J. White, M. Minamitsuji & M. Sasaki extended their earlier work on the curvature perturbation from non-minimally coupled, non-canonical multi-field models of inflation to second-order perturbations. Clarifying the relation between δN formalism as applied in the conformally related Jordan and Einstein frames, the power spectrum, spectral tilt and non-gaussianity in the Jordan frame are derived.

R. Saito & Y. Takamizu studied a resonant effect of a heavy scalar field on bispectrum of primordial curvature perturbations, extending their result on the power spectrum. They showed that an excited oscillation of a heavy scalar field induces a large characteristic peak in the bispectrum when the heavy scalar field has derivative couplings with the inflaton.

Y. Zhang, R. Saito, D. Yeom & M. Sasaki studied a quantum tunneling process in dRGT (de Rham-Gabadadze-Tolley) massive gravity through the Coleman-de Luccia (CDL) instanton. They found that the CDL solution gives the same tunneling rate as in General Relativity in the thin-wall approximation but can be subdominant to the Hawking-Moss solution in contrast to the case in General Relativity.

M. Sasaki, D. Yeom & Y. Zhang studied the wavefunction of the universe in dRGT massive gravity. It is found that the contribution from the massive gravity sector can enhance the probability of a large number of e-folds substantially, and opens a new window to explore the inflationary scenario in the context of quantum cosmology.

T. Narikawa, T. Kobayashi, D. Yamauchi & R. Saito derived a static and spherically symmetric solution in Horndeski's theory and presented conditions under which the Vainshtein mechanism works. Using this solution, they investigated how a signature of the theory appears in observations of cluster lensing.

It has been claimed that the super Hubble modes of the graviton generated during inflation can make loop corrections diverge. T. Tanaka with Y. Urakawa showed that the IR pathology concerning the graviton can be attributed to the presence of residual gauge degrees of freedom in the local observable universe as in the case of the adiabatic curvature perturbation.

M. Sasaki & T. Tanaka with M. B. Frob, J. Garriga, S. Kanno, J. Soda & A. Vilenkin considered Schwinger pair production in 1+1 dimensional de Sitter space, filled with a constant electric field. They found that the adiabatic "in" vacuum associated with the flat chart develops a space-like expectation value for the current, which manifestly breaks the de Sitter invariance of the background fields. They showed that both "upward" and "downward" tunneling contribute to the build-up of the current. They also showed that for light fields a very small electric field leads to a very large current. T. Tanaka with J. Garriga & S. Kanno also studied how the moment of bubble nucleation is probed in the flat limit. They found that the correlation between the rest frame of nucleation and that of the detector is exceedingly sharp.

Together with S. Tsujikawa, A. De Felice has studied the shape of non-gaussianities for the most general second order scalar tensor theories. The result is that, depending on the model, equilaterla, or orthogonal or enfolded shapes can give the dominant contribution to non-gaussianities.

A. De Felice, E. Gumrukcuoglu, C. Lin, & S. Mukohyama have studied the stability of both isotropic FLRW and anisotropic FLRW solutions. The result is that isotropic models do possess a ghost instability making these backgrounds unviable. In another study, A. De Felice & S. Mukohyama, in order to cure the instability of FLRW in massive gravity, have introduced a scalar field (quasi-dilaton) into the action. The result is the de Sitter vacuum is stable.

A. De Felice, T. Nakamura, & T. Tanaka have investigated the ghost less massive bigravity theory. The main contributions coming from this study are: 1) to have found a viable background for the theory: 2) to have found the Vainshtein radius for such a theory; 3) Found parameter space for which graviton oscillations can leave signature on data for future gravitational wave detectors.

Observational Cosmology

The presence of a dipolar statistical anisotropy in the spectrum of cosmic microwave background (CMB) fluctuations was reported by WMAP, and has been recently confirmed by Planck. At the same time, Planck strongly constrained the amplitude of the local-type non-Gaussianity. M. Sasaki & T. Tanaka with S. Kanno showed that the non-linear effect of the dipolar anisotropy generates not only a quadrupole moment in the CMB but also a local-type non-Gaussianity. Consequently, most models proposed so far are almost excluded or at best marginally consistent with observational data. They presented a simple alternative scenario, too.

The large-scale structure of the Universe as well as CMB anisotropies contain valuable cosmological information, and accurate theoretical description as well as efficient data analysis method for them are the key to pursue the precision cosmology. A. Oka, S. Saito, T. Nishimichi, K. Yamamoto, & A. Taruya measured the anisotropic power spectra from the luminous red galaxy sample in the Sloan Digital Sky Survey II. Using the resummed perturbation theory (PT) as theoretical temple of power spectra, they put the simultaneous constraints on the linear growth rate, angular diameter distance, and Hubble parameter at redshift $z = 0.3$, finding that derived results are consistent with flat Λ cold dark matter cosmology.

Related with the above work, T. Okumura, Y-S. Song & A. Taruya tested their methodology using the broad-band baryon acoustic peaks in the anisotropic correlation function to constrain geometric distances and cosmic growth rate against mock galaxy catalogs, and found that with the resummed PT as theoretical template, the methodology works well and can be applicable to real observations. A. Taruya with K. Koyama, T. Hiramatsu, & A. Oka presented a new PT template for redshift-space distortions (RSD) in modified gravity models. As an example, they considered the $f(R)$ gravity, and found that the new template helps to detect a deviation of gravity from GR in an unbiased manner, while the conventional PT template fails to detect it in a model-independent way.

S. Yokoyama, T. Matsubara & A. Taruya computed the galaxy/halo bispectrum to study the signature of primordial non-Gaussianity on large scales. They found that the equilateral- and orthogonal-type non-Gaussianities show distinctive and large scale-dependent behaviors. For the local-type non-Gaussianity, higher-order corrections are found to give a significant impact on the squeezed bispectrum, and eventually dominate over the other contributions.

F. Bernardeau, T. Nishimichi & A. Taruya proposed a novel method of full nulling scheme for cosmic shear observations, which allows us to reduce the small-scale nonlinearities arising from the low-redshift lensing contributions. They tested this method against ray-tracing simulations, and found that with this method, the applicable range of PT template becomes much wider.

Since a first discovery on 1995, many extrasolar planets have been detected, and dynamical characterization of extrasolar planets is a key to explore the planet formation. K. Masuda, T. Hirano, A. Taruya, M. Nagasawa, & Y. Suto analyzed the transit timing variation in Kepler Object of Interest 94 system to constrain the orbital parameters of multiple planets. They found that the orbital motion of planets significantly deviates from the exact periodicity. Y. Xue, Y. Suto, A. Taruya, T. Hirano, Y. Fujii & K. Masuda studied the tidal evolution of the angle between the stellar spin and the planetary orbit axes based on a simple system comprising a Sun-like star and a hot Jupiter, and found that the current model cannot reproduce the observed broad distribution of the spin-orbit angles, at least in its simple form.

T. Namikawa & A. Taruya with D. Yamauchi presented full-sky formulae for the weak lensing observables originated from all types of metric perturbations. Applying the total angular momentum method originally developed in the theoretical studies of CMB, they succeeded to derive a complete set of the full-sky formulae for angular power spectra.

T. Namikawa with D. Yamauchi & A. Taruya derived the constraint on a cosmic string network from the weak lensing effect on the CMB temperature map. The cosmic string network can generate non-scalar metric perturbations, which induces the curl pattern of the deflection angle of CMB photons. They first measured the curl-mode power spectrum from Atacama Cosmology Telescope (ACT) data to check the foreground systematics. Then, they used the Planck lensing data set to put constraints on the string tension and the reconnection probability.

CMB polarization data will soon provide the best avenue for measurements of CMB lensing potential, although it is potentially sensitive to several instrumental effects. Namikawa & R. Takahashi derived "bias-hardened" lensing estimators to mitigate such effects, at the expense of large reconstruction noise, and test them numerically on simulated data.

Gravitational Waves

A. De Felice & T. Tanaka with A. E. Gumrukcuoglu, S. Mukohyama & N. Tanahashi studied cosmological perturbations in bimetric theory with two fluids each of which is coupled to one of the two metrics. Focusing on a healthy branch of background solutions, they clarified the stability of the cosmological perturbations. They found the condition for the absence of the so-called Higuchi ghost is satisfied on the healthy branch. They also derived the conditions for the absence of the gradient instability.

Y. Yamashita & T. Tanaka discussed whether or not bigravity theory can be embedded into the braneworld setup. As a candidate, they considered Dvali-Gabadadze-Porrati two-brane model with the Goldberger-Wise radion stabilization, showing that we can construct a ghost free model whose low energy spectrum is composed of a massless graviton and a massive graviton with a small mass. As is expected, the behavior of this effective theory was shown to be identical to de Rham-Gabadadze-Tolley bigravity.

M. Shibata, K. Taniguchi, H. Okawa, & A. Buonanno performed numerical-relativity simulations for NS-NS mergers in a scalar-tensor theory of gravity, in which the so-called dynamical scalarization can take place. They showed that for a range of coupling parameters between the matter and scalar-field which still do not contradict any current observational results, the dynamical scalarization can indeed occur, and for such cases, gravitational waveforms are significantly different from those in general relativity.

The final phase of compact binary systems composed of neutron star (NS) and/or black hole (BH) is among the most promising sources for ground-based gravitational-wave detectors such as KAGRA. Modeling of gravitaional waves (GW) from the late innspiral to merger phases for the use of data analysis can be carried out only by numerical-relativity studies. K. Hotokezaka, K. Kyutoku, & M. Shibata performed a long-term simulation for the late inspiral phase of NS-NS and showed that the modeling by an effective-one-body approach works well up to a few orbits before the onset of the merger. K. Hotokezaka, K. Kiuchi, Y. Sekiguchi & M. Shibata together with several people explored GW from hypermassive neutron stars formed after the onset of the NS-NS merger, and derived an analytic formula for GW modeling. Shibata's group also provided numerical data of GW from NS-NS/BH-NS derived by numerical-relativity simulations to Read et al., Pannarale et al., Lackey et al., who published their analysis results in this year.

High-Energy Astrophysics

After the merger of NS-NS and BH-NS binaries, a substantial amount of neutron-rich matter can be ejected from the system. The ejected matter will generate heavy unstable elements through r-process nucleosynthesis. Subsequently, these unstable elements decay and heat up the ejected matter, which will shine for 1–10 days with $\sim 10^{41}$ ergs/s for the ejected mass $M_{\rm ej} \sim 0.01 M_\odot$ with the velocity $v \sim 0.2c$. Such possible transient source is called kilonova or macronova. K. Hotokezaka, K. Kiuchi, Y. Sekiguchi, & M. Shibata together with several people showed by numerical simulations for NS-NS mergers that if the equation of state is stiff, quasi-isotropic mass ejection with $M_{\rm ej} \sim 0.01 M_\odot$ and $v \sim 0.2c$ occurs. M. Shibata together with K. Kyutoku & K. Ioka also showed that in BH-NS-binary mergers, *anisotropic* mass ejection with $0.01M_\odot$–$0.1M_\odot$ and $v \sim 0.1c$ occurs if the black-hole spin is > 0.7.

The first discovery of the kilonova/macronova candidate associated with GRB 130603B provides a good source for the calibration of the kilonova/macronova scenario. K. Hotokezaka, K. Kiuchi, Y. Sekiguchi, & M. Shibata together with M. Tanaka and others performed a numerical-relativity plus radiation transfer study to reproduce the light curve of the kilonova/macronova associated with GRB130603B. They showed that the ejected mass should be larger than $\sim 0.02M_\odot$, and thus, if the source is a NS-NS binary, the equation of state of the NSs has to be soft, while the event can be easily reproduced if the source is a BH-NS binary with high BH spin.

Nagakura, Hotokezaka, Sekiguchi & Shibata with Ioka performed a numerical simulation for a jet propagation in the dynamical ejecta based on the NS-NS merger hypothesis of short GRB, for which the opening angle observation suggests that the jet is sharply collimated. They showed that the dynamical ejecta could play a crucial role for confinement of the jet.

Recently, there is discovery of a new class of GRBs, so-called *ultra-long GRBs* (ULGRBs), which have durations of typically $\gtrsim 1000$ s. Y. Suwa with K. Kashiyama, D. Nakauchi, H. Yajima, & T. Nakamura, based on jet-propagation and cocoon-evolution calculations inside a blue supergiant that naturally explains ultra-long duration of prompt emission, proposed possible very bright counterparts of these class from infrared to optical bands. More recently there found a bright bump during afterglow phase in the optical band from one of ULGRBs, GRB 111209A. Y. Suwa with D. Nakauchi, K. Kashiyama, & T. Nakamura showed that the blue supergiant model with cocoon emission can self-consistently explain the ultra-long prompt emission and the bright optical bump of afterglow not only bolometric, but also spectroscopic using photospheric emission model. This study affords the strong collateral evidences for the blue supergiant progenitor model of ULGRBs.

Y. Suwa with T. Fischer, M. Hempel, I. Sagert, & J. Schaffner-Bielich, performed spherically- and axially-symmetric simulations of core-collapse supernovae using different nuclear equation of state, focusing on how the symmetry energy changes the shock dynamics. They found that the symmetry energy affects the electron fraction evolution before the core bounce and becomes less important after the bounce.

Y. Suwa with Y. Takamori, H. Okawa, & M. Takamoto constructed a new formulation to solve pulsar equation, which determines the magnetic field structure around a pulsar. In this equation, there is critical surface where the speed of co-rotational fields exceeds the speed of light, which is singular. So far, there is a numerical method to solve this equation, which inevitably makes unphysical current sheet along the equatorial plane. Their new method is shown to be able to make a solution without such a current sheet, which would be more feasible to represent the magnetosphere around pulsars.

Condensed Matter and Statistical Dynamics Group

Condensed-Matter Physics

The subjects of condensed-matter physics are the states of matter that emerge at low-temperatures as a consequence of non-trivial many-body effects. The main goal in this field is to understand how interplay among such low-energy degrees of freedom as charge, spin and (electron) orbital, when combined with a few simple fundamental principles (e.g. Fermi statistics, electromagnetic force), leads to a variety of phenomena. The area of current research in our group includes dynamical properties of strongly-correlated electrons and ultracold atoms, physics of the iron-based- and the cuprate superconductors, and exotic topological phenomena in low-dimensional quantum magnetism.

Spin dynamics and resonant inelastic x-ray scattering in chromium with commensurate spin-density wave order: After intensive study of iron arsenides motivated by the discovery of high-temperature superconductivity, it has been recognized that both spin and orbital degrees of freedom are the key to understanding the physics of itinerant electron systems. Sugimoto, Tohyama and their collaborators focused on chromium as a typical itinerant magnetic system and theoretically investigated spin dynamics and L_3-edge resonant inelastic x-ray scattering (RIXS) of chromium with commensurate spin-density wave (SDW) order, based on a multiband Hubbard model composed of 3d and 4s orbitals. Obtaining the ground state with the SDW mean-field approximation, they calculated the dynamical transverse and longitudinal spin susceptibility by using random-phase approximation and found that a collective spin-wave excitation seen in inelastic neutron scattering hardly damps up to ~ 0.6 eV. On the other hand, the collective spin-wave

excitation in RIXS spectra was found to be masked by large spectral weight coming from particle-hole excitations with various orbital channels.

Double-pulse deexcitations in a one-dimensional strongly correlated system: One of the outstanding contemporary challenges in condensed matter physics is to understand the dynamics of interacting quantum systems exposed to an external perturbation. Lu, Tohyama, and their collaborators presented a compelling response of a low-dimensional strongly correlated system to an external perturbation. Using the time-dependent Lanczos method, they investigated the ultrafast optical response of the one-dimensional half-filled extended Hubbard model exposed to two successive laser pulses. It was found that following the first pulse, the excitation and deexcitation process between the ground state and excitonic states can be precisely controlled by the relative temporal displacement of the pulses. The underlying physics can be understood in terms of a modified Rabi model. The simulations performed in this work clearly demonstrated the controllability of ultrafast transition between excited and deexcited phases in strongly correlated electron systems.

Optical properties of HfO_2 studied by first-principles local density approximation + U approach: In order to understand optical properties of HfO_2, Li, Lu, Tohyama and their collaborators investigated the band structures of monoclinic HfO_2 by the local density approximation+U approach. With the on-site Coulomb interaction being introduced to 5d orbitals of Hf atom and 2p orbitals of O atom, the experimental band gap was nicely reproduced. The imaginary part of the complex dielectric function showed a small shoulder at the edge of the band gap, coinciding with the experiments. This intrinsic property of crystallized monoclinic HfO_2, which is absent in both the tetragonal phase and cubic phase, can be understood as a consequence of the reconstruction of the electronic states near the band edge following the adjustment of the crystal structure. The existence of a similar shoulder-like-structure in the monoclinic phase of ZrO_2 was predicted.

Symmetry-protected topological phases in ultra-cold fermions in one dimension: There are a variety of states of matter called "topological", that defy the traditional Landau-type description. These states are roughly categorized into two. First class is characterized by long-range entanglement and is robust against any kind of local perturbations. The second category, now dubbed "symmetry-protected topological (SPT)", is stable only in the presence of certain symmetries (e.g., time-reversal, reflection, space groups). Totsuka, Tanimoto and their collaborators showed how various SPT phases appear in SU(N)-symmetric alkaline-earth ultra-cold fermions on an optical lattice in 1D and characterize these phases by using entanglement spectrum. An interesting connection between entanglement spectrum and non-local order parameters was clarified as well.

Damping of dipole oscillations driven by quantum phase slips in one-dimensional ultracold gases: An ultracold gas can be confined in one-dimensional (1D) geometry by focusing a strong 2D optical-lattice potential to the gas. Experimentalists have studied dipole oscillations of such 1D gases in the presence of obstacle potentials to analyze transport properties, and found significant damping of the oscillations, i.e. strong suppression of transport, compared to 3D gases. Danshita and his collaborators interpreted the origin of this suppression of transport as a consequence of quantum phase slips. Using analytical consideration and an exact numerical method of time-evolving block decimation, they showed that the damping rate of a dipole oscillation is proportional to the nucleation rate of a phase slip divided by the flow velocity. Since the damping rate is a typical observable, this relation allows for analyzing phase slips in experiments. They also suggested a universal crossover behavior in the damping rate versus the flow velocity at finite temperatures.

Superfluid-Mott insulator transition of binary Bose mixtures in optical lattices: First-order transition, and associated tricriticality and anomalous hysteresis: The quantum phase transition between superfluid (SF) and Mott insulator (MI) is induced by ramping up the depth of an optical lattice confining a Bose gas, and the transition is well known to be of second order (continuous) if the Bose gas does not have internal degrees of freedom. In previous studies, it has been shown that when one consider systems with internal degrees of freedom, such as two-component bosons and spin-1 bosons, the transition can be of first order near the tip of the Mott lobes at even filling factors. Danshita and the collaborators first considered the hysteretic behavior associated with the first-order transition. When the chemical potential is varied, they found the anomalous hysteresis in which the transition occurs only in a unidirectional way, namely from MI to SF. They next focused on the tricritical points emerging in the ground-state phase diagram when the chemical potential and the hopping are varied. The quantum criticality near the tricritical point was analyzed, and it was shown that the transition temperature versus the chemical potential clearly exhibits properties of the quantum tricriticality and may be used for identifying this criticality in experiments.

Effects of frustration on magnetic excitations in a two-leg spin-ladder system: Motivated by recently discovered a two-leg spin-ladder system $BiCu_2PO_6$, Tohyama and his collaborators e theoretically studied the magnetic excitations in a frustrated spin 1/2 two-leg spin-ladder system, in which antiferromagnetic exchange interactions act on the nearest-neighbor and next-nearest-neighbor bonds in the leg direction, and on the nearest-neighbor bonds in the rung direction. A dynamical spin correlation function at zero temperature was calculated using the dynamical density-matrix renormalization-group method for possible magnetic phases. They proposed that the magnitude of the magnetic exchange interactions and the ground state in $BiCu_2PO_6$ would be determined by comparing our results with inelastic neutron scattering experiments.

Ground states of anisotropic spin model on Kagomé lattice: Quest for realistic spin models that realize putative spin liquid states, that do not show any local order while exhibiting hidden topological order, is one of the most challenging problems in quantum magnetism. Among such models, anisotropic $S = 1/2$ quantum spin models on a Kagomé lattice is believed to bear a featureless spin liquid phase at zero magnetic field. To search for a new spin liquid phases at finite magnetic fields, Totsuka and a group of Toulouse university investigated the nature of the ground states at the magnetization plateaux by using quantum Monte Carlo, etc., and found several evidences for crystalline states of magnetic excitations. They also investigated entanglement entropy of the system to extract information on the long-range properties of the ground states.

Ground-state phase diagram of the spin-1/2 XXZ model on a triangular lattice with a magnetic field: Quantum magnets on a triangular lattice have attracted much attention for many decades, because they are simple and basic systems for studying effects of geometrical frustration. Recently, interest in such systems has been renewed by the experimental realization of optical-lattice quantum simulators of triangular quantum magnets and the compound $Ba_3CoSb_2O_9$ that can be well described by the spin-1/2 XXZ model on a equilateral-triangular lattice. Danshita and his collaborators analyzed the model by means of the cluster mean-field method combined with a scaling scheme to obtain a complete phase diagram at zero temperature in a quantitative manner for the first time. They found a magnetic ordered phase that had never been found in the classical approximations, and a novel degeneracy-lifting mechanism that allows for the emergence of the phase.

Advanced Statistical Dynamics

The subjects of advanced statistical dynamics are nonequilibrium statistical mechanics, nonlinear sciences and biological physics. The main goal in this field is to understand how dynamical nonequilibrium structures are sustained in nature based on tools of statistical physics. Thus, the research areas are spreaded in variety of fields in social sciences, biology, chemisty, engineering, mathematics and physics. The current research activities of our group are granular physics, nonlinear rheology in glassy materials, mesoscopic transport quantum systems, the basis of quantum mechanics and system biology. This academic year, Hayakawa has organized international workshops "Physics of glassy and granular materials" and "Physics of granular flow", and Hayakawa was involved as one of the organizers of Powders & Grains 2013 at Sydney, Australia.

Mode coupling theory for sheared granular liquids: K. Suzuki and H. Hayakawa have studied the theory of sheared dense granular flow in terms of the mode coupling theory (MCT). What they have found is that the cross correlation function of momentum-density destructs the plateau of the density correlation function. As a result, the glass transition observed in thermal systems disappears in granular systems. They also semi-quantitatively reproduce the behavior of the shear viscosity or the shear stress against the density. Hayakawa presented several invited talks on this subject and published one proceedings paper and submit one preprint. Nevertheless, we still have a lot of room for improvement.

Nonequilibrium identities and response theory for dissipative particles: H. Hayakawa and M. Otsuki have extended the application of nonequilibrium identities such as the fluctuation theorem and Jarzynski equality to dissipative particles which does not have any local time reversal symmetry. They derived some exact relations and confirm the validity of them from the direct comparison between the theory and the direct simulation. They published one paper in Phys. Rev. E and Hayakawa published one paper in a French journal. Hayakawa presented several invited talks on this subject.

Test of TDGL equation for sheared granular flow: K. Saitoh and H. Hayakawa have examined the validity of the time-dependent Ginzburg-Landau (TDGL) equation derived from the weakly nonlinear analysis for moderate dense sheared granular flow. They have compare the solution of TDGL equation and the results of the discrete element method (DEM), and confirm that TDGL equation well reproduces the results of DEM. They have published one paper in Phys. Fluids on this subject.

Trial of the extension of mode couping theory for glass transition: G. Szamel, E. Flenner and H. Hayakawa analyze a renormalized perturbation expansion around the mode-coupling theory of the glass transition. They focus on the long-time limit of the irreducible memory function. They discuss a renormalized diagrammatic expansion for this function and re-sum two infinite classes of diagrams. They show that the resulting contributions to the irreducible memory function diverge at the mode-coupling transition. A further re-summation of ladder diagrams constructed by iterating these divergent contributions gives a finite result which cancels the mode-coupling theory's expression for the irreducible memory function. They published this result in EPL.

Effect of elastic vibrations on normal head-on collisions of isothermal spheres: R. Murakami and H. Hayakawa numerically investigate head-on collisions of isothermal viscoelastic spheres. They find that the restitution coefficient oscillates against the impact speed if the solid viscosity inside the sphere is small enough. They confirm that the oscillation arises from the resonance between the duration of contact and the eigenfrequencies of the sphere. This oscillation disappears if there exists the strong solid viscosity in spheres. They also find that a sinusoidal behavior of the restitution coefficient against the initial phase in the eigenmodes for collisions between a thermally activated sphere and a flat wall. As a result, the restitution coefficient can exceed unity if the impact speed of the colliding sphere is nearly equal to or slower than the thermal speed. They have confirmed the existence of the fluctuation theorem for impact processes through our simulation. This result is published in Phys. Rev. E. R. Murakami got PhD mainly from this study.

Jet-induced jammed states of granular jet impacts: T. Sano and H. Hayakawa investigated the impacts of granular jets on the fixed wall in two dimensions numerically. From our two-dimensional simulation, we evaluate the equations of state and the constitutive equations of the flow. The asymptotic divergences of pressure and shear stress similar to the situation near the jamming transition appear for the frictionless case, while their exponents are smaller than those of the sheared granular systems, and are close to the extrapolation from the kinetic theoretical regime. In a similar manner to the jamming for frictional grains, the critical density decreases as the friction constant of grains increases.

Roles of dry friction in the fluctuating motion of an adiabatic piston: T. Sano and H. Hayakawa investigated the motion of an adiabatic piston under dry friction to clarify the roles of dry friction in nonequilibrium steady states. We clarify that dry friction can reverse the direction of the piston motion and causes a discontinuity or a cusp-like singularity for velocity distribution functions of the piston. We also show that the heat fluctuation relation is modified under dry friction.

Energy transport between athermal environments: K. Kanazawa, T. Sagawa, and H. Hayakawa studied energy transport between athermal environments whose fluctuation is characterized by non-Gaussian noise. They consider non-Gaussian Langevin equation to derive generalizations of fundamental non-equilibrium relations such as the Fourier law and the fluctuation relation. They furthermore revealed the absence of the zero-th law of thermodynamics in the presence of athermal environments.

Energy pumping in electrical circuits from avalanche noise: K. Kanazawa, T. Sagawa, and H. Hayakawa studied energy pumping in electrical circuits with athermal noise (i.e., avalanche noise). They modeled this setup with non-Gaussian stochastic model and derived the work and power formulas for a weakly quartic potential manipulation. The formulas imply that we can extract a positive amount of work and power from the avalanche noise as a result of the geometrical effect. These result shows that the athermal fluctuation can be used as an energy source in fluctuating systems.

Peristaltic transport of frictional granular particles: N. Yoshioka and H. Hayakawa have numerically studied flows of frictional granular particles in a deformable tube driven by stress-controlled peristaltic motion of the tube. Three phases are found through the observations of the flow profile and the flow rate. It is also found that through these observations the flow rate might be negative if the amplitude of external peristaltic stress is small enough. Moreover, it is discussed how stiffness of tube affects the flow profile and the flow rate.

Simulation of cohesive fine powders under shear: S. Takada, K. Saitoh and H. Hayakawa performed three dimensional molecular dynamics simulation of cohesive dissipative powders under a shear. By drawing the phase diagrams for several densities, we confirm the existence of various distinct steady phases, where some of them are realized by competition between the equilibrium phase transition and the dynamic instability caused by inelastic collisions. It is found that the shape of clusters depends on the initial condition of velocities of particles when the dissipation is large. In addition, non-Gaussian velocity distribution function appears in the plate-gases coexistence phase, which can be reproduced by a simple stochastic model.

Time crystal phase in a superconducting ring: R. Yoshii, S. Takada, H. Hayakawa, and their collaborators demonstrate a possible setup to exhibit the spontaneous symmetry breaking of the time translation symmetry. They consider a quasi-one-dimensional superconducting ring with a static Zeeman magnetic field applied along the ring and static Aharonov-Bohm magnetic flux penetrating the ring and show that these two magnetic fields stabilize the state, in which both the phase and amplitude have spatial modulations. In this phase, the time translation symmetry is spontaneously broken.

Nonequilibrium pumping for quantum systems: Hayakawa and his coworkers studied geometrical pumping processes and their non-adiabatic effect for transport in quantum dot systems. This academic year, they developed three directions on this study. One is the geometrical expression on excess entropy production in quantum systems. Another one is that the analytical study of geometrical pumping for a quantum dot based on quantum master equation. The other one is that non-adiabatic effect for quantum pumping.

T. Yuge, T. Sagawa, A. Sugita and H. Hayakawa developed the theory of the geometrical expression for the excess entropy production for quantum transport processes. Through this study, we confirm the universality of the idea proposed by T. Sagawa and H. Hayakawa in 2011 even for quantum systems, in which the entropy depends on the operational path in strongly non-equilibrium systems as a result of the existence of Berry-like phase. Their result implies that in general one cannot define a scalar potential whose difference coincides with the excess entropy production in a thermodynamic process, and that a vector potential plays a crucial role in the thermodynamics for non-equilibrium steady state. Their result also recover the previous extended Clausius expression for the entropy production in weakly non-equilibrium systems.

R. Yoshii and H. Hayakawa analytically investigate a non-equilibrium quantum pumping for a single quantum dot connected to external leads on the basis of the quantum master equation. They show that the Coulomb interaction associated with the spin effect in the dot induces the Berry-like phase in the parameter space and this phase results in the excess charge transfer for the cyclic modulation of parameters in leads. They obtain an analytical expression of the curvature of the phase and that for the pumped currents.

K. Watanabe and H. Hayakawa clarified the role of non-adiabatic effects in a quantum pumping. They derived the formula of the non-adiabatic pumping current based on the Markovian quantum master equation. When they periodically control the temperature of two reservoirs for a spin-boson system, they found that the pumping current strongly depended on the initial condition, and thus, the current deviated from that predicted by the adiabatic treatment. They also analytically obtained the contribution of non-adiabatic effects in the pumping current proportional to Ω^2 where Ω is the angular frequency of the temperature control. The validity of the analytic expression was verified by their numerical calculation.

Integral quantum fluctuation theorems under measurement and feedback control: Y. Watanabe and K. Funo and M. Ueda derive integral quantum fluctuation theorems and quantum Jarzynski equalities for a feedback-controlled system and a memory which registers outcomes of the measurement. The obtained equalities involve the information content, which reflects the information exchange between the system and the memory, and take into account the back action of a general measurement contrary to the classical case. The generalized second law of thermodynamics under measurement and feedback control is reproduced from these equalities. We also show that entanglement can be utilized to extract the thermodynamic work beyond classical correlation via feedback control based on measurement on part of a composite system. The net work gain due to entanglement is determined by the change in the mutual information content between the subsystems that is accessible to the memory

M. Murase developed a theory for understanding the biological effects of external polluted environments. It is true that it has long been thought that it is very difficult to identify a clear correlation between suspected environmental cuases and probable biological effects because of conflicting results from scientific studies. In the paper, we introduce a paradigm shift for interpretaing the possible source of conflicting results. It is emphasized that, from the viewpoint of structuralism, the striking parallels between the development of of diseases based on the concept of the general adaptation syndrome developed by Hans Selye and the developmet of knowledge about objects based on the genetic epistemology formulated by Jean Piaget.

M. Murase proposed a theory of constructive cognition on the basis of structuralism. Cognition is such a common experience that we truely try to define it in our everyday life. Yet, no one wha has worked on this problem has ever been able to answer it in a satisfactory way. This is probably not because we lack complete knowledge of components such as molecules, neurones or neural networks at different hierarchical levels of a human being, but because we lack a constructive view integrating the fragments of knowledge at different levels during our investigation of the history of life.

Nuclear Theory Group

The main focus of our research group is the basic investigation of nuclear physics covering all the physical phenomena governed by the strong interactions, such as the structure and the dynamics of nuclei and hadrons, and properties of hadron-quark many-body system in finite temperatures and densities. Here we briefly review our research activity in the academic year of 2013.

Nuclear structure and dynamics

Unified description for the nuclear structure and reaction: Itagaki and collaborators discussed the low-lying states of ^{9}Li with a unified framework of microscopic structure and reaction models. In the structure model, ^{9}Li is described as an α+t+n+n four-body system, and low-lying $1/2^-$, $3/2^-$, $5/2^-$, and $7/2^-$ states were obtained by the stochastic multiconfiguration mixing method. Using these wave functions, the quasielastic cross section at E/A = 60 MeV and the elastic and inelastic cross sections at E/A = 50 MeV on the ^{12}C target were calculated in the framework of the microscopic coupled channel (MCC) method. The characteristic inelastic angular distribution were seen in the $3/2^-$ state; here found the possibility of triaxial deformation and mixing of dineutron components.

Unified description for the shell and cluster structure of nuclei: Itagaki and collaborators proposed an improved version of the antisymmetrized quasicluster model (AQCM) to describe a smooth transition from the α-cluster wave function to the jj-coupling shell model wave function and applied it to the ground state of ^{12}C. The cluster-shell transition is characterized in AQCM by only two parameters: R representing the distance between α clusters and the center of mass and Λ describing the break of α clusters. The optimal AQCM wave function for the ground state of ^{12}C is an intermediate state between the three-α cluster state and the shell model $p3/2$ subshell closure configuration. The result is consistent with that of the antisymmetrized molecular dynamics (AMD), and the optimal AQCM wave function quantitatively agrees with the AMD one, although the number of degrees of freedom in AQCM is significantly fewer.

Collective precession motion of high-spin torus isomer for ^{40}Ca: Ichikawa, Itagaki, and collaborators have investigated the precession motion of the exotic torus configuration in high-spin excited states of ^{40}Ca. For this aim, they used the three-dimensional time-dependent Hartree-Fock (TDHF) method. Although the high-spin torus isomer is a unique quantum object characterized by the alignment of angular momenta of independent single-particle motions, they found that the obtained moment of inertia for rotations about an axis perpendicular to the symmetry axis is close to the rigid-body value. They also analyzed the microscopic structure of the precession motion using the random-phase approximation (RPA) method for high-spin states. In the RPA calculation, the precession motion of the torus isomer is generated by coherent superposition of many one-particle-one-hole excitations across the sloping Fermi surface that strongly violates the time-reversal symmetry. By comparing results of the TDHF and the RPA calculations, they found that the precession motion obtained by the TDHF calculation is a pure collective motion well decoupled from other collective modes.

Nuclear fusion reaction: Ichikawa and his collaborators have demonstrated that when two colliding nuclei approach each other, their quantum vibrations are damped near the touching point. To show this, they for the first time applyed the random-phase-approximation (RPA) method to the two-body ^{16}O + ^{16}O and ^{40}Ca + ^{40}Ca systems. They also calculated the fusion cross section for the ^{40}Ca + ^{40}Ca system using the coupled-channel method with the damping factor simulating the vanishing of the couplings. The calculated results reproduce well the experimental data, indicating that the smooth transition from the sudden to adiabatic processes indeed occurs in the deep sub-barrier fusion reactions.

Hadron structure and dynamics

Structure of near-threshold s-wave resonances: Hyodo has studied the structure of two-body s-wave bound states as well as resonances near the threshold in the single-channel scattering where the scattering length and the effective range are given by real numbers. It is shown that, in the energy region where the effective range expansion is valid, the properties of resonances are constrained only by the position of the pole. It is found that the compositeness defined through the analytic continuation of the field renormalization constant is pure imaginary and normalized for resonances. The interpretation of this quantity is discussed by examining the structure of the hadron resonance $\Lambda_c(2595)$ in the $\pi\Sigma_c$ scattering. It is shown that the $\Lambda_c(2595)$ resonance requires an unnaturally large effective range and hence it is not likely a $\pi\Sigma_c$ molecule.

Heavy quark symmetry in multi-hadron systems: Hyodo in collaboration with Yamaguchi, Ohkoda, Hosaka and Yasui has discussed the properties of hadronic systems containing one heavy quark in the heavy quark limit. The heavy quark symmetry guarantees the mass degeneracy of the states with total spin and parity $(j-1/2)^P$ and $(j+1/2)^P$ with $j \geq 1/2$, because the heavy-quark spin is decoupled from the total spin j of the light components called brown muck. This idea is applied to heavy multi-hadron systems, and the general framework to analyze their properties is formulated. It is explicitly demonstrated that the spin degeneracy and the decomposition of the wave functions in exotic heavy hadron systems generated by the one boson exchange potential. The masses of the brown muck can be extracted from theoretical and experimental hadron spectra, leading to the color nonsinglet spectroscopy.

Universal physics of three bosons with isospin: Hyodo in collaboration with Hatsuda and Nishida has shown that there exist two types of universal phenomena for three-boson systems with isospin degrees of freedom. In the isospin symmetric limit, there is only one universal three-boson bound state with the total isospin one, whose binding energy is proportional to that of the two-boson bound state. With large isospin symmetry breaking, the standard Efimov states of three identical bosons appear at low energies. Both phenomena can be realized by three pions with the pion mass appropriately tuned in lattice QCD simulations, or by spin-one bosons in cold atom experiments. Implication to the in-medium softening of multi-pion states is also discussed.

Nucleon resonances within a dynamical coupled-channels model of πN and γN reactions: Nakamura in collaboration with Kamano, Lee, and Sato studied the nucleon resonances with a dynamical coupled-channels model of πN and γN reactions up to the invariant mass W = 2 GeV. The meson-baryon (MB) channels included are $MB = \pi N, \eta N, K\Lambda, K\Sigma$, and $\pi\pi N$ that has $\pi\Delta$, ρN, and σN resonant components. The meson-baryon amplitudes are obtained from a set of coupled-channels integral equations defined with an interaction consisting of (a) meson-exchange interactions derived from phenomenological Lagrangian, and (b) the transition of a bare excited nucleon state to MB. Parameters in the model are determined by simultaneous fits to $\pi N, \gamma N \to \pi N, \eta N, K\Lambda, K\Sigma$ data up to $W \sim 2.1$ GeV. The pole positions and residues of nucleon resonances are extracted from the amplitudes.

Λ (1405) photoproduction based on chiral unitary model: Recent CLAS data for the $\pi\Sigma$ invariant mass distributions (line-shapes) in the $\gamma p \to K^+\pi\Sigma$ reaction are theoretically investigated by Nakamura in collaboration with Jido. The model consists of gauge invariant photoproduction mechanisms, and the chiral unitary model that gives the rescattering amplitudes where $\Lambda(1405)$ is contained. The $\pi\Sigma$ line-shape data in the $\Lambda(1405)$ region are successfully reproduced by the model for all the charge states. Detailed analysis suggests that the nonresonant background contribution is not negligible, and its sizable effect shifts the $\Lambda(1405)$ peak position by several MeV. This work sets a starting point for a fuller analysis in which line-shape as well as K^+ angular distribution data are simultaneously analyzed for extracting $\Lambda(1405)$ pole(s).

Dispersive model connecting light meson poles with their Regge trajectories: Nebreda and her collaborators studied how the Regge trajectory of a resonance can be obtained from its pole in a scattering process and analytic constraints in the complex angular momentum plane. The method can be applied to resonances that dominate an elastic scattering amplitude. They applied it to the $\rho(770)$ and to the $f_0(500)$ (or σ) resonances, both generated in $\pi\pi$ scattering. While for the first they obtained a linear trajectory characteristic of ordinary quark-antiquark states, for the second they found a non-linear trajectory with a much smaller slope. Moreover, a linear trajectory with a natural slope for the σ resonance yielded an elastic amplitude at odds with the data. These results provide strong support for the non-ordinary nature of the σ meson.

QCD matter and phase diagram

Entropy production in classical Yang-Mills theory from Glasma initial conditions: Elucidating the mechanisms of entropy production and early thermalization is one of the fundamental problems in high-energy heavy-ion collision physics. Analyses based on hydrodynamics suggest the thermalization time $\tau_{\rm th} \sim 1$ fm$/c$, which is significantly shorter than the equilibration time obtained in perturbative QCD. Ohnishi, in collaboration with Iida, Kunihiro, Müller, Schäfer and Takahashi, investigated the thermalization process in classical Yang-Mills field theory starting from noisy glasma-like initial conditions. They found that chaotic behavior appears with small random fluctuations around the chromomagnetic field in the longitudinal direction, while no chaoticity is observed when such fluctuations are absent. Since the entropy production rate can be esitmated as the Kolmogorov-Sinai entropy, sum of exponential growth rates of distance between two trajectories (Lyapunov exponents), the observed chaoticity implies that a significant amount of entropy is produced by classical gluon field dynamics for glasma-like initial conditions.

Resummation of non-global logarithms at finite N_c: In high energy collider experiments, it is often necessary to quantify the amount of radiation from jets in the final state in order to enhance various signals of new physics. This is complicated by the so-called non-global logarithms which arise from multiple emissions of soft gluons. For a long time, the resummation of nonglobal logarithms has been done only in the large-N_c limit. Hatta, in collaboration with Ueda, for the first time performed the resummation of non-global logarithms at finite N_c. This was done by numerically solving the effective Langevin equation which describes the evolution of high energy partons (Wilson lines) under the emission of soft gluons.

Double-spin asymmetry A_{LT} in open charm production: Hatta, in collaboration with Kanazawa and Yoshida, computed the longitudinal-transverse double-spin asymmetry A_{LT} in open charm (D-meson) production measurable at RHIC. The dominant contribution comes from the three-gluon exchange with the transversely polarized proton which has been calculated gauge invariantly at twist-three accuracy. In contrast to single-spin asymmetry, one has to evaluate the non-pole part of the amplitude, and this has been done with the help of the Ward-Takahashi identity.

Exact analytical solutions of second-order conformal hydrodynamics: In collaboration with Noronha and Xiao, Hatta constructed various exact solutions of second-order hydrodynamic equation in theories with conformal symmetry. Starting from a spherically expanding solution in ideal hydrodynamics, they take into account general second-order corrections, and construct, for the first time, fully analytical axisymmetric exact solutions including the case with nonzero vorticity. The key is to perform a conformal transformation from Minkowski space to $AdS_3 \times S^1$ where the problem simplifies.

Criticality in probability distribution of conserved *charges* Morita, in collaboration with Friman and Redlich, investigated fluctuations of the net baryon number at nonzero baryon chemical potential from a viewpoint of the probability distribution. They use the chiral quark-meson model with the functional renormalization group method to characterize a critical property of the probability distribution near the chiral crossover. They found a ratio of the probability distribution to the Skellam distribution with the same mean and variance shows characteristic narrowing near the phase boundary. Theypointed out that the experimental data at the highest centrality bin measured by the STAR collaboration exhibit the similar behavior. They also critically examined the binomial and negative binomial distribution as a baseline in search for the critical behavior.

$\Lambda\Lambda$ interaction from relativistic heavy ion collisions Morita and Ohnishi, in collaboration with Furumoto, investigated $\Lambda\Lambda$ correlation function in heavy ion collisions at the RHIC energy. They computed $\Lambda\Lambda$ correlation function for expanding source models with various interaction potentials in literature and examined effects of collective expansion on the correlation function. By fitting to the experimental data, they found that the scattering length and the effective range of the $\Lambda\Lambda$ interaction can be constrained to $-1.5 < 1/a_0 < -0.8\text{fm}^{-1}$ and $4 < r_{\text{eff}} < 7\text{fm}$, respectively.

Charmonium in external magnetic field Morita, in collaboration with Cho, Hattori, Lee, and Ozaki, investigated effects of strong magnetic fields on the mass of J/ψ and η_c using QCD sum rule and a hadronic effective Lagrangian. They found that magnetic field induces mixing between η_c and the longitudinal model of J/ψ, which causes a level repulsion. They pointed out a proper implementation of the effect of the magnetic field to the spectral ansatz in the QCD sum rule gave the same result as that from the effective Langrangian.

Possible Constraints on the Density Dependence of the Nuclear Symmetry Energy: Sotani and his collaborators systematically examine the fundamental frequencies of shear torsional oscillations in neutron star crusts in a manner that is dependent on the parameter L characterizing the poorly known density dependence of the symmetry energy. The identification of the lowest quasiperiodic oscillation (QPO) among the observed QPOs from giant flares in soft-gamma repeaters as the $\ell = 2$ fundamental torsional oscillations enables us to constrain the parameter L as $L \geq 47.4$ MeV, which is the most conservative restriction on L obtained in the present work that assumes that the mass and radius of the flaring neutron stars range 1.4-1.8 $M_\odot$ and 10-14 km. Next, we identify one by one a set of the low-lying frequencies observed in giant flares as the fundamental torsional oscillations. The values of L that can reproduce all the observed frequencies in terms of the torsional oscillations coupled with a part of dripped neutrons via entrainment effects are then constrained as 101.1 MeV $\leq L \leq$ 131.0 MeV. Alternatively, if only the second lowest frequency observed in SGR 1806$-$20 has a different origin, one obtains relatively low L values ranging 58.0 MeV $\leq L \leq$ 85.3 MeV, which seem more consistent with other empirical constraints despite large uncertainties.

Magnetic QCD critical point: Yamamoto in collaboration with T. D. Cohen argued the possible existence of a new critical point associated with a deconfinement phase transition in QCD at finite temperature and in a magnetic field. This new critical point can be studied using lattice QCD simulations without suffering from a sign problem.

Chiral Langevin theory for non-Abelian plasmas: Yamamoto in collaboration with Akamatsu gave a physical argument that charged plasmas with chirality imbalance are unstable and tend to reduce the imbalance. They also constructed a new effective theory which describes this “chiral plasma instability” for high-temperature non-Abelian plasmas at the magnetic scale. Based on their chiral Langevin theory, the time scale of the chiral plasma instability is estimated to be $1/[g^4 \ln(1/g)]^{-1}$ at weak coupling.

Magnetars and chiral plasma instabilities: Ohnishi and Yamamoto gave a possible new mechanism for a strong and stable magnetic field of magnetars due to the chiral plasma instability in the presence of a chirality imbalance of electrons that occurs associated with the parity-violating weak process during core collapse of supernovae. Their mechanism naturally generates a strong magnetic field of order 10^{18} G at the core with a large magnetic helicity that ensures the stability of the magnetic field.

QCD phase diagram at finite baryon and isospin chemical potentials in Polyakov loop extended quark meson model: Ueda and Ohnishi with their collaborators investigate the QCD phase diagram of isospin asymmetric matter using the Polyakov loop extended quark meson (PQM) model with vector interaction. Isospin chemical potential is found to reduce the temperature of the QCD critical point, and the critical point disappear at large isospin chemical potential. The order of the QCD phase transition in the neutron star core is also discussed by comparing the QCD phase diagram in PQM and corresponding baryon and isospin chemical potentials of neutron star matter in relativistic mean field models. It is found that the isospin chemical potential in the neutron star core is large enough and the chiral phase transition could be crossover.

QCD phase diagram at strong coupling including auxiliary field fluctuations: Ichihara and Ohnishi in collaboration with Nakano investigated the QCD phase diagram and the mechanism for the sign problem in a combined framework of the auxiliary filed Monte-Carlo (AFMC) and the chiral angle fixing (CAF) methods in the strong coupling limit. CAF was develped as a tool to obtain appropriate order parameters respecting the chiral symmetry in the chiral limit. There is a milder sign problem, which was found to originate from high-momentum modes of auxiliary fields. The obtained chiral phase transition boundary in CAF is consistent with another method, Monomer-Dimer-Polymer simulations.

Particle Physics Group

Particle physics is a branch of physics studying the origin of matter and space-time as well as their interactions, the most fundamental problems in Nature. Its final goal is to reveal the underlying physical laws and components of the nature. A lot of important mysteries are remaining unanswered, and this group has research activities in various directions to reach this goal.

In particle phenomenology, the current experimental results are considered to be very accurately described by the Standard Model (SM) with $SU(3) \times SU(2) \times U(1)$ gauge group. However, this model cannot be the final theory for the following reasons; it contains too many tunable parameters which can only be determined by experiments, it suffers from the hierarchy problem, and it does not contain the dark matter and the neutrino masses. Thus particle physics beyond the SM is actively investigated by many members of this group. The study of the Higgs sector is now one of the hot topics thanks to the LHC experiments at CERN. The Higgs sector explains the origin of the particle masses through the mechanism of the spontaneous symmetry breaking. Another important topic is the mechanism of the supersymmetry breaking. The supersymmetry is a highly attractive idea, since it solves the hierarchy problem of the SM and unifies naturally the gauge couplings of the SM at a high energy scale, suggesting a Grand Unified Theory (GUT) of gauge fields and matters. However, no experimental evidence of the supersymmetry has been observed yet. Reconciliation of the present experimental situation with theoretical requirements is highly wanted. Supergravity, a local gauge theory of supersymmetry, is also investigated by some members of the group.

Quantum Chromodynamics (QCD) is a non-Abelian gauge theory coupled with matter fields. This theory describes the hadronic systems, and has various applications in particle phenomenology as well as in astrophysics. Because of its strong interactions, understanding its properties requires non-perturbative approaches to quantum field theories. Lattice QCD gives a practical and powerful numerical method to analyze the non-perturbative aspects of QCD.

It is yet not known how to incorporate the principle of quantum mechanics into the gravity or the general relativity. Application of the standard quantization procedure to the general relativity is met with many serious problems, including uncontrollable UV divergence. A consistent theory of quantum gravity seems to require a new notion of space-time, which replaces the classical space-time notion that is a continuous smooth manifold. Noncommutative space-time (or fuzzy space, more generally) is one candidate, which actually has been noted to appear in quantum gravity and string theory under certain conditions. Based on this quantum space-time notion, quantum gravity is investigated by some of the group members.

String theory is a theory of one-dimensionally extended objects like string, trying to give a consistent unified theory of all the interactions and matters. To relate the string theory to the real nature, compactification is a vital step, since the consistency of the string theory requires the space-time dimension to be ten, and the extra six-dimensions must be compactified to small sizes. The mode of compactification determines the possible contents of gauge theory and matters in low energy, and finding realistic compactifications is an important topic. This is studied by the group members. However, at present infinite possibilities of compactifications are known, and non-perturbative formulation of the string theory seems to be required for it to have predictable powers to the real nature. As study in this direction, the string field theory and the M-theory are investigated by the group members, too. Black hole physics based on string theory and mathematical aspects of string theory are also actively researched by the group members.

Not only as a unified theory, the discovery of the AdS/CFT correspondence open the possibility of applying the string theory to studying dynamics of general strong coupling system. A wide range of fields including black hole physics, condence matter physics, also quantum information theory is now investigated by means of the ADS/CFT correspondence or more general gauge/gravity duality (or holography). At the same time, this duality provides significant novel links between gauge theory and string theory. These hot topics are also actively investigated by many members of the group.

Historically the development of particle physics came hand in hand with that of field theory, which is not only a common language of particle physics but also a central tool in modern theoretical physics, including cosmology, condensed matter, and statistical physics. Thinking of this powerful generality of field theory, some of the group members study related topics in condensed matter physics and integrable systems.

Here is a summary of main works of the members of the particle physics group in the academic year 2013.

Particle phenomenology and supersymmetry

— Inflation vs supersymmetry breaking scale—

Recent experimental information such as the Planck satellite results provides cosmological parameters with increasing accuracy, which enables us to perform detailed numerical examination of realistic model parameters in various candidate inflation models. Imai and Izawa investigated characteristic features of realistic parameter choice for primordial inflation with supersymmetric Higgs inflaton as an example of particle physics inflation model. They discussed constraints from observational results and analyzed the degree of fine tuning needed to induce slow-roll inflation for wide range of soft supersymmetry breaking scale. The observed amplitude of density fluctuations implies that the minimal fine tuning for the combined electroweak scale and inflaton flatness predicts the spectral index around the central value derived from observational data.

— Muon g-2 and supersymmetric models —
Even though supersymmetric (SUSY) extensions of the Standard Model (SM) are believed to be one of the most attractive physics beyond the SM, no concrete signals of SUSY particles have been observed at the LHC. Under such a situation, indirect searches for SUSY particles using the processes such as the muon $g-2$ and the charged lepton flavor violation are useful to probe SUSY particles. Nomura has given two invited talks about the situation of the muon g-2 calculation since he joined YITP in October 2013. Nomura also discussed lepton flavor violation in the Next-to-MSSM (NMSSM) with Nakamura (Tohoku Univ.).

— Dark matter and flavour physics —
Dark matter is one of the best evidences of beyond the particle Standard Model. The stability might be related to the underlying flavour symmetry of quarks and leptons. Takayama with Omura(Muchich Tech.), Kobayashi, Hamada, Ogasawara, Yasuhara(Kyoto U.) studied a model where the residual parity after the breaking of discrete non-Abelian flavour symmetry leaves the lightest parity odd particle stable and provide a dark matter candidate, and discussed the characteristic structure of neutrino mass and lepton flavour violating processes.

Quantum gravity

An ultimate goal of research of quantum gravity is to successfully construct a theory which does not contain space-time in its basic formulation but generates it as an infrared emergent phenomenon. An important point in this direction of research is the choice of fundamental variables. The two-dimensional quantum gravity is known to be successfully described by the matrix models which have matrices as fundamental variables. As generalization to higher dimensions, Sasakura and a few other groups proposed a long time ago a series of models which have tensors as fundamental variables. Recently, these tensor models were analytically analyzed, and it was shown that singular manifolds dominate. This property is rather pathological and disappointing, since our actual space cannot be identified with a singular manifold, and therefore the tensor models do not look suited for quantum gravity. On the other hand, it is known that this pathological behavior commonly appears in lattice approaches to quantum gravity in Euclidean signature, and can be cured by introducing a time direction. In fact, the tensor models above are in Euclidian signature. Prompted by these facts, Sasakura introduced a few years ago a time direction to tensor models by constructing a canonical formalism of a tensor model which has a tensor with three indices as its fundamental variable. This new model is formulated as a totally constrained system with a number of first-class constraints including also “local” Hamiltonian ones. Remarkably, the “local” Hamiltonian constraints can be shown to be unique under some physically reasonable assumptions. Moreover there exists a formal limit in which the first-class constraint algebra of the tensor model approaches that of the ADM formalism of general relativity. After the formulation of the canonical tensor model, the next question is its dynamics, whether it really generates a space-time as its infrared emergent phenomenon. In the academic year of 2013, a few but promising properties concerning this question were found: Sasakura showed that locality is favored as a result of quantum dynamics for cardinality N = 2, and Sasakura and Sato in Wits university in South Africa showed that the mini-superspace approximation of general relativity in any dimensions can be derived from the canonical tensor model with N = 1. However, since N is supposed to be the number of “points” composing a space, the dynamics for larger N must be clarified for physical purposes. A possible strategy to tackle this problem would be to relate the canonical tensor model with a simpler dynamical system, and Sasakura and Sato showed that there exist intimate relations between the canonical tensor model and a statistical system on random networks.

String theory & SUSY gauge theories

— Superstring field theory —
Kunitomo attempted to construct the full equations of motion for the Neveu-Schwarz (NS) and the Ramond (R) sectors of the heterotic string field theory. Although they are nonpolynomical both in the NS string field V and also the R string field Ψ, he found that they can be constructed order by order in Ψ. Their explicit forms with the gauge transformations were given up to the next-to-next-to-leading order in Ψ. A subset of the terms were also determined to all oders. He also proposed a covariant action supplemented with a constraint by introducing an auxiliary R string field.

— Localization and exact results —
For supersymmetric gauge theories on a certain compact maniifold, we can compute some ovservables exactly by using the localization technique. Sugisthita (Kyoto U.) and Terashima success to apply the localization technique to some theories on manifolds with boundaries, and obtained the exact partition fucntion for them.

Nosaka and Terashima discovered new kind of continuous deformation of round four-sphere which partly preserves $\mathcal{N}=2$ supersymmetry, and constructed the supersymmetric Yang-Mills action on it. Using localization technique, they obtained general formulae for the partition function and supersymmetric Wilson loops. In particular, with gauge group SU(2) and with additional four hypermultiplets in fundamental representation, the partition function coincides with the four point function of 2D Liouville theory with Liouville coupling b determined by the 4D geometry. This is consistent with the AGT conjecture. Unlike previous examples of 4D theory, however, here b is not restricted to be real.

Since the discovery by Alday, Gaiotto and Tachikawa (AGT), many nontrivial relations have been discovered between quantum field theories in various dimensions through the studies of M5-branes wrapped on curved spaces. A particularly important example is the relation between observables in 4D $\mathcal{N}=2$ SUSY gauge theories on four-sphere and correlators in 2D Liouville or Toda CFTs. Hama and Hosomichi extended their previous work and studied the $\mathcal{N} = 2$ SUSY gauge theories on ellipsoids in the limit of extreme squashing. They found an interesting simplification in the expression of partition function, and compared it with the correlators in the so-called light asymptotic limit of Liouville theory.

— Branes in M-theory —

M-theory is the strong coupling limit of type IIB superstring theory which should be defined non-perturbatively. In M-theory the non-trivial dualities of superstring theories will be unified and should be manifest. This also explain the interesting and mysterious dualities of the supersymmetric gauge theories through the branes in M-theory. Sakai (Ritsumeikan) and Terashima investigated the BPS equations which determine the configuration of an M2-M5 bound state preserving half of the supersymmetries in the M2-brane effective action and showed that they admit a Lax representation. Using this, they constructed explicitly the most general solutions describing two M2-branes suspended between two parallel M5-branes as well as two semi-infinite M2-branes ending on an M5-brane.

— AdS/CFT —

Narayan, Takayanagi and Trivedi studied the holographic entanglement entropy for a plane wave background in an AdS spacetime. This is dual to a class of excited states in the conformal field theory which is characterized by a stationary energy flow. They found a phenomena analogous to the phase transition depending on the direction of subsystem relatived to that of the energy flow.

Nozaki, Numasawa, and Takayanagi proposed a holographic model of local quench. A local quench is triggered by large local excitations. We studied how entanglement dynamically changes by investigating the time evolution of entanglement entropy. And to investigate the local structure of quantum entanglement in general quantum system, we introduced a new quantity which is called ""quantum density". By using this quantity, we found a simple relationship between the amount of quantum information possessed by a massive object and its total energy based on the AdS/CFT.

Nozaki, Numasawa, Prudenziati and Takayanagi studied an counterpart of Einstein equation in terms of entanglement entropy, which is expected to be an important key to understanding the nature of quantum gravity. Especially, they studied the AdS3/CFT2 duality and found the differential equations which are satisfied by the holographic entanglement entropy and which are equivalent to the Einstein equation. Bhattacharya and Takayanagi generalized thisanalysis to higher dimensions and also discussed how the results are modified when we consider AdS black hole backgrounds.

Shiba and Takayanagi presented a simple class of non-local field theories whose ground state entanglement entropy follows a volume law. They confirmed the volume law both from numerical calculations and from analytical estimation. If we consider holography in spacetimes whose curvatures are much smaller than AdS spaces such as those in the flat spacetime, their holographic entanglement entropy satisfies a volume law instead of the area law. The volume law behaviors in their model agreed with holographic results.

Mollabashi, Nozaki, Ryu, and Takayanagi studied the time evolution of cMERA (continuous multi-scale entanglement renormalization ansatz) under quantum quenches in free field theories. Previously we proposed the method of building the holographic metric from the data of conformal field theory. We also constructed the corresponding metric using our previous proposal and confirmed that it qualitatively agrees with its gravity dual given by a half of the AdS black hole spacetime argued by Hartman and Maldacena.

Nozaki, Numasawa and Takayanagi studied the time evolution of entanglement entropy for local operator excited states for free field theories in various dimensions. They confirmed that the results are interpreted as the entanglement between the finite dimensional Hilbert space, including the EPR state. They also gave an intuitive interpretation of these results in terms of entangled quasi particles and suggested that these results are applied to higher dimensional theories.

Y. Asano, G. Ishiki, T. Okada and S. Shimasaki investigated the gauge/gravity correspondence for the gauge theories with SU(2|4) symmetry. They applied the localization method to a quarter BPS sector of the gauge theories and found that, in the strong coupling region, the eigenvalue density of a scalar field reproduces part of the dual geometries in the type IIA supergravity.

M. Hanada, Y. Hyakutake, G. Ishiki and J. Nishimura performed a Monte Carlo simulation of a 1D SUSY gauge theory at finite temperature to test the gauge/gravity correspondence. They found that the internal energy of the gauge theory reproduces precisely the internal energy of a dual black hole solution on the gravity side inculuding the first string coupling (1/N) correction.

Hanada studied the properties of large-N gauge theories in the M-theory like parameter region (the gauge coupling is fixed, rather than the 't Hooft coupling). Previously he had shown that the perturbative sector is continuously connected to the 't Hooft limit. With Azeyanagi (Harvard), Honda (KEK), Matsuo (KEK) and Shiba (KEK), he showed similar property in the instanton sector. (arXiv:1307.0809, to appear in JHEP). Now he is trying to apply this method to read off the geometric data in M-theory form gauge theory. He is also trying to use it to study the instanton effect for the confinement and chiral symmetry breaking.

— Black hole entropy in three dimensional higher spin thoeries

Higher spin theories describe systems where gravitons interact with massless spin larger than three fields (higher spin fields). Recently black hole solutions in three dimensional higher spin theories are extensively discussed. Ugajin, with Kraus found a formula which computes entropy of higher spin black holes, by making use of so called conical singularity approach. The resulting entropy turns out to reproduce the dual CFT entropy.

Quantum quench processes in two dimensional conformal field theories are time dependent processes in which the system is suddenly excited by changing parameters of the Hamiltonian of the system. Especially in global quenches, entanglement entropy is thermalized. Ugajin proposed a way to systematically construct holographic duals of quenches. He also showed how the time evolution of entanglement entropy is reproduced from the holographic geometry.

— Black hole microstates and exotic branes

Black holes have thermodynamical entropy and must represent a statistical mechanical ensemble of many underlying microstates. Identifying the microstates in string theory is a key to understand quantum gravity and resolve fundamental problems such as the information paradox. Some of the microstates have been constructed in supergravity, but they are known to be insufficient to account for the black hole entropy. Therefore, it is important to search for a wider class of microstate solutions in more general frameworks.

Masaki Shigemori, based on his previous work on six-dimensional supergravity, constructed a new class of microstate solutions that are genuinely six-dimensional. Previously constructed microstate solutions were mostly five-dimensional but much more solutions are expected to exist in six dimensions by exciting traveling waves along the sixth direction. This class of solutions is expected to give intuition for finding more general solutions.

Masaki Shigemori with de Boer and Mayerson (University of Amsterdam) studied configurations of exotic branes, which are expected to be important for understanding general microstates. In generic situations, black hole microstates must involve non-geometric spacetime, a generalized notion of spacetime predicted by string theory. Exotic branes are important examples of non-geometric spacetime. He classified exotic branes in the near-brane limit focusing on the relation between the preserved supersymmetry and the nilpotent orbit in the U-duality group. He also found an intricate interplay between the monodromy of the brane and the nilpotent orbit.

— ABJM theory —

Honda and Moriyama have studied the ABJM theory and its extension which describe the multiple M2-brane system. Especially, they have proved that the normalized vacuum expectation value of the half-BPS Wilson loop satisfy the Giambelli formula, which was originally found for the character itself before taking the expectation value.

— F-theory and string landscape —

Andreas P. Braun, Yusuke Kimura and Taizan Watari studied flux compactification of F-theory on the product of attractive K3 surfaces, and its application to string landscape. We investigated elliptic fibrations of a K3 surface to extract physical information such as distribution of gauge groups over the landscape of vacua.

— Non-perturbative study on duality and phase structure in string theory —

Non-perturbative study on string theory opens a new frontier toward fundamental understanding of string theory. Traditional analysis of string theory by perturbation theory cannot captures vacuum structure of string theory, even with taking into account all the solition/instanton configurations for all order. A key for the missing non-perturbative data is supplied by an advanced study on asymptotic perturbative/instanton expansions (i.e. on Stokes phenomenon) in string theory and by seeking for a new non-perturbative principle of string theory.

Irie with Chan (Tunghai) and Yeh (NCTS) elaborated non-perturbative check of string duality by an analysis on Stokes phenomena in minimal string theory and found an appearance of discrepancy at the level of “non-perturbative” duality in string theory. They showed that non-perturbative duality provides a non-trivial constraint (rather than a correspondence) on the relative weights for instanton sectors (D-instanton fugacity) in string theory. Therefore, this is a new non-perturbative principle of string theory which has been missed for a long time. They also analyzed phase structure of minimal string theory and non-perturbative dynamics associated with it. They argued that three basic ingredients of vacuum structure (tachyon, meta-stability, true vacuum) should be understood as an interrelationship of a variety of asymptotic perturbative expansions (non-perturbative vacuum connection formula) in string theory, and proposed it as a new representation of Stokes phenomena in string theory.

Lattice QCD

— Hadron-Hadron Interactions —

Aoki with Ishii (Tsukuba), Doi, Ikeda (Riken) and Inoue (Nihon) derived asymptotic behavior of the Nambu-Bethe-Salpeter (NBS) wave function at large space separation for multi-particles in quantum field theories. They showed that the NBS wave function carries information of the on-shell T-matrix such as generalized phase shifts and mixing angles for multi-particles in own asymptotic behavior.

Murano and Aoki with Ishii, Nemura, Sasaki (Tsukuba), Doi, Hatsuda, Ikeda (Riken) and Inoue (Nihon) calculated the spin-oribit force between nucleon from lattice QCD. They found a large attractive spin-orbit potential in the isospin-triplet channel.

Aoki with Ishii (Tsukuba), Doi, Hatsuda (Riken) and Kurth (Wuppertal) calculated the phase shift of $I = 2$ $\pi\pi$ scattering using two different approaches, the standard finite volume method and the HAL QCD potential method. They found that both approaches give consistent results over the wide range of the scattering energy.

Aoki and Murano with Ishii, Nemura, Sasaki (Tsukuba), Doi, Hatsuda, Ikeda (Riken) and Inoue (Nihon) investigated quark mass dependence of the equation of state (EOS) for nucleonic matter using the nucleon-nucleon interaction extracted form lattice QCD. They observed saturation of nuclear matter and derived mass-radius relation of the neutron star with this EOS.

Aoki and Murano with Ishii, Nemura, Sasaki (Tsukuba), Doi, Hatsuda, Ikeda (Riken), Charon (Tokyo) and Inoue (Nihon) studied charmed tetra quarks through the S-wave meson-meson interactions in lattice QCD. They found repulsive interactions in the isospin triplet channel while result suggests attractive interactions for the isospin singlet channel.

Etminan (YITP and Birjand), Aoki and Murano with Ishii, Nemura, Sasaki (Tsukuba), Doi, Hatsuda, Ikeda (Riken) and Inoue (Nihon) investigated the nucleon-omega interaction in lattice QCD. They found a possibility of the bound state in this channel.

— *QCD at finite temperature and density* –

Aoki with Saito, Kanaya (Tsukuba), Ejiri, Nakagawa, Okuno (Niigata), Hatsuda (Riken), Ohno (Bielefeld) and Umeda (Hiroshima) studies the phase structure of lattice QCD with heavy quarks at finite temperature and density by a histogram method. They determined the critical surface in 2+1 flavor QCD in heavy-quark region at all value of the chemical potential.

— *Chiral properties of QCD* —

Aoki with Creutz (BNL) investigated some aspect of 2-flavor QCD with non-zero θ term at low energy, using chiral perturbation theory. They found at $\theta = \pi$ that the eta condensation occurs at small quark mass, violating the CP symmetry spontaneously.

Yukawa International Program for Quark-Hadron Sciences

From the beginning of the academic year of 2007, Yukawa Institute for Theoretical Physics launched a new five-year project, "Yukawa International Program for Quark-Hadron Sciences (YIPQS)", sponsored by "Ministry of Education, Culture, Sports, Science and Technology, JAPAN (MEXT)". At the end of the academic year of 2010, the government approved to convert the YIPQS project budget into a more stable normal budget, and now we can run the program from a longer term point of view.

Aim of the program

By the end of 1970's, the final understanding was reached that Quantum Chromodynamics (QCD) is the fundamental theory of the strong interaction which was originally discovered by Hideki Yukawa. Still, nevertheless, only little has been established from QCD on various possible forms of hadrons or quarks. For example, while scaling behaviors of the lepton-nucleon cross section in the deep-inelastic scattering region and some properties of ground state hadrons have been precisely understood in perturbative and lattice QCD calculations, respectively, the study of bare nuclear force just started very recently. We have not yet reached the stage to understand properties of excited hadrons above the threshold including the exotic hadrons, binding mechanism of nuclei with more than two nucleons, nuclear matter equation of state, and the vacuum structures at extremely high temperature in the Early Universe and at extremely high density in compact stars, from the fundamentaly theory, namely QCD. In other words, there is still a vast area of research interest which is to be explored. To advance our exploration, it is necessary not only to make full use of existing theoretical techniques but also to develop new theories and to establish new frameworks. The expected achievement would cast a strong impact on our understanding of various forms of matter at various levels in nature. One may face a situation that one should restructure the current understanding about possible forms of matter.

The primary purpose of the YIPQS is to establish a new area of research fields; the quark-hadron sciences. For this purpose, with cooperating with present and near-future experimental activities, Yukawa Institute for Theoretical Physics will advance theoretical research not only in quark-hadron physics but also in related areas, as listed below, which constitute indispensable building blocks for the quark-hadron sciences.

Examples of related areas include; quark-gluon plasma, hadron physics, lattice QCD, dark energy, dark matter, baryogenesis, CP violation, strongly-correlated systems, phase transition of internal degrees of freedom of matter, physics of the Early Universe, matter at extreme conditions, structure of unstable nuclei and nucleosynthesis, compact star physics, optical lattice, (super)string theory, AdS/CFT correspondence, non-perturbative and/or non-equilibrium dynamics, etc.

International collaboration program

As a core activity of the YIPQS, long-stay programs are organized on research topics ranging over quark-hadron physics and related fields of theoretical physics. The proposal of the program is open for the community, with a requirement that the organizing committee should include a member of Yukawa Institute. The theme of the long-stay program is selected by the YIPQS executive committee with taking account of comments and opinions from the international advisory committee. The program is to be endorsed by the steering/advisory committee of the Yukawa Institute. The proposed program plan is also to be examined by the user's committee of the Yukawa Institute.

Two to three long-stay programs will be held annually; the duration of each program is one to three months. World-leading scientists are invited for each theme, and the Yukawa Institute provides participants with relaxed and at-home atmosphere so that there may be active discussions and fruitful collaborations, which we hope that will ultimately lead to Nobel-prize class results. To publicize the aim of creating and advancing the field of quark-hadron sciences, the activities and outcomes of the YIPQS will be announced regularly on the website.

Long-stay programs

In this academic year the following three long-stay programs were held;

1. May. 5 – June. 22, 2013:
   "Gravitational Waves and Numerical Relativity"
   http://http://www2.yukawa.kyoto-u.ac.jp/ws/2013/ykis2013/workshop/workshop.php
   Chairman: Masaru Shibata

2. Oct. 14 – Nov. 15, 2013:
   "Supernovae and Gamma-Ray Bursts 2013"
   http://www2.yukawa.kyoto-u.ac.jp/ws/2013/sngrb/SN-GRB2013.html
   Chairman: Shigehiro Nagataki

3. Nov. 18 – Dec. 20, 2013:
   "New Frontiers in QCD 2013 — Insight into QCD matter from heavy-ion collisions —"
   http://www2.yukawa.kyoto-u.ac.jp/ws/2013/nfqcd/
   Chairman: Masayuki Asakawa and Akira Ohnishi

The detailed information of each program can be seen at the website written above.

International molecule-type workshops

Smaller-size international collaboration programs are also organized to cope with the rapid development of the research in this field. The program is named a "molecule-type" international program. It is expected that the group discussion in this small program will evolve to form a research collaboration. The proposal has been received anytime within the budget limit. This program should involve at least one core participant from abroad, and should be long for two weeks or more. The selection of this program is also made by the executive committee.

In this academic year there were five international programs of this molecule-type as listed below;

1. Apr. 8 – Apr. 19, 2013:
   "Local Enhancement of Superexchange Interaction in High-Temperature Superconductors"
   Core members: Giniyat Khaliullin, Takami Tohyama

2. June 23 – July 06, 2013:
   "Physics of Granular Flows"
   Core members: Meheboob Alam, Hisao Hayakawa

3. Dec. 05 – Dec. 25, 2013:
   "Modified gravity"
   Core Members: Daniele Steer, Shinji Mukohyama, Misao Sasaki, Takahiro Tanaka

4. Mar. 10 – Mar. 23, 2014:
   "New correlations in exotic nuclei and advances of theoretical models"
   Core Members: George Bertsch, Hiroyuki Sagawa, Naoyuki Itagaki

5. Mar. 10 – Mar. 21, 2014:
   "Exotic structures of spacetime"
   Core Members: Nicholas Warner, Olaf Hohm, Masaki Shigemori, Tadashi Takayanagi

Organization

The executive committee was organized in the Yukawa Institute to run the whole program. The committee members are:
Akira Ohnishi (chair), Sinya Aoki, Yoshitaka Hatta, Hisao Hayakawa, Naoyuki Itagaki, Taichiro Kugo, Teiji Kunihiro, Hiroshi Kunitomo, Misao Sasaki, Masaru Shibata, Yudai Suwa, Tadashi Takayanagi, Takahiro Tanaka, Takami Tohyama.

One associate professor was hired to enhance the research activities at the Yukawa Institute.

The website of the program is;
http://www2.yukawa.kyoto-u.ac.jp/ yipqs.project/index-e.php.

2.2 Publications

2.2.1 YITP preprints (January∼December 2013)

13-1 Yu-ichi Takamizu, Tsutomu Kobayashi, *Nonlinear superhorizon curvature perturbation in generic single-field inflation*, arXiv:1301.2370 [gr-qc], (January)

13-2 Kenji Morita, Bengt Friman, Krzysztof Redlich, Vladimir Skokov, *Net quark number probability distribution near the chiral crossover transition*, arXiv:1301.2873 [hep-ph], (January)

13-3 Xingang Chen, Hassan Firouzjahi, Mohammad Hossein Namjoo, Misao Sasaki, *A Single Field Inflation Model with Large Local Non-Gaussianity*, arXiv:1301.5699 [hep-th] , (January)

13-4 Per Kraus, Tomonori Ugajin, *An Entropy Formula for Higher Spin Black Holes via Conical Singularities*, arXiv:1302.1583 [hep-th], (January)

13-5 A. Ohnishi, S. Cho, T. Furumoto, T. Hyodo, D. Jido, C. M. Ko, K. Morita, S. H. Lee, M. Nielsen, T. Sekihara, S. Yasui, K. Yazaki (ExHIC Collaboration), *Exotic hadrons and hadron-hadron interactions in heavy ion collisions*, arXiv:1301.7261 [nucl-th], (January)

13-6 Kouki Nakata, *The temperature dependence of quantum spin pumping generated using electron spin resonance with three-magnon splittings*, arXiv:1302.4777 [cond-mat.mes-hall] , (January)

13-7 Jinn-Ouk Gong, Misao Sasaki, *Squeezed primordial bispectrum from general vacuum state*, arXiv:1302.1271 [astro-ph.CO], (February)

13-8 Tatsuya Narikawa, Tsutomu Kobayashi, Daisuke Yamauchi, Ryo Saito, *Testing general scalar-tensor gravity and massive gravity with cluster lensing*, Phys.Rev.D **87**, 124006 (2013), arXiv:1302.2311 [astro-ph.CO], (February)

13-9 Yukinao Akamatsu, Naoki Yamamoto, *Chiral Plasma Instabilities*, arXiv:1302.2125 [nucl-th], (February)

13-10 Hideaki Iida, Teiji Kunihiro, Berndt Mueller, Akira Ohnishi, Andreas Schaefer, Toru T. Takahashi, *Entropy production in classical Yang-Mills theory from Glasma initial conditions*, Phys. Rev. D **88**, 094006 (2013), arXiv:1304.1807 [hep-ph], (February)

13-11 Naoki Sasakura, *A canonical rank-three tensor model with a scaling constraint*, arXiv:1302.1656 [hep-th], (February)

13-12 Emilio Elizalde, Ekaterina O. Pozdeeva, Sergey Yu. Vernov, Ying-li Zhang, *Cosmological Solutions of a Nonlocal Model with a Perfect Fluid*, JCAP **2013.07**, 034 (2013), arXiv:1302.4330 [hep-th] , (February)

13-13 Masahiro Nozaki, Tokiro Numasawa, Tadashi Takayanagi, *Holographic Local Quenches and Entanglement Density*, arXiv:1302.5703 [hep-th], (February)

13-14 Chul-Moon Yoo, Tomohiro Harada, Naoki Tsukamoto, *Wave Effect in Gravitational Lensing by the Ellis Wormhole*, arXiv:1302.7170 [gr-qc], (February)

13-15 Naoki Sasakura, *Canonical Tensor Model with Local Time and its Uniqueness*, arXiv:1302.5464 [hep-th], (February)

13-16 Tadahiro Suhara, Naoyuki Itagaki, József Cseh, Marek Płoszajczak, *Novel and simple description for smooth transition from α-cluster to jj-coupling shell model wave function*, arXiv:1302.5833 [nucl-th], (February)

13-17 Yoritaka Iwata, Kei Iida, Naoyuki Itagaki, *Synthesis of thin-long heavy nuclei in ternary collisions*, Phys. Rev. C **87**, 014609 (2013), arXiv:1211.1304 [nucl-th], (February)

13-18 Takashi Hiramatsu, Minoru Eto, Kohei Kamada, Tatsuo Kobayashi, Yutaka Ookouchi, *Instability of colliding metastable strings*, arXiv:1304.0623 [hep-ph], (March)

13-19 Ryo Saito, Yu-ichi Takamizu, *Localized Features in Non-Gaussianity from Heavy Physics*, JCAP **2013.06**, 031 (2013), arXiv:1303.3839 [astro-ph.CO], (March)

13-20 Norihiro Iizuka, Daniel Kabat, Shubho Roy, Debajyoti Sarkar, *Black Hole Formation at the Correspondence Point*, arXiv:1303.7278 [hep-th], (March)

13-21 Koji Hashimoto, Norihiro Iizuka, Taro Kimura, *Towards Holographic Spintronics*, arXiv:1304.3126 [hep-th], (March)

13-22 Atsushi Naruko, Cyril Pitrou, Kazuya Koyama, Misao Sasaki, *Second order Boltzmann equation : gauge dependence and gauge invariance*, arXiv:1304.6929 [astro-ph.CO], (March)

13-23 Guido Cossu, Sinya Aoki, Hidenori Fukaya, Shoji Hashimoto, Takashi Kaneko, Hideo Matsufuru, Jun-Ichi Noaki, *Finite temperature study of the axial U(1) symmetry on the lattice with overlap fermion formulation*, arXiv:1304.6145 [hep-lat], (April)

13-24 Su Houng Lee, Kenji Morita, Taesoo Song, Che Ming Ko, *Free energy versus internal energy potential for heavy quark systems at finite temperature*, arXiv:1304.4092 [nucl-th], (April)

13-25 Hiroshi Ueda, Takashi Z. Nakano, Akira Ohnishi, Marco Ruggieri, Kohsuke Sumiyoshi, *QCD phase diagram at finite baryon and isospin chemical potentials in Polyakov loop extended quark meson model with vector interaction*, Phys. Rev. D **88**, 074006 (2013), arXiv:1304.4331 [nucl-th], (April)

13-26 T. Kurth, N. Ishii, T. Doi, S. Aoki, T. Hatsuda, *Phase shifts in I=2 $\pi\pi$-scattering from two lattice approaches*, JHEP, 2013.12 015 (2013), (arXiv:1305.4462)[hep-lat]April

13-27 K. Murano, N. Ishii, S. Aoki, T. Doi, T. Hatsuda, Y. Ikeda, T. Inoue, H. Nemura, K. Sasaki, (HAL QCD Collaboration), *Spin-Orbit Force from Lattice QCD*, arXiv:1305.2293 [hep-lat], (April)

13-28 Masahiro Nozaki, Tokiro Numasawa, Andrea Prudenziati, Tadashi Takayanagi, *Dynamics of Entanglement Entropy from Einstein Equation*, arXiv:1304.7100 [hep-th], (April)

13-29 Yoshitaka Hatta, Takahiro Ueda, *Resummation of non-global logarithms at finite N_c*, Nucl. Phys. B **874**, 808 (2013) , arXiv:1304.6930 [hep-ph], (April)

13-30 Kunihiko Terasaki, *Decay Property of Axial-Vector Tetra-Quark Mesons*, arXiv:1304.7080 [hep-ph], (April)

13-31 Jinping Li, Songhe Meng, Lingling Li, Hantao Lu, Takami Tohyama, *First-principles generalized gradient approximation (GGA) +Ud+Up studies of electronic structures and optical properties in cubic HfO2*, Computational Materials Science **81**, 397 (2014), arXiv:1305.0108 [cond-mat.mtrl-sci], (May)

13-32 Wontae Kim, Bum-Hoon Lee, Dong-han Yeom, *Black hole complementarity and firewall in two dimensions*, JHEP **1305**, 060 (2013), arXiv:1301.5138 [gr-qc] , (May)

13-33 Bum-Hoon Lee, Wonwoo Lee, Changheon Oh, Daeho Ro, Dong-han Yeom, *Fubini instantons in curved space*, JHEP **1306**, 003 (2013), arXiv:1204.1521 [hep-th], (May)

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Yoshitaka Hatta

Journal Papers

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Nucl. Phys. B **874** (2013) 184 (13 pages), arXiv:1304.6930 [hep-ph], YITP-13-30.

2. Y. Hatta, K. Kanazawa and S. Yoshida,
"Double-spin asymmetry A_{LT} in open charm production,"
Phys. Rev. D **88** (2013) 014037 (8 pages), arXiv:1305.7001 [hep-ph], YITP-13-40.

3. Y. Hatta, J. Noronha and B. Xiao,
"Exact analytical solutions of second order conformal hydrodynamics,"
Phys. Rev. D **89** (2014) 051702(R) (5 pages), arXiv:1401.6248 [hep-th], YITP-14-6.

Books and Proceedings

1. Y. Hatta,
"Nucleon spin decomposition at twist three,"
Int. J. Mod. Phys. Conf. Ser., **25** (2014) 1460032 (8 pages), arXiv:1308.4836 [hep-ph].

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"Complete gauge invariant decomposition of the nucleon spin,"
PoS (Hadron 2013) 150 (5 pages).

Talks at International Conferences

1. "Nucleon spin decomposition at twist three,"
in "QCD evolution workshop," Jefferson Lab, USA, May 2013.

2. "Nucleon spin decomposition at twist three," Invited,
in "QCD landscape of the nucleon and atomic nuclei," Lawrence Berkeley National Lab., CA, USA, August 2013.

3. "Complete decomposition of the nucleon spin," Invited,
in "Hadron 2013," Nara Prefectural Public Hall, Japan, November 2013.

4. "Gluon helicity ΔG from a universality class of operators on a lattice,"
in "Brain circulation workshop," Brookhaven National Lab., USA, March 2014.

Invited Seminars (in Japan)

1. "Gluon helicity ΔG from a universality class of operators on a lattice,"
Dept. of Math. and Phys., Osaka City Univ., February 2014.

2. "Gluon helicity ΔG from a universality class of operators on a lattice,"
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Hisao Hayakawa

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6. Hisao Hayakawa and Michio Otsuki, "Nonequilibrium identities and response theory for dissipative particles", Phys. Rev. E **88** (2013) 032117 (9 pages).

7. Tatsuro Yuge, Takahiro Sagawa, Ayumu Sugita, and Hisao Hayakawa, "Geometrical Excess Entropy Production in Nonequilibrium Quantum Systems", J. Stat. Phys. **153** (2013) 312-441.

8. Kuniyasu Saitoh and Hisao Hayakawa, "Quantitative test of the time dependent Gintzburg-Landau equation for sheared granular flow in two dimensions ", Phys. Fluids **25** (2013) 070606 (12 pages).

9. Kiyoshi Kanazawa, Takahiro Sagawa, and Hisao Hayakawa, “Heat conduction induced by non-Gaussian athermal fluctuations", Phys. Rev. E **87** (2013) 052124 (10 pages).

Books and Proceedings

1. Satoshi Takada and Hisao Hayakawa, "Pattern dynamics of cohesive granular particles under plane shear", AIP Conf Proc. 1542 (2013) 819-822.

2. Koshiro Suzuki and Hisao Hayakawa, "Mode-coupling theory for sheared granular liquids", AIP Conf. Proc. 1542 (2013) 670-673.

3. Tomohiko G. Sano and Hisao Hayakawa, "Numerical analysis of impact processes of granular jets ", AIP Conf. Proc. 1542 (2013) 622-625.

4. Michio Otsuki and Hisao Hayakawa, "Constitutive relations of jammed frictionless granular materials under oscillatory shear", AIP Conf. Proc. 1542 (2013) 503-506.

Talks at International Conferences

1. “Mode coupling theory for dense granular flows under a plane shear: the effect of cross-correlation between current and density ,” Invited,in “Glastag,” Münster, Germany,October 2013.

2. “Can the mode-coupling theory describe the jamming transition of sheared granular materials?", Invited, in 7th. International Discussion Meeting on Relaxations in Complex Systems, Barcelona, SpainJuly 2013.

3. “Mode-coupling theory for sheared granular liquids ", in Powders & Grains 2013 , Sydney, Australia, July 2013.

4. “Non-equilibrium identities and nonlinear response theory for Granular Fluids", in Mini-workshop on Physics of Granular Flows, Kyoto, June 2013.

5. “Non-equilibrium identities and nonlinear response theory for Granular Fluids", Invited, in Conference on Complex Dynamics in Granular Systems, Beijing, June 2013.

6. “Mode-coupling theory for sheared granular liquids ", Invited, in the workshop on Complex Dynamics in Granular Systems, Beijing, May 2013.

Invited Seminars (Overseas)

1. “Non-equilibrium identities and nonlinear response theory for Granular Fluids,”at Sapienza University of Rome, Italy, February 2014.

2. "Role of Dry Friction in Fluctuating Motion of Adiabatic Piston" at Georg-August University of Göttingen, Germany, October 2013.

3. "Mode-coupling theory for sheared fluids", at Institute for Material Physics, DLR, Cologne, Germany, October 2013.

4. "Mode-coupling theory for sheared thermostat fluids" at University of Konstanz, Germany, October 2013.

5. "Non-equilibrium identities and nonlinear response theory for dissipative classical systems" at Beihang University at Beijing, China

Invited Seminars (in Japan)

1. “Lecture on Non-equilibrium Statistical Mechanics in Open Dissipative Systems,” Shizuoka Prefecture University, March 2014 (3-days, in Japanese).

2. “Jamming Transition for Granular Materials: Scaling Theory and its Current Status,” Dept. of Phys., Ochanomizu Univ., November 2013 (in Japanese).

Kazuo Hosomichi

Journal Papers

1. N. Hama and K. Hosomichi,
“AGT relation in the light asymptotic limit,”
JHEP **1310**, 152 (2013) (11 pages),
YITP-13-70, arXiv:1307.8174[hep-th].

Talks at International Conferences

1. “Seiberg-Witten Theories on Ellipsoid,” Invited,
“Simons Workshop in Mathematics and Physics,” Simons Center for Geometry and Physics, USA,
July-August 2013.

2. “AGT relation in the light asymptotic limit,” Invited,
“CFT and Integrability in memory of Alexei Zamolodchikov,” CQUeST Korea,
December 2013.

3. “Self-Dual Strings and 2D SYM,” Invited,
Kavli IPMU-FMSP Workshop “Supersymmetry in Physics and Mathematics,” IPMU Japan,
March 2014.

Invited Seminars (Overseas)

1. "Seiberg-Witten Theories on Ellipsoid,"
National Taiwan University, May 2013.

2. "Seiberg-Witten Theories on Ellipsoid,"
National University of Singapore,
September 2013.

Invited Seminars (in Japan)

1. "SUSY theories on curved manifolds,"
at "Workshop on Particle Physics 2013"
(Tokyo Inst. Tech. / Ibaraki Univ.)
Kusatsu Seminar-House,
November 2013.

2. "Gepner Construction of D-branes on K3,"
workshop "superstring theory and VOA",
Rikkyo University, February 2014.

Ken-Iti Izawa

Journal Papers

1. T. Imai and K.-I. Izawa,
"Minimal Fine Tuning in Supersymmetric Higgs Inflation,"
Prog. Theor. Exp. Phys. (2014) 053B01, YITP-13-37, arXiv:1305.5307 [hep-ph].

Masatoshi Murase

Journal Papers

1. M. Murase and T. Murase,
"Constructive Cognition: Extension of Self-nonself Cirulation Theory"
Journal of Quality Education 5 29-51 (2013).

2. M. Murase and T. Murase,
"Investigating Polluted Environment Adaptation Syndrome Based on Structuralism: A Perspective of Self-nonself Circulation Theory as a Unified Theory of Life,"
Jpn J. Clin. Ecol. Vol.22, No.2, 80-91, 2013.

Talks at International Conferences

1. "Theoretical Biology"
CC3DMR (Collaborateive Conference on 3D & Materials Research), 24-28, June, 2013.

Organizer of International Conferences

1. "The Global Partnership on Science Education through Engagement in Kyoto (GSEE/Kyoto),"
GSEE/Kyoto: Science Education in Kyoto, Date: Apr. 28 (Sun.), 2013, 10:00 - 20:00, Place: Panasonic Auditorium, Yukawa Memorial Hall, Kyoto University.

2. "The Global Partnership on Science Education through Engagement in Kyoto (GSEE/Kyoto),"
Let's Enjoy Science. Date: Oct. 20 (Sun.), 2013, 13:00 - 17:20 Venue: Clock Tower Centennial Hall, Kyoto University.

3. "The Global Partnership on Science Education through Engagement in Kyoto (GSEE/Kyoto),"
GSEE/Kyoto Summit: Initiatives that Can Change Science Education Date: Oct. 20 (Sun.) - Oct. 23 (Wed.), 2013, Venue: The Westin Miyako Kyoto.

Invited and Public Lectures (in Japan)

1. "Integrated Life Science and Medicine,"
Mie University, Graduate School of Medicine, May, 11, 2013.

2. "Structuralism and Living Systems,"
Kitazato University, June 8-9, 2013.

3. "Integrated Science and Constructive Cognition,"
Ritsumeikan University, Sep.9-13, 2013.

4. "Structuralism and biophysics,"
Kyoto Recearch Park, Nov. 28, 2013.

5. "Biophysics and Applications,"
Kyoto University, Sep. 27, 2013.

6. "Bioscience and Mathematics,"
Kyoto University, Oct. 18, 2013.

7. "Bioscience and Theories,"
Kyoto University, Nov. 12, 2013.

Hiroshi Kunitomo

Journal Papers

1. H. Kunitomo,
"The Ramond sector of the heterotic string field theory,"
Prog. Theor. Exp. Phys. **043B01** (2014) (28 pages), YITP-13-131, arXiv:1312.7197 [hep-th].

Akira Ohnishi

Journal Papers

1. K. Kamikado, T. Kunihiro, K. Morita, A. Ohnishi, "Functional Renormalization Group Study of Phonon Mode Effects on Chiral Critical Point", Prog. Theor. Exp. Phys. **2013** (2013), 053D01 [14 pages], YITP-12-90, arXiv:1210.8347 [hep-ph].

2. Masahiro Isaka, Masaaki Kimura, Akinobu Doté, Akira Ohnishi, “Splitting of the p orbit in triaxially deformed ${}^{25}_{\Lambda}$Mg", Phys. Rev. C **87** (2013), 021304(R) [5 pages].

3. Hideaki Iida, Teiji Kunihiro, Berndt Müller, Akira Ohnishi, Andreas Schäfer, Toru T. Takahashi, “Entropy production in classical Yang-Mills theory from Glasma initial conditions", Phys. Rev. D **88** (2013), 094006 [13 pages], YITP-13-10, arXiv:1304.1807 [hep-ph].

4. Hiroshi Ueda, Takashi Z. Nakano, Akira Ohnishi, Marco Ruggieri, Kohsuke Sumiyoshi, “QCD phase diagram at finite baryon and isospin chemical potentials in Polyakov loop extended quark meson model with vector interaction", Phys. Rev. D **88** (2013), 074006 [9 pages], YITP-13-26, arXiv:1304.4331 [nucl-th].

Books and Proceedings

1. Terukazu Ichihara, Takashi Z. Nakano, Akira Ohnishi, “QCD phase diagram at strong coupling including auxiliary field fluctuations", PoS **LATTICE 2013** (2013), 143, YITP-13-118, arXiv:1311.5352 [hep-lat].

2. Masahiro Isaka, Hiroaki Homma, Masaaki Kimura, Akinobu Dote, Akira Ohnishi, “Structure of Be Hyper Isotopes", Few Body Syst. **54** (2013), 1219.

3. Masahiro Isaka, Masaaki Kimura, Akinobu Doté, Akira Ohnishi, “Excited states with Λ hyperon in p-orbit in ${}^{25}_{\Lambda}$Mg", Nucl. Phys. A **914** (2013), 189.

4. A. Ohnishi, S. Cho, T. Furumoto, T. Hyodo, D. Jido, C. M. Ko, K. Morita, S. H. Lee, M. Nielsen, T. Sekihara, S. Yasui, K. Yazaki (ExHIC Collaboration), “Exotic hadrons and hadron-hadron interactions in heavy ion collisions", Nucl. Phys. A **914** (2013), 377, YITP-13-5, arXiv:1301.7261 [nucl-th].

5. Kohsuke Tsubakihara, Akira Ohnishi, “Three-body couplings in RMF and its effects on hyperonic star equation of state" Nucl. Phys. A **914** (2013), 438 YITP-12-97, arXiv:1211.7208 [nucl-th].

6. Masahiro Isaka, Hiroaki Homma, Masaaki Kimura, Akinobu Doté, Akira Ohnishi, “Structure of neutron-rich Be hyper isotopes", Few Body Syst. **54** (2013), 395.

Talks at International Conferences

1. “Explicit three-body couplings in RMF and its effects on symmetry energy”, Invited, in “3rd Int. Symp. on Nuclear Symmetry Energy”, NSCL/FRIB, East Lansing, Michigan, USA, July 2013.

2. “Phase diagram and a sign problem in lattice QCD at strong coupling”, in “New Frontiers in QCD 2013 — Insight into QCD matter from heavy-ion collisions —”, YITP, Kyoto, Japan, November 2013.

Invited Seminars (Overseas)

1. “Phase diagram and a sign problem in lattice QCD at strong coupling”, Yonsei University, Seoul, Korea, November 2013.

Invited Seminars (in Japan)

1. “Physics of Neutron Star Matter — current status and challenges —”, Dept. of Phys., Nagoya University, October 2013.

2. “Phase diagram and a sign problem in lattice QCD at strong coupling”, in “Lattice QCD at finite temperature and density”, KEK, Tsukuba, Japan, January 2014.

Misao Sasaki

Journal Papers

1. Y. l. Zhang, R. Saito, D. h. Yeom and M. Sasaki, JCAP **1402**, 022 (2014) [arXiv:1312.0709 [hep-th]].

2. A. Enea Romano, S. Sanes, M. Sasaki and A. A. Starobinsky, Europhys. Lett. **106**, 69002 (2014) [arXiv:1311.1476 [astro-ph.CO]].

3. S. Kanno, M. Sasaki and T. Tanaka, PTEP **2013**, no. 11, 111E01 (2013) [arXiv:1309.1350 [astro-ph.CO]].

4. X. Chen, H. Firouzjahi, E. Komatsu, M. H. Namjoo and M. Sasaki, JCAP **1312**, 039 (2013) [arXiv:1308.5341 [astro-ph.CO]].

5. M. Sasaki, D. h. Yeom and Y. l. Zhang, Class. Quant. Grav. **30**, 232001 (2013) [arXiv:1307.5948 [gr-qc]].

6. J. White, M. Minamitsuji and M. Sasaki, JCAP **1309**, 015 (2013) [arXiv:1306.6186 [astro-ph.CO]].

7. J. O. Gong, S. Pi and M. Sasaki, JCAP **1311**, 043 (2013) [arXiv:1306.3691 [hep-th]].
8. X. Chen, H. Firouzjahi, M. H. Namjoo and M. Sasaki, JCAP **1309**, 012 (2013) [arXiv:1306.2901 [hep-th]].
9. A. Naruko, C. Pitrou, K. Koyama and M. Sasaki, Class. Quant. Grav. **30**, 165008 (2013) [arXiv:1304.6929 [astro-ph.CO]].
10. L. Alabidi, K. Kohri, M. Sasaki and Y. Sendouda, JCAP **1305**, 033 (2013) [arXiv:1303.4519 [astro-ph.CO]].
11. J. O. Gong and M. Sasaki, Class. Quant. Grav. **30**, 095005 (2013) [arXiv:1302.1271 [astro-ph.CO]].

Books and Proceedings
Talks at International Conferences

1. "Violating Non-Gaussianity Consistency Relation in Single Field Inflation," Invited, in "IEU Cosmology Conference 2013, Reconstructing the Universe," Ewha Womans University, Seoul, Korea, 5 June, 2013.
2. "Delta N and related topics," Invited Lectures, in "DGP Cosmology School," Physics Center, Bad Honnef, Germany, 11 July, 2013.
3. "Curvature perturbation in non-minimally coupled multi-scalar models of inflation," Invited, in "KITPC Program: Cosmology After Planck," KITPC, Beijing, China, 26 July, 2013.
4. "Evading the non-Gaussianity consistency relation in single field inflation," Invited, in "New Challenges for Early Universe Cosmologists," Lorentz Center, Leiden University, Netherlands, 7 August, 2013.
5. "Evading non-Gaussianity consistency in single field inflation," Plenary, in "International Workshop on Particle Physics and Cosmology after Higgs and Planck," Chongqing University of Posts and Telecommunications, Chongqing, China, 6 September, 2013.
6. "Curvature perturbation in non-minimally coupled multi-field inflation and its conformal frame dependence," Invited, in "Symposium on Gravity and Light," IPMU, University of Tokyo, Kashiwa, Japan, 1 October, 2013.
7. "CMB dipolar statistical anisotropy," Invited, in "SKKU Symposium on Astrophysics and Cosmology 2013," Sungkyunkwan University, Suwan, Korea, 2 December, 2013.

Invited Seminars (Overseas)

1. "Inflation and cosmological perturbations – from fantasy to precision cosmology – " Colloquium at University of Barcelona, Barcelona, Spain, 8 May 2013.
2. "Inflation and cosmological perturbations," Northwesst University, Xian, China, 29 July, 2013.

Invited Seminars (in Japan)

1. "CMB dipolar statistical anisotropy - a signature of string theory landscape? -" Kobe University, Kobe, 25 December, 2013.

Public Lectures

1. "New perspectives in cosmology" in "GSEE Symposium: Let's Enjoy Science!" Kyoto University, Kyoto, 20 October, 2013.
2. "Recent trends in cosmology," in "IOP Spring Seminar and Reception," British Embassy, Tokyo, 25 March, 2014.

Naoki Sasakura

Journal Papers

1. N. Sasakura and Y. Sato, "Interpreting canonical tensor model in minisuperspace," Phys. Lett. **B732** (2014) 32-35, arXiv:1401.2062 [hep-th], YITP-14-1.
2. N. Sasakura, "Quantum canonical tensor model and an exact wave function," Int. J. Mod. Phys. A **28** (2013) 1350111 (18 pages), arXiv:1305.6389 [hep-th], YITP-13-36.

Books and Proceedings

1. N. Sasakura, "Quantization of the canonical tensor model and an exact wave function," J. Phys. Conf. Ser. **490** (2014) 012014 (4 pages).

Invited Seminars (in Japan)

1. “Quantization of the canonical tensor model and an exact wave function,”
KEK, September 2013 (in Japanese, in the meeting “Discrete approaches to dynamics of field and space-time").

Masaru Shibata

Journal Papers

1. M. Shibata and K. Kawguchi,
“Virial relation and first law in scalar-tensor theories of gravity”,
Phys. Rev. D **87** (2013) 104031-1–12.

2. K. Kyutoku, K. Ioka, and M. Shibata,
“Anisotropic mass ejection from black hole-neutron star binaries: Diversity of electromagnetic counterparts”,
Phys. Rev. D **88** (2013) 041503 (R)-1–6.

3. J.S. Read, L. Baiotti, J. D. E. Creighton, J. L. Friedman, B. Giacomazzo, K. Kyutoku, C. Markakis, L. Rezzolla, M. Shibata, and K. Taniguchi,
“Matter effect on binary neutron star waveforms”,
Phys. Rev. D **88** (2013) 044021-1–21

4. K. Hotokezaka, K. Kiuchi, K. Kyutoku, T. Muranushi, Y. Sekiguchi, M. Shibata, and T. Taniguchi,
“Remnant massive neutron stars of binary neutron star mergers: Evolution process and gravitational waveform”,
Phys. Rev. D **88** (2013) 044026-1–30.

5. F. Pannarale, E. Berti, K. Kyutoku, and M. Shibata,
“Nonspinning black hole-neutron star mergers: a model for the amplitude of gravitational waveforms”,
Phys. Rev. D **88** (2013) 084011-1–21.

6. K. Hotokezaka, K. Kyutoku, M. Tanaka, K. Kiuchi, Y. Sekiguchi, M. Shibata, and S. Wanajo,
“Progenitor Models of the Electromagnetic Transient Associated with the Short GRB 130603B”,
Astrophys. J. Lett. **778** (2013) L6.

7. K. Kyutoku, K. Ioka, and M. Shibata,
“Ultra-Relativistic Counterparts to Binary Neutron Star Mergers in Every Direction, X-ray-to-Radio Bands and Second-to-Day Timescales”,
Mon. Not. R. Astron. Soc. **437** (2014) L6.

8. M. Tanaka, K. Hotokezaka, K. Kyutoku, S. Wanajo, K. Kiuchi, Y. Sekiguchi, and M. Shibata,
“Radioactively Powered Emission from Black Hole-Neutron Star Mergers 130603B”,
Astrophys. J. **780** (2014) 31.

9. B.D. Lackey, K. Kyutoku, M. Shibata, P.R Brady, and J.L. Friedman,
“Extracting equation of state parameters from black hole-neutron star mergers: aligned-spin black holes and a preliminary waveform model”,
Phys. Rev. D **89** (2014) 043009-1–22.

10. H. Nagakura, K. Hotokezaka, Y. Sekiguchi, M. Shibata, and K. Ioka,
“Jet Collimation in the Ejecta of Double Neutron Star Merger: New Canonical Picture of Short Gamma-ray Bursts”,
Astrophys. J. Lett. **784** (2014) L28.

Talks at International Conferences

1. “Merger of binary neutron stars in numerical relativity: status and issues” (invited) in “Gravitational Wave Tests of Alternative Theories of Gravity in the Advanced Detector Era”, Boseman, USA, April 5–7, 2013.

2. “Coalescence and explosion of compact neutron star binaries” (invited) in “ICTS program on numerical relativity”, Bangalore, India, June 24–July 5, 2013.

3. “Merger of binary neutron stars” in “20th international conference on general relativity and gravitation”, Warsaw, Poland, July 8–13, 2013.

4. “Mass ejection and electromagnetic counterparts of neutron-star-binary mergers” in “CoCoNut meeting 2013”, Meudon, France, Dec. 4–6, 2013.

5. “Revising stability of 5D Myers-Perry black hole in the Z4c formalism” (invited) in “New frontier in dynamical gravity”, Cambridge, UK, March 24–28, 2014.

Invited Seminars (Overseas)

1. “Mass ejection and electromagnetic counterparts of neutron-star-binary mergers”, at colloquium of Dept. of Phys., University of Wisconsin-Milwaukee, USA, Oct. 11, 2013.

2. "Gravitational waves and electromagnetic counter parts of binary neutron star mergers," at Caltech/JPL Association for Gravitational-Wave Research Seminar Series, Caltech, USA, March 11, 2014.

Invited Seminars (in Japan)

1. “Mass ejection and electromagnetic counterparts of neutron-star-binary mergers”, Dept. of Phys., Rikkyo Univ., Dec. 17, 2013.

2. “Mass ejection and electromagnetic counterparts of neutron-star-binary mergers”, Center for Computational Science, Tsukuba Univ., Jan. 29, 2014.

Yudai Suwa

Journal Papers

1. K. Kashiyama, D. Nakauchi, Y. Suwa, H. Yajima, and T. Nakamura “Luminous Supernova-like UV/Optical/Infrared Transients Associated with Ultra-long Gamma-Ray Bursts from Metal-poor Blue Supergiants,” Astrophys. J. **770** (2013) 8 (9 pages), YITP-13-137, arXiv:1212.6431 [astro-ph.HE].

2. D. Nakauchi, K. Kashiyama, Y. Suwa, and T. Nakamura, “Blue Supergiant Model for Ultra-Long Gammay-Ray Burst with Superluminous-Supernova-Like Bump,” Astrophys. J. **778** (2013) 67 (11 pages), YITP-13-138, arXiv:1307.5061 [astro-ph.HE].

3. T. Fischer, M. Hempel, I. Sagert, Y. Suwa, and J. Schaffner-Bielich, “Symmetry energy impact in simulations of core-collapse supernovae” Eur. Phys. J. A **50** (2014) 46 (18 pages), arXiv:1307.6190 [astro-ph.HE].

4. Y. Takamori, H. Okawa, M. Takamoto, and Y. Suwa, “An Alternative Numerical Method for the Stationary Pulsar Magnetospheres in the Force-Free System” Publ. Astron. Soc. Japan **66** 25 (17 pages), arXiv:1209.3855 [astro-ph.HE].

Fumihiro Takayama

Talks at International Conferences

1. “From Glasma to Quarkyonic,” SKKU International Symposium on Astrophysics and Cosmology from Particle to Universe, Sungkyunkwan Univ., Suwon, R.Korea, December 2013.

Tadashi Takayanagi

Journal Papers

1. K. Narayan, T. Takayanagi and S. P. Trivedi, “AdS plane waves and entanglement entropy,” JHEP **1304** (2013) 051, [arXiv:1212.4328 [hep-th]].

2. M. Nozaki, T. Numasawa and T. Takayanagi, “Holographic Local Quenches and Entanglement Density,” JHEP **1305** (2013) 080 [arXiv:1302.5703 [hep-th]].

3. M. Nozaki, T. Numasawa, A. Prudenziati and T. Takayanagi, “Dynamics of Entanglement Entropy from Einstein Equation,” Phys. Rev. D **88** (2013) 2, 026012 [arXiv:1304.7100 [hep-th]].

4. J. Bhattacharya and T. Takayanagi, “Entropic Counterpart of Perturbative Einstein Equation,” JHEP **1310** (2013) 219 [arXiv:1308.3792 [hep-th]].

5. N. Shiba and T. Takayanagi, “Volume Law for the Entanglement Entropy in Non-local QFTs,” JHEP **1402** (2014) 033 [arXiv:1311.1643 [hep-th]].

6. A. Mollabashi, M. Nozaki, S. Ryu and T. Takayanagi, “Holographic Geometry of cMERA for Quantum Quenches and Finite Temperature,” JHEP **1403** (2014) 098 [arXiv:1311.6095 [hep-th]].

7. M. Nozaki, T. Numasawa and T. Takayanagi, "Quantum Entanglement of Local Operators in Conformal Field Theories," Phys. Rev. Lett. **112** (2014) 111602 [arXiv:1401.0539 [hep-th]].

Talks at International Conferences

1. "Property of EntanglementEntropy for Excited States," Invited, Workshop: Emergence and Entanglement II, Perimeter Institute, Waterloo, Canada, May, 2013.
2. "Holographic Entanglement Entropy," Invited, lectures given at Holography 2013 :Gauge/gravity duality and strongly correlated systems, APCTP, Pohang, Korea, June, 2013.
3. "Holographic Entanglement Entropy of Excited States," Invited, Strings 2013, Sogang University, Seoul, Korea, June, 2013.
4. "Entanglement Entropy and Gravity/Condensed Matter Correspondence," Invited, Plenary Lecture at The 20th International Conference on General Relativity and Gravitation (GR20), Uniwersytet Warszawski, Warsaw, Poland, July, 2013.
5. "Holographic Entanglement Entropy of Excited States," Invited, Gauge/Gravity Duality 2013, Max Planck Institute for Physics, Munich, Germany, July, 2013.
6. "Entanglement Entropy and AdS/CFT," Invited, Lectures at Arnold Sommerfeld School 'Gauge-gravity duality and condensed matter physics', Munich, Germany, Aug., 2013.
7. "Excited States and Holographic Entanglement Entropy," Invited, Mathematics and Physics of the Holographic Principle, Isaac Newton Institute for Mathematical Sciences, Cambridge, UK, Oct., 2013.
8. "Quantum entanglement and holographic spacetime," Invited, plenary talk at19th International Symposium on Particle, Strings and Cosmology (PASCOS), Taipei, Taiwan, Nov., 2013.
9. "Quantum Entanglement of Local Operators in Conformal Field Theories," Invited, International Symposium RIKKYO MathPhys 2014, Jan., 2014.
10. "Quantum Entanglement and Holography ," Invited, lectures at 8th Asian Winter School, Puri, India, Jan., 2014.
11. "Time Evolution of Entanglement Entropy for Local Operator Excitations in Conformal Field Theories," Invited, Aspen Winter Conference: New Perspectives on Thermalization: Condensed Matter, Quantum Information, QCD and String Theory, Aspen, USA, March, 2014.
12. "Entanglement Entropy and Spacetime," Invited, Lectures at Spring School on Superstring Theory and Related Topics, Trieste, Italy, March, 2014.

Talks at Domestic Conferences

1. "AdS/CFT and MERA," Invited, in "Symposium: Entanglement between Information, Quantum Physics and Geometry" at JPS meeting, Tokai U., Kanagawa, Japan, March 2014.

Takahiro Tanaka

Journal Papers

1. S. Kanno, M. Sasaki and T. Tanaka, "A viable explanation of the CMB dipolar statistical anisotropy," PTEP **2013** (2013) 11, 111E01, YITP-13-79 arXiv:1309.1350 [astro-ph.CO].
2. T. Tanaka and Y. Urakawa, "Loops in inflationary correlation functions," Class. Quant. Grav. **30** (2013) 233001, YITP-13-78 arXiv:1306.4461 [hep-th].
3. J. Garriga, S. Kanno and T. Tanaka, "Rest frame of bubble nucleation," JCAP **1306** (2013) 034, YITP-13-77 arXiv:1304.6681 [hep-th].
4. A. De Felice, T. Nakamura and T. Tanaka, "Possible existence of viable models of bi-gravity with detectable graviton oscillations by gravitational wave detectors," PTEP **2014** (2014) 4, 043E01, YITP-13-76 arXiv:1304.3920 [gr-qc].

5. S. Isoyama, R. Fujita, H. Nakano, N. Sago and T. Tanaka,
"Evolution of the Carter constant for resonant inspirals into a Kerr black hole: I. The scalar case,"
PTEP **2013** (2013) 6, 063E01, YITP-12-102 arXiv:1302.4035 [gr-qc].

6. K. Yagi, L. C. Stein, N. Yunes and T. Tanaka,
"Isolated and Binary Neutron Stars in Dynamical Chern-Simons Gravity,"
Phys. Rev. D **87** (2013) 084058, YITP-13-75 arXiv:1302.1918 [gr-qc].

7. T. Tanaka and Y. Urakawa,
"Strong restriction on inflationary vacua from the local gauge invariance II: Infrared regularity and absence of secular growth in the Euclidean vacuum,"
PTEP **2013** (2013) 6, 063E02, YITP-13-74 arXiv:1301.3088 [hep-th].

8. T. Tanaka and Y. Urakawa,
"Strong restriction on inflationary vacua from the local gauge invariance I: Local gauge invariance and infrared regularity,"
PTEP **2013** (2013) 8, 083E01, YITP-12-110 arXiv:1209.1914 [hep-th].

Talks at International Conferences

1. " Memory of initial condition in de Sitter space,"
JPS meeting, Tokai university, March 2014.

2. "Graviton Oscillation in viable model of bigravity,"
in GWPAW, Pune, India, Dec. 2013.

3. "A viable explanation of the CMB dipolar statistical anisotropy,"
in New Perspectives on Cosmology, Pohang, Korea, Nov. 2013.

4. "Gravitational wave Oscillation in bi-metric gravity,"
in CosPA, Hawaii, USA, Nov. 2013.

5. "Graviton Oscillation in viable bigravity models,"
in JGRG, Hirosaki university, Nov. 2013.

6. "Adiabatic evolution of the constants of motion in resonance (I),"
in Capra Meeting, Dublin, Ireland, July 2013.

7. "How about modified propagation of Gravitational waves?," invited,
in Gravitational Wave Tests of Alternative Theories of Gravity in the Advanced Detector Era, Montana State university, USA, April 2013.

Invited Seminars (Overseas)

1. "Graviton Oscillation in a viable bigravity model,"
Heidelberg university, Germany, Sep. 2013.

2. "Graviton Oscillation in a viable bigravity model,"
Barcelona university, Spain, Sep. 2013.

3. "Adiabatic evolution of extreme mass-ratio inspiral,"
Montana State university, USA, April. 2013.

Invited Seminars (in Japan)

1. "Inflationary cosmology after Planck,"
Kyoto-sangyo university, May 2013.

2. "Possible existence of viable models of bigravity with detectable graviton oscillations by gravitational wave detectors,"
IPMU, May. 2013.

3. "Graviton Oscillation in a viable bigravity model,"
Kobe university, Nov. 2013.

4. "Infrared Phenomena of Field Theory in de Sitter space
Riken, Dec. 2013.

Atsushi Taruya

Journal Papers

1. K. Masuda, T. Hirano, A. Taruya, M. Nagasawa and Y. Suto,
"Characterization of the KOI-94 System with Transit Timing Variation Analysis: Implication for the Planet-Planet Eclipse,"
Astrophys. J. **778**, (2013) id.185 (16 pages), YITP-13-90, arXiv:1310.5771 [astro-ph].

2. A. Oka, S. Saito, T. Nishimichi, A. Taruya and K. Yamamoto,
"Simultaneous constraints on the growth of structure and cosmic expansion from the

multipole power spectra of the SDSS DR7 LRG sample,"
Mon. Not. Royal. Soc. **439** (2014) 2515-2530, YITP-13-92, arXiv:1310.2820[astro-ph].

3. A. Taruya, K. Koyama, T. Hiramatsu, A. Oka,
"Beyond consistency test of gravity with redshift-space distortions at quasilinear scales,"
Phys. Rev. D **89** (2014) id.043509 (18 pages), YITP-13-93, arXiv:1309.6783[astro-ph].

4. S. Yokoyama, T. Matsubara, A. Taruya,
"Halo/galaxy bispectrum with primordial non-Gaussianity from integrated perturbation theory,"
Phys. Rev. D **89** (2014) id.043524 (21 pages), YITP-13-94, arXiv:1310.4925[astro-ph].

5. Y. Xue, Y. Suto, A. Taruya, T. Hirano, Y. Fujii, K. Masuda,
"Tidal Evolution of the Spin-Orbit Angle in Exoplanetary Systems,"
Astrophy. J. **784** (2014) id.66 (9 pages), arXiv:1401.5876[astro-ph].

Talks at International Conferences

1. "Beyond consistency test of gravity with redshift-space distortions at quasilinear scales," Plenary,
in workshop on "Origin of cosmic structures : numerical and theoretical approaches," at GRAVASCO meeting, Institut Henri Poincaré, Paris, France,
November 2013.

2. "Confronting Planck cosmology with large-scale structure observations," Invited,
in "The CMB and theories of the primordial universe,", YITP, Japan,
August 2013.

3. "Large-scale structure and precision cosmology," Invited,
in "APC-YITP collaboration: mini-workshop on gravitation and cosmology,", YITP-X-13-03, Japan,
February 2014.

Invited Seminars (Overseas)
Invited Seminars (in Japan)

1. "Non-Equilibrium Evolution of Self-Gravitating Many-Body Systems,"
Dept. of Phys., Osaka City Univ., November 2013 (in Japanese).

2. "Cosmology with Large-Scale Structure: Progress on Perturbative Approach,"
Dept. of Astronomy, Kyoto Univ., November 2013 (in Japanese).

Seiji Terashima

Journal Papers

1. S. Sugishita and S. Terashima,
"Exact Results in Supersymmetric Field Theories on Manifolds with Boundaries,",
JHEP **1311** (2013) 021, YITP-13-72, arXiv:1308.1973 [hep-th].

2. K. Sakai and S. Terashima,
"Integrability of BPS equations in ABJM theory,"
JHEP **1311** (2013) 002, YITP-13-80, arXiv:1308.3583 [hep-th].

3. T. Nosaka and S. Terashima,
"Supersymmetric Gauge Theories on a Squashed Four-Sphere,"
JHEP **1312** (2013) 001, YITP-13-112 arXiv:1310.5939 [hep-th].

Talks at International Conferences

1. "On M5-branes in ABJM theory," Invited,
in "Todai/Riken joint workshop on Super Yang-Mills, solvable systems and related subjects,"University of Tokyo, Tokyo, Japan,
October 2013.

Invited Seminars (in Japan)

1. "Brick Walls for Black Holes in AdS/CFT,"
Osaka Univ., June 2013.

2. "On M5-branes solutions in ABJM theory,"
Komaba, Univ. of Tokyo, October 2013 (in Japanese).

3. "Exact results in supersymmetric field theories on manifolds with boundaries,"
Riken, October 2013 (in Japanese).

4. "Exact results in SUSY gauge theories," (Series Lectures)
Tohoku Univ., January 2014 (in Japanese).

Keisuke Totsuka

Journal Papers

1. H. Nonne, M. Moliner, S. Capponi, P. Lecheminant and K. Totsuka, "Symmetry-protected topological phases of alkaline-earth cold fermionic atoms in one dimension", Europhys. Lett. **102** (2013) 37008 (6 pages), arXiv:1210.2072 [cond-mat].

2. K. Hasebe and K. Totsuka, "Topological Many-Body States in Quantum Antiferromagnets via Fuzzy Supergeometry", Symmetry **5** (2013) 119 (96 pages), arXiv:1303.2287 [hep-th].

Talks at International Conferences

1. "Symmetry-protected topological phases of alkaline-earth ultra-cold fermionic atoms in one dimension", in "Emergent Quantum Phenomena in Condensed Matter," Institute for Solid State Physics, Kashiwa, Japan, June 2013.

2. "Symmetry-protected topological phases of alkaline-earth ultra-cold fermionic atoms in one dimension", in "International Conference on Statistical Physics (STATPHYS25)," Seoul National University, Seoul, Korea, July 2013.

3. "Symmetry-protected topological phases of alkaline-earth ultra-cold fermionic atoms in one dimension", in "Trends in the Theory of Correlated Materials (TTCM13)," École Polytechnique Fédéral de Lausanne, Lausanne, Switzerland, October 2013.

Yu Watanabe

Journal Papers

1. Ken Funo, Yu Watanabe, and Masahito Ueda "Thermodynamic work gain from entanglement" Phys. Rev. A 88, 052319 (2013).

2. Ken Funo, Yu Watanabe, and Masahito Ueda "Integral quantum fluctuation theorems under measurement and feedback control" Phys. Rev. E 88, 052121 (2013).

3. Yui Kuramochi, Yu Watanabe and Masahito Ueda "Simultaneous continuous measurement of photon-counting and homodyne detection on a free photon field: dynamics of state reduction and the mutual influence of measurement backaction" J. Phys. A: Math. Theor. vol.46 425303 (2013).

Books and Proceedings

1. Yu Watanabe "Formulation of Uncertainty Relation Between Error and Disturbance in Quantum Measurement by Using Quantum Estimation Theory" Springer, 2014 (ISBN: 978-4-431-54492-0).

Talks at International Conferences

1. Yu Watanabe, "Random matrix study of time scale of thermalization after a quantum quench," in Interdisciplinary mini-workshop on nonequilibrium physics, at Kyoto University, December 2013.

Invited Seminars (in Japan)

1. "Eigenstate Randomization Hypothesis: a thermalization mechanism on isolated quantum systems," Institute for Molecular Science, Okazaki, April 2013 (Ohmori group meeting).

2. "Quantum fluctuation theorems under measurement and feedback control," Nagoya Niversity, Nagoya, August 2013 (Tanimura group meeting).

3. "Theory of simultaneous continuous measurement process of photon counting and homodyne detection," Nagoya Niversity, Nagoya, August 2013 (Tanimura group meeting).

4. "Formulations of uncertainty relation by using quantum estimation theory," Osaka City University, Osaka, November 2013 (Sugita group meeting).

2.2.3 Publications and Talks by Research Fellows and Graduate Students (April 2013– March 2014)

Naofumi Hama

Journal Papers

1. N. Hama and K. Hosomichi,
   "AGT relation in the light asymptotic limit," JHEP **1310**, 152 (2013), YITP-13-70, arXiv:1307.8174 [hep-th].

Talks at International Conferences

1. "Seiberg-Witten Theories on Ellipsoids," in "Sakura in Saclay," Saclay, Paris, France,May 2013.
2. "AGT relation in the light asymptotic limit," in "PASCOS 2013," Taipei, Taiwan,November 2013.

Invited Seminars (Overseas)

1. "AGT relation in the light asymptotic limit," National Taiwan University, Taipei, Taiwan,November 2013.

Invited Seminars (in Japan)

1. "AGT relation in the light asymptotic limit," Dept. of Phys., Univ. of Tokyo, October 2013 (in Japanese).
2. "BMN行列模型のラージN極限について," 岡山光量子研究所, December 2013. (in Japanese)
3. "超対称行列量子力学とゲージ/重力対応," Dept. of Phys., Tsukuba Univ., March 2014 (in Japanese).

Goro Ishiki

Journal Papers

1. M. Honda, G. Ishiki, S. -W. Kim, J. Nishimura and A. Tsuchiya, "Direct test of the AdS/CFT correspondence by Monte Carlo studies of N=4 super Yang-Mills theory," JHEP **1311**, 200 (2013) [arXiv:1308.3525 [hep-th]].

Invited Seminars (in Japan)

1. "Large-N reduction for $\mathcal{N}=4$ super Yang-Mills theory,"
   Dept. of Phys., Tohoku Univ., December 2013 (in Japanese).

Hirotaka Irie

Journal Papers

1. C. T. Chan, H. Irie and C. H. Yeh,
   "Duality Constraints on String Theory I: Instantons and spectral networks," arXiv:1308.6603 [hep-th], YITP-13-64.

Talks at International Conferences

1. "Vacuum Connection Formula and Duality Bootstrap for Strings," Invited,
   in "Integrability, Symmetry and Quantum Space-Time (ISAQS) 2014," YITP, Kyoto University, Kyoto, Japan,
   Jan 2014

Invited Seminars (Overseas)

1. "Stokes Phenomena and Quantum Integrability in Non-critical String/M Theory," CQUeST, Sogang University, Korea, September 2013.
2. "Duality Constraints on String Theory," CQUeST, Sogang University, Korea, September 2013.
3. "Duality Constraints on String Theory," String Seminar, National Taiwan University, Taiwan, September 2013.

Invited Seminars (in Japan)

1. "Duality Constraints on String Theory," Dept. of Phys., Kyoto University, November 2013.

Wakana Iwakami

Talks at International Conferences

1. "Various Flow Patterns behind the Accretion Shock Wave for Core-Collpase Supernovae," (poster),
   in "Supernovae and Gamma-Ray Bursts 2013," Yukawa Institute for Theoretical Physics, Kyoto University, Japan,
   Octorber 2013.

2. "Parametric Study of Explosion for Rotational Core-Collapse Supernovae," (oral),
   in "Multi-Messengers from Core-Collapse Supernovae," Fukuoka University, Japan,
   December 2013.

Invited Seminars (in Japan)

1. "Parametric Study of Flow Patterns behind the Standing Accretion Shock Wave for Core-Collapse Supernovae,"
   National Astronomical Observatory of Japan, January 2014.

Kiyoshi Kanazawa

Journal Papers

1. K. Kanazawa, T. Sagawa, and H. Hayakawa,
   "Heat conduction induced by non-Gaussian athermal fluctuations,"
   Phys. Rev. **E87** (2013) 052124 (10 pages), arXiv:1209.2222 [cond-mat].

Talks at International Conferences

1. "Heat conduction induced by non-Gaussian athermal fluctuations,"
   in "Statphys25,", Seoul National University, Seoul, South Korea,
   July 2013.

2. "Heat conduction induced by non-Gaussian athermal fluctuations,"
   in "Frontier of Statistical Physics and Information Processing 2013,", Yukawa Institute for Theoretical Physics, Kyoto, Japan
   July 2013.

3. "Heat conduction induced by non-Gaussian athermal fluctuations,"
   in "Physics of Granular Flows,", Yukawa Institute for Theoretical Physics, Kyoto, Japan
   July 2013.

Invited Seminars (in Japan)

1. "Energy transport driven by athermal non-Gaussian fluctuations,"
   The Institute for Solid State Physics, The University of Tokyo, February 2014.

2. "Heat conduction induced by non-Gaussian athermal fluctuations,"
   NTT Basic Research Laboratories, May 2013 (in Japanese).

Yusuke Kimura

Journal Papers

1. A. P. Braun, Y. Kimura and T. Watari,
   "The Noether-Lefschetz problem and gauge-group-resolved landscapes: F-theory on K3xK3 as a test case,"
   JHEP **1404** (2014) 050 (89 pages), YITP-13-129, arXiv:1401.5908 [hep-th].

Talks at International Conferences

1. "F-theory on K3xK3 and Gauge-Group-Resolved Landscape,"
   Poster Presentation,
   in "KEK Theory Workshop 2014," KEK, Tsukuba, Japan,
   February 2014.

Invited Seminars (in Japan)

1. "F-theory on K3xK3 and landscape,"
   Dept. of Phys., Kochi Univ., September 2013 (JPS Autumn Meeting).

Hiroyuki Nakano

Journal Papers

1. S. Isoyama, R. Fujita, H. Nakano, N. Sago and T. Tanaka,
   "Evolution of the Carter constant for resonant inspirals into a Kerr black hole: I. The scalar case,"
   PTEP **2013**, no. 6, 063E01 (2013)
   [arXiv:1302.4035 [gr-qc]].

2. I. Hinder, A. Buonanno, M. Boyle, Z. B. Etienne, J. Healy, N. K. Johnson-McDaniel, A. Nagar and H. Nakano *et al.*, "Error-analysis and comparison to analytical models of numerical waveforms produced by the NRAR Collaboration," Class. Quant. Grav. **31**, 025012 (2014) [arXiv:1307.5307 [gr-qc]].

Talks at International Conferences

1. "Analytical Modeling for Binary Black Holes", (poster presentation) Yukawa International Seminar 2013 – Gravitational Waves –, YITP, Kyoto University, Japan, June 2013.

2. "Spin-Regge-Wheeler-Zerilli formalism and gravitational waves", (poster presentation) The 23rd Workshop on General Relativity and Gravitation in Japan, Hirosaki University, Japan, November 2013.

Toshiya Namikawa

Journal Papers

1. T. Namikawa, and R. Takahashi, "Bias-Hardened CMB Lensing with Polarization," MNRAS **438** (2014) 1507-1517 (11 pages), YITP-13-110, arXiv:1310.2372 [astro-ph.CO].

2. T. Namikawa, D. Yamauchi and A. Taruya, "Constraining cosmic string parameters from curl mode of CMB lensing," Phys. Rev. **D88** (2013) 083525, YITP-13-83, arXiv:1308.6068 [astro-ph.CO].

Daisuke Nomura

Invited Seminars (in Japan)

1. Lectures on "Indirect searches for new physics," at "Flavor Physics Workshop 2013," Iseshima, November 28, 2013.

2. "Status of muon $g-2$ calculation," at "The 7th collaboration meeting on muon $g-2$/EDM experiments at J-PARC," KEK, December 6, 2013.

Noburo Shiba

Journal Papers

1. N. Shiba and T. Takayanagi, "Volume Law for the Entanglement Entropy in Non-local QFTs," JHEP 1402 (2014) 033 (16 pages), YITP-13-115, arXiv:1311.1643 [hep-th]

Invited Seminars (in Japan)

1. "Volume Law for the Entanglement Entropy in Non-local QFTs," YITP, Kyoto Univ., December 2013.

Masaki Shigemori

Journal Papers

1. M. Shigemori, "Perturbative 3-charge microstate geometries in six dimensions," JHEP **10** (2013) 169 (23 pages), YITP-13-66, arXiv:1307.3115 [hep-th].

2. H. Awata, S. Hirano and M. Shigemori, "The Partition Function of ABJ Theory," Prog. Theor. Exper. Phys., **2013** (2013) 053B04 (39 pages), arXiv:1212.2966 [hep-th].

3. J. de Boer and M. Shigemori, "Exotic Branes in String Theory," Phys. Rep., **532** (2013) 65 (54 pages), arXiv:1209.6056 [hep-th].

Books and Proceedings

1. M. Shigemori, "Exotic branes and black hole microstates," Int. J. Mod. Phys. Conf. Ser. **21** (2013) 77.

Talks at International Conferences

1. "Aspects of exotic branes," Invited, in "Fourth Joburg Workshop on String Theory," University of Witwatersrand, Johannesburg, South Africa, September 2013.

2. "Aspects of exotic branes," Invited, in "KIAS-YITP joint workshop 2013 — String Theory, Black Holes and Holography," Yukawa Institute for Theoretical Physics, Kyoto, Japan, July 2013.

Invited Seminars (Overseas)

1. "Aspects of exotic branes",
CEA Saclay, France, November 2013.

2. "Aspects of exotic branes",
Nikhef, Netherlands, October 2013.

Invited Seminars (in Japan)

1. "Classifying codimension-2 branes in three dimensions",
Kansai particle seminars, Osaka, December 2013.

2. "Aspects of exotic branes",
Tsukuba University, July 2013.

3. "Aspects of exotic branes",
Tohoku University, May 2013.

Satoshi Takada

Books and Proceedings

1. S. Takada and H. Hayakawa,
"Pattern dynamics of cohesive granular particles under plane shear,"
AIP Conf. Proc. **1542** (2013) 819 (4 pages), arXiv:1211.3801[cond-mat].

Jonathan White

Journal Papers

1. J. White, M. Minamitsuji and M. Sasaki
"Non-linear curvature perturbation in multi-field inflation models with non-minimal coupling,"
JCAP **1309** (2013) 015 (32 pages), YITP-13-51, arXiv:1306.6186 [astro-ph.CO].

Talks at International Conferences

1. "Non-linear curvature perturbation in multi-field inflation with non-minimal coupling," (poster presentation)
in "CMB2013," OIST, Okinawa, Japan, June 2013.

2. "Curvature perturbation in multi-field inflation models with non-minimal coupling,"
in "The CMB and theories of the primordial universe," YITP, Kyoto, Japan,
August - September 2013.

Takashi Yoshida

Journal Papers

1. K. Takahashi, T. Yoshida and H. Umeda,
"Evolution of progenitors for electron capture supernovae,"
Astrophys. J. **771** (2013) 28 (13 pages), arXiv:1302.6402 [astro-ph].

2. T. Yoshida, S. Okita and H. Umeda,
"Type Ic core-collapse supernova explosions evolved from very massive stars,"
Mon. Not. R. Astron. Soc. **438** (2014) 3119-3127, arXiv:1312.7043 [astro-ph].

Invited Seminars (in Japan)

1. "Evolution of massive stars,"
Hotel Shikisai, Kanagawa, October 2013 (Meeting for Theoretical Astronomy).

Yuichiro Sekiguchi

Journal Papers

1. K. Hotokezaka, K. Kiuchi, K. Kyutoku, T. Muranushi, Y. Sekiguchi, M. Shibata and K. Taniguchi,
"Remnant massive neutron stars of binary neutron star mergers: Evolution process and gravitational waveform,"
Phys. Rev. **D88** (2013) 044026 (30 pages), arXiv:1307.5888 [astro-ph.HE].

2. K. Hotokezaka, K. Kyutoku, M. Tanaka, K. Kiuchi, Y. Sekiguchi, M. Shibata and S. Wanajo,
"Progenitor Models of the Electromagnetic Transient Associated with the Short Gamma Ray Burst 130603B,"
Astrophys. J. Lett. **778** (2013) L16 (5 pages), arXiv:1310.1623 [astro-ph.HE].

3. M. Tanaka, K. Hotokezaka, K. Kyutoku, S. Wanajo, K. Kiuchi, Y. Sekiguchi and M. Shibata
"Radioactively Powered Emission from Black Hole-Neutron Star Mergers,"
Astrophys. J. **780** (2013) 31 (9 pages), arXiv:1310.2774 [astro-ph.HE].

4. H. Nagakura, H. Hotokezaka, Y. Sekiguchi and M. Shibata,
"Jet Collimation in the Ejecta of Double

Neutron Star Mergers: A New Canonical Picture of Short Gamma-Ray Bursts,"
Astrophys. J. Lett. **784** (2014) L28 (5 pages), arXiv:1403.0956 [astro-ph.HE].

Talks at International Conferences

1. "Electromagnetic counterparts of compact binary mergers," Invited,
   in "KAGRA face to face meeting," Toyama University, Toyama, Japan,
   August 2013.

2. "Foundations of numerical hydrodynamics," Invited lecture,
   in "2013 International School on Numerical Relativity and Gravitational Waves," APCTP Headquarters, Pohang, Korea,
   August 2013.

3. "Binary Neutron Star Merger in Numerical Relativity: current status and future prospect," Invited,
   in "2013 International School on Numerical Relativity and Gravitational Waves," APCTP Headquarters, Pohang, Korea,
   August 2013.

4. "Neutrinos and Gravitational Waves from GRBs," Invited,
   in "Supernovae and Gamma-Ray Bursts in Kyoto 2013," Yukawa Institute for Theoretical Physics, Kyoto, Japan,
   November 2013.

2.3 Seminars, Colloquia and Lectures

▷ 2013.4.1 — 2014.3.31

4.2 Daisuke Yamamoto (RIKEN): Quantum phases in spin-dimers on a triangular lattice

4.4 Susumu Inoue (Max-Planck-Institut fuer Kernphysik): Probing small-scale cosmic density fluctuations through high-redshift 21cm absorption systems

4.5 Masanori Hanada (Yukawa Inst.): What is 'large-N'?

4.10 Michikazu Kobayashi (Kyoto Univ.) :Statistical mechanics of non-Abelian topological defects

4.11 Uros Seljak (University of California Berkeley): Probing fundamental physics with cosmological observations

4.12 Masaki Shigemori (Yukawa Inst.) :Exotic branes in string theory

4.12 Frederic Piechon (Laboratoire de Physique des Solides Universite Paris-Sud Orsay) :Distant-neigbhor hopping in graphene and Haldane models

4.12 Marco Ruggieri (Department of Physics and Astronomy Catania University Catania Italy) :Elliptic flow of the Color Glass Condensate

4.12 Yoshitomo Kamiya (Los Alamos National Laboratory Theoretical Division) :Multiferroic Behavior in Trimerized Mott Insulators

4.15 Mikhail S. Volkov (Laboratoire de Mathematiques et Physique Theorique (France)): Self-accelerating cosmologies and black holes in theories with massive gravitons

4.17 Motoi Tachibana (Saga University) :Holographic cold nuclear matter as dilute instanton gas

4.18 Hayato Motohashi (RESCEU/YITP) :Cosmological consequences of f(R) modified gravity for accelerated expansion of the Universe

4.19 Goro Ishiki (YITP Kyoto Univ.) :Large-N reduction for theories on three-sphere

4.23 Jens Hoppe (Sogang University, Seoul) :Noncommutative Surfaces

4.24 Ippei Danshita (YITP, Kyoto Univ.) :YITP Colloquium:Destroying superfluids with optical lattices: Mott transition and superflow breakdown

4.24 Masato Itami (Kyoto Univ.) :Dependence on an effective representation of baths for the adiabatic piston problem

4.25 Dong-han Yeom (YITP Kyoto Univ.) :Black hole complementarity controversy and an idea of Maldacena and Hawking g

4.26 Takashi Okada (YITP, Kyoto Univ.) :Exact results of theories with SU(2|4) symmetry and gauge/gravity correspondence

4.30 Teppei Yoshida (Kyoto Univ.) :Impurity effects and superconducting gap nodes in iron-based superconductors

5.1 Shunsuke Yabunaka (Department of Physics Kyoto Univ.) :Interface approach to self propelled motion of a fluid droplet under chemical reaction

5.8 Meheboob Alam (Jawaharlal Nehru Center for Advanced Scientific Research/YITP) :Microcopic and Macroscopic Properties of Granular Poiseuille Flow from Event-driven Simulations

5.9 Robert D. Pisarski (BNL) :An effective theory for QCD near the critical temperature

5.14 Anthony James Leggett (University of Illinois at Urbana-Champaign) :Superfluid 3-He:the early days as seen by a theorist

5.17 Taro Kimura (RIKEN Nishina Center) :Spin transport analysis via gauge/gravity duality

5.20 Yoshitaka Hatta (YITP Kyoto Univ.) :YITP Colloquium: Jets and high energy scattering in QCD

5.21 Xavier Plat (LPT IRSAMC Paul-Sabatier University Toulouse) :Magnetization plateaux in spin-tube antiferromagnets

5.23 Karlo Penc (ISSPO Wigner Research Centre for Physics/Institute for Solid State Physics The University of Tokyo) :Spin liquid phases in the SU(4) and SU(3) Heisenberg model on the honeycomb lattice

5.24 Yohei Fuji (Institute for Solid State Physics University of Tokyo) :Haldane phases and topological phase transitions in quantum spin ladders

5.29 Yasuhiro Yamada (Department of Applied Physics Univ. of Tokyo) :Resolution effects on the current statistics in the resonant level model

5.31 Yuki Yokokura (Kyoto Univ.) :A Self-consistent Model of the Black Hole Evaporation

6.5 Jaeha Lee (Univ. of Tokyo) :Mathematical Foundations of Weak Measurement and its Application to Precision Measurement

6.6 Yosuke Imamura (Tokyo Institute of Technology) :Factorization of orbifold partition functions

6.10 Frans Pretorius (Princeton Univ.) Y:ITP Colloquium: Gravity in Higher Dimensions

6.13 Shinji Mukohyama (Kavli IPMU U of Tokyo) :Overview of massive gravity and cosmology

6.17 Ken Funo (Department of Physics The University of Tokyo) :Quantum Fluctuation Theorems under Measurement and Feedback control

6.20 Chunshan Lin (Kavli IPMU) :SO(3) massive gravity

6.26 Norihiro Tanahashi (Kavli IPMU) :Horizon instability of an extreme Reissner-Nordstrom black hole

6.27 Asghar Qadir (National University of Sciences and Technology (NUST)): Observing molecular hydrogen clouds by using the CMBR

7.8 Heng-Yu Chen (National Taiwan University) :On Geometric Transitions and Integrable Structures in Supersymmetric Gauge Theories

7.11 Takeshi Morita (KEK) :Black brane thermodynamics from supersymmetric field theories.

7.19 Jie Meng (School of Physics Peking University) :New generation of relativistic approach for nuclear structure

7.25 Tomohisa Takimi (Tata Institute of Fundamental Research) :Phase structures of Chern-Simons matter theories on $S^2 \times S^1$

8.2 Wen-Yu Wen (Chung-Yuan Christian University) :Holographic Principle v.s. Generalized Uncertainty Principle

8.2 Chul-Moon Yoo (School of Science Nagoya University) :Black Hole Universe: Time evolution

8.9 Naoki Yamamoto (YITP/Maryland U.) :Kinetic theory with quantum anomalies

8.13 Shinsei Ryu (University of Illinois at Urbana-Champaign) :Symmetry-protected topological phases generalized Laughlin's arguments and orbifolds

8.16 Noriaki Ogawa (Korea Institute for Advanced Study) :Chiral Phase Transition in High-Density Holographic QCD with Gravitational Back-Reaction

8.22 Hui-Hai Zhao (Department of Applied Physics.The Institute for Solid State Physics The Univ. of Tokyo) :Tensor network methods on spin models

8.23 Norihiro Iizuka (YITP Kyoto Univ.) :The firewall argument and discussion on black hole quantum mechanics

8.23 Bum-Hoon Lee (Center for Quantum Spacetime, Sogang University Korea) :Tunnelings and Bubbles Revisited

8.29 Masaya Kunimi (Department of Basic Science The University of Tokyo) :Analysis of excitations and stability of superfluidity in spatially non-uniform Bose-Einstein condensates

8.29 Shinya Aoki (YITP Kyoto Univ.) :YITP Colloquium: Nuclear forces from quarks and gluons

9.10 Naoto Tsuji (Department of Physics The University of Tokyo) :Nonequilibrium dynamical cluster theory and its applications

9.10 Luis Alvarez-Gaume (CERN) :Minimal Inflation

9.11 Janez Bonca (Josef Stephan Institute Slovenia) :Numerical study of relaxation dynamics in a lightly doped Mott insulator

9.11 Mahesh Bandi (Collective Interactions Unit OIST) :Fragility and hysteretic creep in frictional granular jamming

9.13 Takeshi Kondo (Institute for Solid State Physics University of Tokyo) :Two energy scales in the copper oxide high temperature superconductor revealed by angle-resolved photoemission spectroscopy

9.13 Atsushi Taruya (YITP Kyoto Univ.) :YITP Colloquium: Precision Cosmology with Large-scale Structure Observations

9.25 Yi Wang (Kavli IPMU) :Non-Bunch-Davies Anisotropy

9.27 Takeshi Fukuyama (RCNP Osaka University) :Searching for New Physics beyond the Standard Model in Electric Dipole Moment

9.27 Warren Carlson (University of the Witwatersrand South Africa) :Black-Holes and Simulations

9.30 Michal P. Heller (Universiteit van Amsterdam (the Netherlands) /National Centre for Nuclear Research (Poland)):A hole-ographic spacetime

10.1 Tooru Tsuribe (Department of Earth and Space Science Graduate School of Science Osaka Univ.) :Dynamical Mass Accretion and Growth of Binary Protostars

10.4 Akinori Tanaka (Osaka University) :Localization on round three-sphere revisited

10.9 Ritoban Basu Thakur (University of Illinois Urbana Champaign) :Low-mass WIMP searches with SuperCDMS

10.10 Francis Bernardeau (Institut de Physique Theorique CEA-Saclay) :The growth of gravitational instabilities in an expanding universe

10.11 Francesco Nitti (Laboratoire APC University of Paris VII) :The Trailing String in Confining Holographic Theories

10.11 Janos Balog (Wigner Research Centre Budapest Hungary) :Quark-antiquark potential at two loops

10.25 T.N.Pham (CNRS) :BaBar and Belle Measurements of the $\gamma\gamma^* \to \pi^0$ Transition Form Factor and Chiral Anomaly

10.28 Frederic van Wijland (Universite Paris Diderot-Paris 7) :Brownian dynamics can be glassy or trivial

10.30 Takashi Imamura (Research Center for Advanced Science and Technology the University of Tokyo) :Replica approach to the 1d KPZ equation

10.31 Gustav Holzegel (Imperial College London) :Existence of Dynamical Vacuum Black Holes

10.31-11.1 Can Kozcaz (Theoretical Particle Physics Group SISSA) :Lecture Series: The refined topological vertex and the M-strings

11.6 Ivan Kostov (IPhT CEA Saclay) :Three-point function of scalar operators in N=4 SYM

11.6 Didina Serban (IPhT CEA Saclay) :Three-point function of scalar operators in N=4 SYM at higher loop

11.6 Takeshi OOSHIDA (Tottori University) :Analytical calculation of the displacement correlation tensor: from single-file diffusion to two-dimensional glassy liquids

11.8 Keiko Murano (YITP Kyoto Univ.) :First calculation of the spin-orbit force in the parity odd sector in NN system from Lattice QCD.

11.12 Denis Golez (Josef Stephan Institute Slovenia) :Lifshitz phase transitions in the ferromagnetic regime of the Kondo lattice model

11.13 Ryo Murakami (YITP Kyoto Univ.) :Effect of Elastic Vibrations on Normal Head-on Collisions of Isothermal Elastic Spheres

11.14 Christian Byrnes (University of Sussex) :Constraining the small scale perturbations in our big universe

11.15 Mitsutoshi Fujita (Kavli IPMU) :From Maxwell-Chern-Simons theory in AdS_3 towards hydrodynamics in 1+1 dimension

11.18 Koki Nakata (YITP Kyoto Univ.) :Non-Equilibrium Quantum Spin Transport Theory Based on Schwinger-Keldysh Formalism; Related Topics to Spin Current

11.19 Ilia Musco (Centre of Mathematics for Applications University of Oslo) :Gravitational collapse: structure formation and scalar fields

11.22 Daisuke Nomura (YITP Kyoto Univ.) :Muon g-2

11.25-27 Takashi Hosokawa (The Univ. of Tokyo) :Lecture Series: The formation of massive stars

11.26 Takashi Hosokawa (The University of Tokyo) :Diversity of the First Stars

11.28 Vladimir Kazakov (Ecole Normale Superieure/YITP) :YITP Colloquium: N=4 SYM as a solvable gauge theory in 4 dimensions

11.29 Susanne Reffert (CERN) :Deformed supersymmetric gauge theories from string- and M-theory:Introduction to the fluxtrap background

11.29 Domenico Orlando (Ecole Normale Superieure (Paris)): Deformed supersymmetric gauge theories from string- and M-theory: Applications

12.3 Denis Golez (Josef Stephan Institute Slovenia) :Ultrafast Relaxation of a Photo-Carrier in Antiferromagnetic Spin Background

12.4 Jiangming Yao (Department of Physics Tohoku University) :Covariant density functional theory for nuclear collective excitations

12.6 Ali Mollabashi (Institute for research in fundamental sciences (IPM)): Crystalline Geometries from Fermionic Vortex Lattice

12.11 Tomohiko Sano (YITP Kyoto Univ.) :Roles of Dry Friction in Fluctuating Motion of Adiabatic Piston

12.13 Vladimir Kazakov (Ecole Normale Superieure/YITP) :On correlation functions and anomalous dimensions of planar N=4 SYM theory in weak coupling and BFKL approximation

12.17 Shun Saito (Kavli IPMU) :Precise measurement of cosmic expansion history and growth of the large-scale structure from the updated BOSS CMASS galaxy clustering

12.18 Noburo Shiba (YITP Kyoto Univ.) :Volume Law for the Entanglement Entropy in Non-local QFTs

12.18 Ryosuke Yoshii (YITP Kyoto Univ.) :Transport in Aharonov-Bohm ring with embedded quantum dot

12.20 Bernard Raffaelli (YITP Kyoto Univ.) :An unusual quantum point of view concerning inertia and its consequences for Newton gravitational constant spacetime and cosmological constant.

1.14 Seyed Akbar Jafari (Sharif Univ. of Technology Iran) :Kondo resonance from vacancies in graphene

1.15 Sheng-Lan Ko (Durham University) :The novel (single) M5 brane action - motivated from stacking of M2 branes

1.15 Andrew Iskauskas (Durham University) :Noncommutative SU(2) Instantons

1.15 Takahiro Nishinaka (Rutgers University USA) :Topological strings and 5d TN partition function

1.15 Atsuo Shitade (Dept. Phys. Kyoto Univ.) :Heat Responses and Field Theory in a Curved Spacetime

1.16 Richard Easther (The University of Auckland) :Dynamics and Observables for Multifield Inflation

1.20 Wei Li (Max Planck Institute for Gravitational Physics (AEI)): Quantum Decoherence with Holography

1.21 Jure Kokalj (Josef Stephan Institute Slovenia) :Thermodynamic properties of a model for organic charge-transfer salts

1.21 Julien Armijo (Universidad de Chile Chile) :Quantum and thermal density fluctuations in an ultracold 1D Bose gas

1.23 Ion-Olimpiu Stamatescu (U. Heidelberg ITP & Heidelberg FEST) :Langevin Equation simulations for complex action and QCD at non-zero chemical potential

1.30 Patrick Brady (University of Wisconsin-Milwaukee/YITP Kyoto Univ.) :YITP Colloquium: Gravitational-wave Astronomy on the Cusp

1.30-31 Takayuki Muto (Division of Liberal Arts Kogakuin University) :Lecture Series: Protoplanetary Disks and Planet Formation

1.31 Song He (YITP Kyoto Univ.) :Holographic entanglement temperature and for low thermal excited states

1.31 Takayuki Muto (Kogakuin University) :Protoplanetary Disk Morphology Revealed by Imaging Observations

2.4 Oonogi Tetsuya (Graduate School of Science Osaka Univ.) :Position space formulation for Dirac fermions on honeycomb lattice

2.4-7 Yusuke Nishida (Tokyo Institute of Technology) :Lecture series: Quantum many-body and few-body physics near a Feshbach resonance

2.5 Eto Mikio (Dept. of Physics Keio Univ.) :Optical Phonon Lasing in Semiconductor Double Quantum Dot

2.7 Anna Hasenfratz (Department of Physics University of Colorado) :Strongly coupled gauge theories in and out of the conformal window

2.7 Nikolaj Bittner (Max-Planck Institute fur Festkorperforschung) :Kinetic theory for non-centrosymmetric superconductors

2.12 Pawel Caputa (YITP Kyoto Univ.) :Semiclassical correlators with giant gravitons

2.14 Yuichiro Nakai (Harvard Univ./KEK) :Natural Supersymmetry in Warped Space

2.19 James Michael Lattimer (State University of New York) :Neutron Star Radii: Large or Small?

2.19-20 Tetsuo Deguchi (Ochanomizu University) :Lecture Series: Nonequilibrium dynamics of integrable quantum many-body systems and some fundamental aspects of statistical mechanics

2.21 Tetsuo Hyodo (YITP Kyoto Univ.) :YITP Colloquium: Universal physics of three bosons with isospin

2.24 Gaurav Narain (The Inst. of Mathematical Sciences India) :Renormalization group approach to Quantum Gravity

2.24 Sato Yuki (University of the Witwatersrand) :Ising model on random networks and canonical tensor model

2.24 Seto Ryohei (Levich Institute City College of New York) :Shear Thickening: Introducing Friction to Suspension Rheology

2.26 Kuniyasu Saitoh (University of Twente the Netherlands) :Shear banding in dense granular flow: A new law for the friction coefficient

2.26-28 Taichi Kugo (Kyoto Sangyo Univ./Maskawa Institute for Science and Culture) :Lecture Series: Super Conformal Tensor Calculus in 4d Space-Time

2.27-28 Takeru Suzuki (Nagoya Univ.) :Lecture series: Phyics of Wave/Turbulence-driven stellar winds

2.28 Takeru Suzuki (Nagoya Univ.) :Stellar winds from young solar-type stars

3.3 Christopher Russell (Hokkai-Gakuen University) :Using 3D Dynamic Models to Reproduce X-ray Properties of Colliding-Wind & Gamma-ray Binaries

3.5 Yuto Murashita (Dept. of Physics Univ. of Tokyo) :Nonequilibrium Equalities Derived from Lebesgue's Decomposition

3.5-6 Hitoshi Nakada (Chiba Univ.) :Lecture Series: Mean-Field Approximation and Effective Interactions for Atomic Nuclei

3.12 Shiraz Minwalla (Tata Institute of Fundamental Research) :Lecture:Chern Simons theories with fundamental matter and their gravity duals

3.7 Taichiro Kugo (Kyoto Sangyo University) :Stuckelberg-BRST Approach to the No-Ghost Theorem in Massive Gravity

3.11 Alejandro Ibarra (Technical University Munich) :Searching for spectral features in the gamma-ray sky

3.13 Andrei Marshakov (Lebedev Physics Institute ITEP and NRU HSE Russia) :Extended prepotentials for quiver gauge theories

3.13 Shiraz Minwalla (Tata Institute of Fundamental Research) :YITP Colloquium: The Fluid Gravity Correspondence

3.14 Yigal Shamir (Tel Aviv Univresity) :Phase with no mass gap in non-perturbatively gauge-fixed Yang-Mills theory

3.18 Jeong-Hyuck Park (Sogang University) :How many is different? Answer from the ideal Bose gas.

3.19 Duc Anh Le (Hanoi National University of Education) :Mott transitions in three-component Falicov-Kimball model

3.24 Kent Yagi (Montana State Univ.) :No-Hair-like Relations for Neutron Stars

3.24 Masato Minamitsuji (Instituto Superior Tecnico Lisbon) :Black hole solutions in the scalar-tensor theory with nonminimal derivative coupling

3.25 Yuko Urakawa (Institute for advanced research Nagoya Univ.) :AdS/CFT and prospects on cosmology

3.26 Eiichiro Komatsu (MPI for Astrophysics) :Polarization of the Cosmic Microwave Background: Toward an Observational Proof of Cosmic Inflation

2.4 Visitors (2013)

Atom-type Visitors

Honda, Masazumi KEK (E)
2013.05.08 – 2013.08.25

Oka, Akira Univ. of Tokyo (A)
2013.12.09 – 2013.12.24

Tanaka, Akinori Osaka Univ. (E)
2014.01.06 – 2014.01.31

Oka, Akira Univ. of Tokyo (A)
2014.01.20 – 2014.02.03

Visitors

Khaliullin, Giniyat Max Planck Institute (C)
2013/4/7 – 2013/4/21

Seljak, Uros UC Berkeley (A)
2013/4/10 – 2013/4/13

Volkov, Mikhail Univ. of Tours (A)
2013/4/11 – 2013/4/16

Motohashi, Hayato RESCEU, Univ. of Tokyo (A)
2013/4/15 – 2013/4/19

Scardigli, Fabio Politecnico of Milano (A)
2013/4/15 – 2013/4/22

Tachibana, Motoi Saga Univ. (N)
2013/4/15 – 2013/4/17

Honda, Masazumi KEK (E)
2013/4/17 – 2013/4/20

Sato, Yuki KEK (E)
2013/4/24 – 2013/4/27

Shiba, Shotaro KEK (E)
2013/5/6 – 2013/5/10

Plat, Xavier Univ. Paul Sabatier (C)
2013/5/7 – 2013/6/12

Pisarski, Robert BNL (N)
2013/5/8 – 2013/5/12

Kanno, Sugumi Tufts Univ. (A)
2013/5/13 – 2013/5/31

Penc, Karlo ISSPO/ISSP Univ. of Tokyo (C)
2013/5/22 – 2013/5/26

Nishigaki, Shinsuke Shimane Univ. (E)
2013/5/24 – 2013/5/24

Kimura, Tetsuji Rikkyo Univ. (E)
2013/6/3 – 2013/6/4

Sasaki, Shin Kitasato Univ. (E)
2013/6/3 – 2013/6/4

Maruhn, Joachim Universitat Frankfurt (N)
2013/6/8 – 2013/6/15

Ansoldi, Stefano Univ. of Udine (A)
2013/6/15 – 2013/8/12

Kim, Sang Pyo Kunsan National Univ. (A)
2013/6/20 – 2013/7/12

Chen, Heng-Yu National Taiwan Univ. (E)
2013/6/30 – 2013/7/13

Mori, Michiyasu JAEA (C)
2013/7/1 – 2013/7/3

Izumi, Keisuke Taiwan Univ. (A)
2013/7/2 – 2013/7/15

Sato, Yuki KEK (E)
2013/7/2 – 2013/7/27

Vairinhos, Helvio Univ. of Porto (E)
2013/7/2 – 2013/7/27

Meng, Jie Peking Univ. (N)
2013/7/5 – 2013/8/3

Hirano, Shinji Univ. of the Witwatersrand (E)
2013/7/8 – 2013/7/12

Nagata, Keitaro KEK (E)
2013/7/8 – 2013/7/10

Kabat, Daniel Lehman College (E)
2013/7/12 – 2013/7/20

Lu, Hantao Lanzhou Univ. (C)
2013/7/15 – 2013/7/22

MASUI, Hiroshi Kitami Institute of Technology (N)
2013/7/16 – 2013/7/17

Ishizuka, Chikako Tokyo Univ. of Science (N)
2013/7/17 – 2013/7/19

Liang, Haozhao RIKEN (N)
2013/7/17 – 2013/7/18

Marmorini, Giacomo RIKEN (C)
2013/7/22 – 2013/7/23

Motohashi, Hayato RESCEU, Univ. of Tokyo (A)
2013/7/22 – 2013/7/26

Takimi, Tomohisa Tata Institute of Fundamental Research (E)
2013/7/25 – 2013/7/28

Dorey, Patrick E. Durham Univ. (E)
2013/7/28 – 2013/8/4

Wen, Wen - Yu Chung Yuan Christian Univ. (E)
2013/7/28 – 2013/8/12

Takimi, Tomohisa Tata Institute of Fundamental Research (E)
2013/8/1 – 2013/8/4

Yoo, Chul-Moon Nagoya Univ. (A)
2013/8/1 – 2013/8/9

Ikeda, Tatsuhiko Univ. of Tokyo (C)
2013/8/5 – 2013/8/16

Mollabashi, Ali Institute for research in Fundamental Sciences (E)
2013/8/15 – 2014/3/24

Sato, Yuki KEK (E)
2013/8/15 – 2013/8/16

Ansoldi, Stefano Univ. of Udine (A)
2013/8/18 – 2013/8/31

Deruelle, Nathalie APC, Univ. Paris 7 (A)
2013/8/19 – 2013/8/31

Bucher, Martin APC, Univ. Paris 7 (A)
2013/8/20 – 2013/9/7

Sago, Norichika Kyushu Univ. (A)
2013/8/20 – 2013/8/23

Lee, Bum-Hoon Sogang Univ., Korea (A)
2013/8/22 – 2013/8/28

Bonca, Janez Ljubljana Univ. (C)
2013/8/26 – 2013/9/2

Sago, Norichika Kyushu Univ. (A)
2013/8/26 – 2013/9/6

Bonca, Janez Ljubljana Univ. (C)
2013/9/7 – 2013/9/24

Ikeda, Tatsuhiko Univ. of Tokyo (C)
2013/9/9 – 2013/9/17

Carlson, Warren Univ. of the Witwatersrand (A)
2013/9/13 – 2013/10/1

Cornell, Alan Univ. of the Witwatersrand (A)
2013/9/15 – 2013/9/24

Sousbie, Thierry Institute de Astrophysique de Paris (A)
2013/9/19 – 2013/9/20

Sobko, Evgeny Ecole Normale Superieure (E)
2013/9/23 – 2013/11/4

Heller, Michal P. Universiteit van Amsterdam/National Centre for Nuclear Research (E)
2013/9/30 – 2013/10/2

Balog, Janos Wigner RCP (旧 KFKI) (E)
2013/10/1 – 2013/10/17

Bernardeau, Francis RESCEU, Univ. of Tokyo (A)
2013/10/2 – 2013/10/16

Thakur, Ritoban Basu Univ. of Illinois Urbana Champaign (E)
2013/10/8 – 2013/10/10

Bajnok, Zoltan Wigner Research Centre for Physics (E)
2013/10/15 – 2013/10/19

Pham, Tri Nang Centre for Theoretical Physics (E)
2013/10/15 – 2013/10/25

van Wijland, Frederic Universite Paris Diderot-Paris 7 (C)
2013/10/21 – 2013/10/28

Golez, Denis Jozef Stephan Institute (C)
2013/10/27 – 2013/12/20

Ryu, Shinsei Univ. of Illinois (E)
2013/10/28 – 2013/11/1

Urakawa, Yuko Univ. of Barcelona (A)
2013/10/28 – 2013/11/1

Holzegel, Gustav Imperial College (A)
2013/10/29 – 2013/11/4

Kozcaz, Can Theoretical Particle Physics Group, SISSA (E)
2013/10/30 – 2013/11/3

Kostov, Ivan Service de Physique Theorique de Saclay (E)
2013/11/1 – 2013/11/8

Pi, Shi APCTP (A)
2013/11/1 – 2013/11/4

Servan, Didina Service de Physique Theorique de Saclay (E)
2013/11/1 – 2013/11/8

Kozcaz, Can Theoretical Particle Physics Group, SISSA (E)
2013/11/7 – 2013/11/11

Chan, Chuan-Tsung Tunghai Univ., Taiwan (E)
2013/11/8 – 2013/11/15

Byrnes, Christian Univ. of Sussex (A)
2013/11/9 – 2013/11/16

Yeh, Chi-Hsien National Center for Theoretical Science (E)
2013/11/10 – 2013/11/18

Musco, Ilia Univ. of Oslo (A)
2013/11/18 – 2013/11/20

Hosokawa, Takashi Univ. of Tokyo (A)
2013/11/24 – 2013/11/27

Palomo, Hector Bombin Perimeter Institute for Theoretical Physics (C)
2013/11/25 – 2014/1/8

Nishioka, Tatsuma Institute for Advanced Study (E)
2013/12/2 – 2013/12/3

Pi, Shi APCTP (A)
2013/12/2 – 2014/1/26

Steer, Daniele Univ. of Paris 7 (A)
2013/12/5 – 2013/12/19

Möller, Peter Los Alamos National Laboratory (N)
2013/12/15 – 2013/12/26

Suhara, Tadahiro Matsue College of Technology (N)
2013/12/25 – 2013/12/26

Jafari, Seyed Akbar Sharif Univ. of Tech. (C)
2014/1/4 – 2014/1/30

Lee, Bum-Hoon Sogang Univ. (E)
2014/1/6 – 2014/1/9

Hirano, Shinji Univ. of the Witwatersrand (E)
2014/1/6 – 2014/1/10

Hirabayashi, Yoshiharu Hokkaido Univ. (N)
2014/1/9 – 2014/1/9

Ohkubo, Shigeo Univ. of Kochi (N)
2014/1/9 – 2014/1/9

Etminan, Faisal Univ. of Birjand (E)
2014/1/10 – 2014/4/1

Iskauskas, Andrew Durham Univ. (E)
2014/1/10 – 2014/1/17

Ko, Sheng-Lan Durham Univ. (E)
2014/1/10 – 2014/1/17

Smith, Douglas Durham Univ. (E)
2014/1/10 – 2014/1/17

Young, Samuel Univ. of Sussex (A)
2014/1/10 – 2014/2/10

Easther, Richard The Univ. of Auckland, New Zealand (A)
2014/1/15 – 2014/1/21

Armijo, Julien Universidad de Chile (C)
2014/1/16 – 2014/2/21

Kokalj, Jure Jozef Stephan Institute (C)
2014/1/19 – 2014/2/22

Li, Wei Max Planck Institute for Gravitational Physics (E)
2014/1/19 – 2014/1/25

Hirano, Shinji Univ. of the Witwatersrand (E)
2014/1/20 – 2014/1/24

Bittner, Nikolaj Max Planck Institute for Solid State Research (C)
2014/1/29 – 2014/2/28

Muto, Takayuki Kogakuin Univ. (A)
2014/1/29 – 2014/1/31

Leung, Godfrey Univ. of Nottingham (A)
2014/1/30 – 2014/3/1

Eberhardt, Boris DLR-Institute of Materials Physics in Space (C)
2014/1/31 – 2014/2/28

Chen, Xingang Univ. of Texas at Dallas (A)
2014/2/1 – 2014/2/8

Langlois, David APC (A)
2014/2/3 – 2014/2/13

Lee, Wonwoo Center for Quantum Spacetime, Sogang Univ. (A)
2014/2/3 – 2014/2/9

Urban, Alexander Lee Univ. of Wisconsin-Milwaukee (A)
2014/2/3 – 2014/2/9

Hasenfratz, Anna Univ. of Colorado (E)
2014/2/4 – 2014/2/8

Narain, Gaurav Institute of Mathematical Sciences (E)
2014/2/4 – 2014/2/27

Nishida, Yusuke Tokyo Institute of Technology (C)
2014/2/4 – 2014/2/7

Eto, Mikio Keio Univ. (C)
2014/2/5 – 2014/2/7

Pankow, Chris Paul Univ. of Wisconsin-Milwaukee (A)
2014/2/5 – 2014/2/25

Sorbo, Lorenzo The Univ. of Massachusetts, Amherst (A)
2014/2/5 – 2014/2/9

Sato, Yuki Univ. of the Witwatersrand (E)
2014/2/8 – 2014/2/28

Nguyen, Quynh Lan Hanoi National Univ. of Education (A)
2014/2/10 – 2014/2/22

Saitoh, Kuniyasu Universiteit Twente (C)
2014/2/16 – 2014/2/28

Ishizuka, Chikako Tokyo Univ. of Science (N)
2014/2/17 – 2014/2/26

Valageas, Patrick IPhT, CEA Saclay (A)
2014/2/17 – 2014/3/7

Deguchi, Tetsuo Ochanomizu Univ. (C)
2014/2/19 – 2014/2/20

Nishimichi, Takahiro Institut d'Astrophysique de Paris (A)
2014/2/19 – 2014/2/26

Ishida, Muneyuki Meisei Univ. (E)
2014/2/20 – 2014/3/11

Le Tiec, Alexandre Observatory of Paris (A)
2014/2/20 – 2014/3/17

Hayasaki, Kimitake Korea Astronomy and Space Science Institute (A)
2014/2/21 – 2014/3/7

Zhou, Bo (N)
2014/2/22 – 2014/3/31

Manske, Dirk Max Planck Institute for Solid State Research (C)
2014/2/23 – 2014/2/28

Ohkubo, Shigeo Univ. of Kochi (N)
2014/2/23 – 2014/3/7

Song, Yong-Seon KASI (A)
2014/2/23 – 2014/3/8

Okumura, Teppei Kavli IPMU, Univ. of Tokyo (A)
2014/2/24 – 2014/2/26

Saito, Shun Kavli IPMU, Univ. of Tokyo (A)
2014/2/24 – 2014/2/26

Kayo, Issha Toho Univ. (A)
2014/2/25 – 2014/2/26

Nishizawa, Atsushi Kavli IPMU, Univ. of Tokyo (A)
2014/2/25 – 2014/2/26

Kugo, Taichi Kyoto Sangyo Univ. (E)
2014/2/26 – 2014/2/28

Mori, Michiyasu JAEA (C)
2014/2/27 – 2014/2/28

Suzuki, Takeru Nagoya Univ。 (A)
2014/2/27 – 2014/2/28

Cho, Gi-Chol Ochanomizu Univ. (E)
2014/2/28 – 2014/3/3

Fujita, Ryuichi Instituto Superior Técnico (A)
2014/3/3 – 2014/3/14

Sago, Norichika Kyushu Univ. (A)
2014/3/3 – 2014/3/14

Yamanaka, Yoshiya Waseda Univ. (N)
2014/3/3 – 2014/3/4

Hirabayashi, Yoshiharu Hokkaido Univ. (N)
2014/3/4 – 2014/3/5

Nakada, Hitoshi Chiba Univ. (N)
2014/3/4 – 2014/3/6

Pi, Shi APCTP (A)
2014/3/4 – 2014/3/14

Kashiwa, Hiroshi RIKEN, BNL Research Center (N)
2014/3/6 – 2014/3/9

Kugo, Taichi Kyoto Sangyo Univ. (E)
2014/3/6 – 2014/3/7

Morita, Kenji Frankfurt Institute for Advanced Studies (N)
2014/3/6 – 2014/3/18

Ibarra, Alejandro Technical Univ. Munich (E)
2014/3/8 – 2014/3/12

Kadoh, Daisuke KEK (N)
2014/3/8 – 2014/3/9

Nagata, Keitaro KEK (N)
2014/3/8 – 2014/3/9

Shamir, Yigal Tel Aviv Univ. (E)
2014/3/8 – 2014/3/31

Bertsch, George F. Institute for Nuclear Theory (INT) (N)
2014/3/10 – 2014/3/23

Hohm, Olaf Ludwig-Maximilians Univ. (E)
2014/3/10 – 2014/3/20

Itakura, Kazunori KEK (N)
2014/3/10 – 2014/3/12

Izumi, Keisuke Leung Center for Cosmology and Particle Astrophysics (A)
2014/3/10 – 2014/3/18

Masuda, Kota Univ. of Tokyo (N)
2014/3/10 – 2014/3/12

Minwalla, Shiraz Tata Institute of Fundamental Research (E)
2014/3/11 – 2014/3/14

Le, Duc Anh Hanoi National Univ. of Education (C)
2014/3/12 – 2014/3/25

Tanaka, Masaomi NAOJ (A)
2014/3/13 – 2014/3/14

Kugo, Taichi Kyoto Sangyo Univ. (E)
2014/3/14 – 2014/3/14

Warner, Nicholas Univ. of Southern California (E)
2014/3/15 – 2014/3/23

Matsueda, Hiroaki Sendai National College of Technology (C)
2014/3/17 – 2014/3/18

Deruelle, Nathalie APC, Univ. Paris 7 (A)
2014/3/18 – 2014/4/17

Lim, Yeunhwan Institute for Basic Science (N)
2014/3/18 – 2014/3/25

Ito, Nobuyasu Univ. of Tokyo (C)
2014/3/20 – 2014/3/21

Kugo, Taichi Kyoto Sangyo Univ. (E)
2014/3/20 – 2014/3/20

Kun, Ferenc Univ. of Debrecen (C)
2014/3/20 – 2014/3/22

Komatsu, Eiichiro Max-Planck-Institut für Astrophysik (A)
2014/3/23 – 2014/3/31

Urakawa, Yuko Nagoya Univ. (A)
2014/3/24 – 2014/3/26

Chan, Chuan-Tsung Tunghai Univ., Taiwan (E)
2014/3/28 – 2014/4/6

Yeh, Chi-Hsien NCTS, Taiwan (E)
2014/3/28 – 2014/4/6

In the above lists, the symbols A, C, E and N in the parentheses are thefollowing abbreviations of research fields:
A: Astrophysics and Cosmology
C: Condensed Matter and Statistical Physics
E: Elementary Particle Theory
N: Nuclear Physics Theory

Chapter 3

Workshops and Conferences

3.1 International Workshops and Conferences

Since 1978, a series of international physics workshops, called *Yukawa International Seminar (YKIS)* are held annually or bi-annually. *The Nishinomiya Yukawa Memorial Project* was initiated by Nishinomiya city where the late Prof. Hideki Yukawa lived when he wrote his famous papers on the meson theory. As one of the major programs of this project, an international symposium open to public was held every year in Nishinomiya city, and its post/pre-workshop held at YITP. In recent years both the Nishinomiya Yukawa Symposium and its post/pre-workshops are held at YITP, Kyoto.

As of the academic year 2007, Yukawa Institute for Theoretical Physics launched a new five-year project, "*Yukawa International Program for Quark-Hadron Sciences* (YIPQS)." A few research topics are selected each year and a long-term workshop focused on each topic, extending over a period of a few months, is organized by inviting leading experts from the world. Emphasis is laid on fostering fruitful collaboration among the workshop participants.

In addition to these regular annual conferences, many international workshops and conferences of various sizes and durations from several days to more than one month are held every year.

Here is a list of main international workshops and conferences held in the academic year 2011.

Yukawa International Seminar (YKIS2013)

YKIS2013 : Gravitational waves -Revolution in Astronomy and Astrophyscs-

Jun 3 - Jun 7, 2013, Chaired by Masaru Shibata 140 participants (60 from abroad)
For details, see
http://www2.yukawa.kyoto-u.ac.jp/ws/2013/ykis2013/conference/conference.php

Nishinomiya-Yukawa Symposium 2013

Nishinomiya Yukawa Symposium on New Frontiers in QCD 2013 — Insight into QCD matter from heavy-ion collisions —

Nov 18 - Dec 20, 2013, Chaired by Masayuki Asakawa and Akira Ohnishi, 135 participants (64 from abroad)
For details, see http://www2.yukawa.kyoto-u.ac.jp/ws/2013/nfqcd/index.html

3.2 YITP Workshops

YITP workshops are one of the main activities of Yukawa Institute. The aim of them is to open new research fields and stimulate nationwide collaborations. Workshop plans can be proposed by any researcher and are approved by the Committee on Research Projects of the Institute. Small workshops, summer schools and regional schools to educate young researchers are positively supported.
In the past 5 years, more than 20 workshops are held each year with 1500 strong participants visiting YITP. The list of the workshops together with the number of participants for the last academic year is given below.

▷ 2013.4.1 — 2014.3.31

Here is the list of workshops with the dates, the names of organizers, the number of participants.

YITP-W-13-1
New Developments in Dirac fermions in condensed matter systems, Jun.19-21. Masao Ogata,Yoshikazu Suzumura,Takami Tohyama,Yuki Fuseya,Takao Morinari, *95-participants,*

YITP-W-13-2
KIAS-YITP joint workshop "String Theory, Black Holes and Holography", Jul.1-5. Kimyeong Lee, Makoto Natsuume, Misao Sasaki, Seiji Terashima, Piljin Yi, Tadashi Takayanagi, *177-participants,*

YITP-W-13-3
Frontier of Statistical Physics and Information Process 2013, Jul.11-14. Masayuki Ohzeki,Takahiro Sagawa,Kazumasa A Takeuchi, Muneki Yasuda, Yu Watanabe, *114-participants,*

YITP-W-13-4
Physics of glassy and granular materials, Jul.16-29. Akira Furukawa, Takahiro Hatano, Hisao Hayakawa, Kunimasa Miyazaki Michio Otsuki, Atsuko Shimosaka, Toshitsugu Tanaka, Toshihiko Umekage, Hajime Yoshino, *80-participants,*

YITP-W-13-5
Financial Networks and Systemic Risk Analysis, Jul.17- 19. Hideaki Aoyama, Guido Caldarelli, Hiroshi Yoshikawa, Stefano Battison, Yuichi Ikeda, Hiroshi Iyetomi, Yoshi Fujiwara, Aki-hiro Sato, Wataru Souma, Irena Vodensca, Tsutomu Watanabe, *70-participants,*

YITP-W-13-6
Mathematical Statistical Physics, Jul.29-Aug.3. Hal Tasaki, Tetsuo Deguchi, Takashi Hara, Hisao Hayakawa, Masaki Oshikawa, Kazumitsu Sakai, Tomohiro Sasamoto, *100-participants,*

YITP-W-13-7
Summer School on Astronomy and Astrophysics 2013, Jul.29-Aug.1. Keisuke Nakagawa, Hiroaki Imada, Kohei Hayashi, Hikaru Nakano, Michiko Umei, Yusuke Fujimoto, Kei Yamada, Masaki Takayama, Yuta Hiranuma, Mika Kagaya, Satoshi Tanaka, *347-participants,*

YITP-W-13-8
YONUPA Summer School 2013, Aug.4-9. Kazuya Ishikawa, Takahiro Terada, Teppei Kitahara, Masaki Yoshikawa, Akio Tomiya, Sho Deguchi, Chihiro Saijo, Yukihiro Fujimoto, Takahiro Nishi, Saori Maeda, Osamu Takachio, *286-participants,*

YITP-W-13-9
Progress in Particle Physics 2013, Aug.5-9. Masahiro Ibe, Yutaka Ookouchi, Kinya Oda, Ryuichiro Kitano, Fumihiro Takayama, Koichi Hamguchi, Hidenori Fukaya, Shigeki Matsumoto, Koichi Yoshioka, *144-participants,*

YITP-W-13-10
The 58th Condensed Matter Physics Summer School, Aug.12-16. Kana Fuji, Daisuke Hishitani, Shun Takano, Taiki Haga, Shun Okushima, Chikak Sato, Ryuhei Ishiyama, Kazuhiko Tanimoto, Masahiko Miyara, Hidetoshi Sugihara, Yuta Sasaki, Yuichi Oonuma, Megumi Masuda, Hideyuki Kwa-

soko, *198-participants,*

YITP-W-13-11
19 th International Summer Institute on Phenomenology of Elementary Particles and Cosmology (SI2013), Aug.17-23. Fumihiro Takayama, Nobuhiro Maekawa, Taichi Kugo, Masahiro Yamaguchi, Tatsuo Kobayashi, Koichi Hamaguchi, Haruhiko Terao, Morimitsu Tanimoto, Takeshi Kurimoto, Jisuke Kubo, Kiwoon Choi, Jihne E. Kim, Pyungwon Ko, Dong-Won Jung, Hyung Do Kim, Jae Sik Lee, Kang Young Lee, Seung Joon Lee, Jeonghyeon Song, Kingman Cheung, George Hou, Hai-Yang Cheng, Otto Kong, *121-participants,*

YITP-W-13-12
Field Theory and String Theory, Aug.19-23. Tatsuo Azeyanagi, Yuji Okawa, Mitsuhiro Kato, Hiroshi Kunitomo, Tadashi Sakai, Makoto Sakamoto, Tadashi Takayanagi, Yuji Tachikawa, Koji Hashimoto, Masashi Hamanaka, Kazuo Hosomiti, Satoshi Yamaguchi, Kentaroh Yoshida, *150-participants,*

YITP-W-13-13
Thermal Quantum Field Theory and Their Applications, Aug.26-28. Masayuki Asakawa, Kei Iida, Ikuo Ichinose, Tomohiro Inagaki, Shinji Ejiri, Akira Ohnishi, Masahiko Okumura, Masakiyo Kitazawa, Masaki Sakagami, Motoi Tachibana, Yusuke Nakamura, Chiho Nonaka, *100-participants,*

YITP-W-13-14
The 53th Summer School for Japanese Young Biophysics Researchers, Sep.6-9. , *90-participants,*

YITP-W-13-15
Physics of Iron-Based Superconductors, Oct.8-9. Kazuhiko Kuroki, Ryotao Arita, Hiroaki Ikeda, Yoshiaki Ono, Hiroshi Kontani, Takami Tohyama, Yuji Matsuda, *73-participants,*

YITP-W-13-16
East Asia Joint Seminars on Statistical Physics 2013, Oct.21-24. Hideotshi Nishimori, Hsuan-Yi Chen, Hisao Hayakawa, Masayuki Ohzeki, Hyunggyu Park, Shinichi Sasa, Tomohiro Sasamoto, Kazutaka Takahashi, Lei-Han Tang, Hal Tasaki, *100-participants,*

YITP-W-13-17
Hadron in nucleus, Oct.31-Nov.2. Hiroyuki Fujioka, Satoru Hirenzaki, Atsushi Hosaka, Tetsuo Hyodo, Kenta Itahashi, Daisuke Jido, Hideko Nagahiro, Akira Ohnishi, Kyouichiro Ozawa, *75-participants,*

YITP-W-13-18
Quantum Information Physics, Dec.4-6. Gen Kimura, Tadashi Takayanagi, Izumi Tsutsui, Keisuke Totsuka, Yasusada Nambu, Masahiro Hotta, Hiroaki Matsueda, Takao Morinari, Yu Watanabe, *55-participants,*

YITP-W-13-19
New Horizon in Quantum Information Science, Mar.23-25, 2014. Keisuke Fujii, Yoshifumi Nakata, Masayuki Ohzeki, Makoto Negoro, Yu Watanabe, Tomoyuki Morimae, *40-participants,*

YITP-W-13-20
Summer School 'From quark to supernovae', Aug.20-24. Shinya Aoki, Masaru Shibata, Tetsuo Hatsuda, Emiko Hiyama, *73-participants,*

YITP-W-13-21
Science of Complex Systems, Jan.20-21, 2014. Yukio Gunji, Takashi Ikegami, Kenichiro Mogi, *32-participants,*

3.3 Regional Schools supported by YITP

▷ 2011.4.1—2012.3.31

Here is the list of the Regional Schools with the dates, the place, the name(s) of the main invited Lecturer(s) and the participating Universities.

YITP-S-13-1
Hokuriku Spring School 2013, May 24 - 26, National TATEYAMA Youth Outdoor Learning Center.
Mitsuru Kakizaki

YITP-S-13-2
Chubu Summer School 2012, Sep. 1-4, Yamanakako Seminar House, Tokai Univesity.
Shogo Aoyama

YITP-S-13-3
18th Niigata-Yamagata joint school, Nov. 1-3, National Nasu Kashi Youth Friendship Center.
Takehiko Asaka

YITP-S-13-4
The 36th Shikoku Seminar on Particle and Nuclear Physics, Dec.14-15, Tokushima University.
Zenro Hioki

YITP-S-13-5
The 26th Hokkaido Nuclear Theory Group Meeting, Feb.20-22, 2014, Hokkaido University.
Shuichiro Ebata

YITP-S-13-6
Hokuriku-Shinetsu Winter School 2014, Feb.20 -23, 2014, Hakusanri.
Daijiro Suematsu