YITP Annual Report

Yukawa Institute For
Theoretical Physics
Kyoto University

2009

Foreword

We present here an annual report of the scientific activities of Yukawa Institute for Theoretical Physics during the academic year 2009.

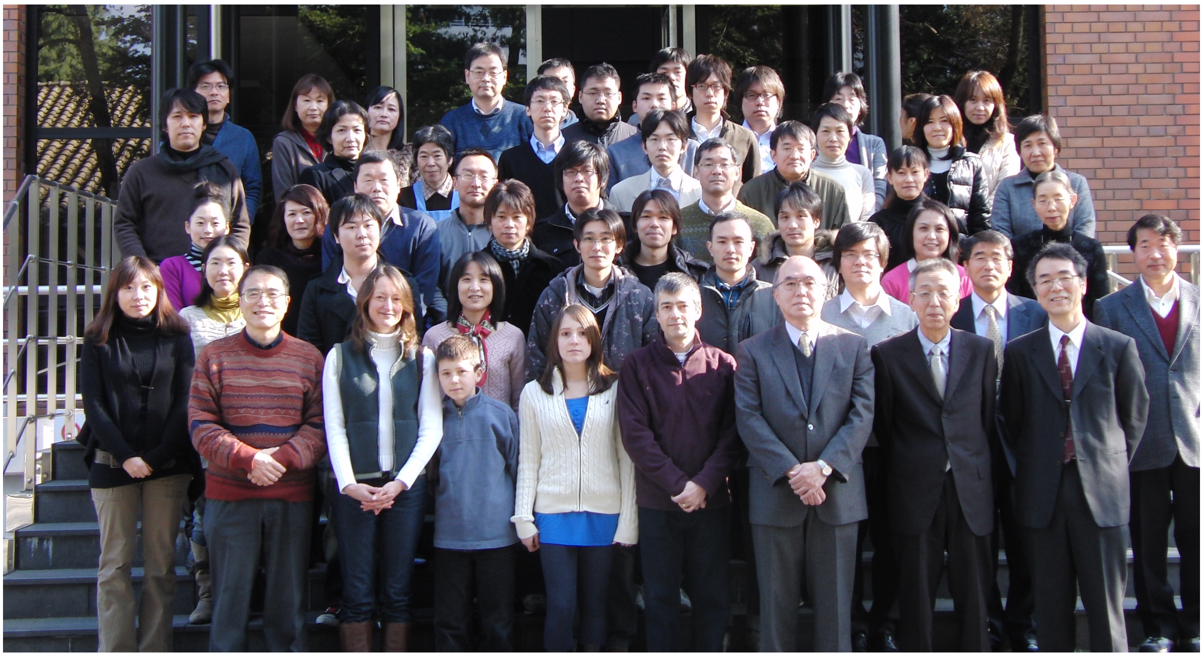
From the year 2007 we started our new project of "Yukawa International program of Quark-Hadron Sciences (YIPQS)" funded by Japan Ministry of Education, Culture, Sports, Science and Technology. In this project we select a few research topics each year for long-term workshops and invite leading experts from abroad to stimulate discussions and foster collaborations among workshop participants. In the year 2009 we held three long-term workshops in the area of non-equilibrium, nuclear, and particle physics and extensive discussions have been exchanged. Our report contains some of the results obtained during these workshops.

Director
Tohru Eguchi

Contents

Chapter 1

People



4 January 2010

1.1 Regular Staff and Guest Professors (2009 April – 2010 March)

Regular Staff

Tohru Eguchi
Professor (E)

Taichiro Kugo
Professor (E)

Ken-ichi Shizuya
Professor (E)

Misao Sasaki
Professor (A)

Hisao Hayakawa
Professor (C)

Takami Tohyama
Professor (C)

Takahiro Tanaka
Professor (A) [2008.4.1 –]

Akira Ohnishi
Professor (N) [2008.4.1 –]

Masaru Shibata
Professor (A) [2009.1.1 –]

Ryu Sasaki
Associate Professor (E)

Masatoshi Murase
Associate Professor (C)

Hiroshi Kunitomo
Associate Professor (E)

Naoki Sasakura
Associate Professor (E)

Tetsuya Onogi
Associate Professor (E) [– 2009.5.31]

Keisuke Totsuka
Associate Professor (C)

Shigehiro Nagataki
Associate Professor (A)

Ken-iti Izawa
Associate Professor (E)

Yoshiko Kanada-Enyo
Associate Professor (N) [– 2010.3.1]

Kenji Fukushima
Associate Professor (N)

Kazuo Hosomichi
Associate Professor (E) [2009.1.1 –]

Takao Morinari
Research Associate (C)

Daisuke Jido
Research Associate (N)

Seiji Terashima
Research Associate (E)

Hirofumi Wada
Research Associate (C)

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. Hans Feldmeier
(GSI, Darmstadt)
2009.4.1 — 2009.6.30
Nuclear structure and reaction theory with microscopic ab-initio methods

Prof. Tomio Yamakoshi Petrosky
(University of Texas,Austin)
2009.7.1 — 2009.9.30
Roles of Complex Spectral Analysis of the Liouville Equation in Nonequilibrium Physics

Prof. Andrei Marshakov
(LPI, ITEP)
2009.10.1 — 2009.12.31
Strings, supersymmetric gauge theories and integrable systems

Prof. David Graham Wands
(University of Portsmouth)
2010.1.1 — 2010.3.31
Theory of early universe

1.2 Research Fellows and Graduate Students (2009 April – 2010 March)

Research Fellows

Yuuiti Sendouda (A) [2007.4.1 – 2010.3.31]

Antonino Flachi (A) [2007.10.1 – 2010.3.31]

Toru Takahashi (N) [2007.10.1 – 2010.3.31]

Antonio Enea Romano (A) [2007.10.28 – 2009.10.27]

Kotaro Miura (N) [2008.4.1 – 2010.3.31]

Frederico Arroja (A) [2008.10.31 – 2010.10.30]

Eigo Shintani (E) [2009.2.1 – 2009.5.31]

Takatoshi Ichikawa (N) [2009.4.1 – 2010.3.31]

Eiji Kaneshita (C) [2009.4.1 – 2010.3.31]

Naoki Yoshioka (C) [2009.4.1 – 2010.3.31]

Shunichiro Kinoshita (A) [2009.4.1 – 2010.3.31]

Masato Taki (E) [2009.4.1 – 2010.3.31]

Yuya Sasai (E) [2009.4.1 – 2010.3.31]

Kazunobu Maruyoshi (E) [2009.4.1 – 2010.3.31]

Ryo Takahashi (A) [2009.4.1 –]

Marco Ruggieri (N) [2009.9.28 – 2011.9.27]

Takashi Shimomura (E) [2009.10.1 – 2010.3.31]

Charles Young (E) [2009.10.14 – 2010.10.31]

Luca Baiotti (A) [2009.11.1 –]

Janson Andrew Doukas (A) [2009.11.25 –]

Kenta Kiuchi (A) [2010.2.1 –]

Alberto Martinez Torres (N) [2010.3.10 –]

Graduate Students

Koji Azuma (E) [2009.4.1 –]

Masahiro Ikeda (C) [2009.4.1 –]

Kouki Ishimoto (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 –]

Youri Doeleman (A) [2009.4.1 –]

Takeshi Kuroiwa (C) [2008.4.1 –]

Kazuhiko Kamikado (N) [2008.4.1 –]

Manabu Sakai (E) [2008.4.1 –]

Shingo Mizuguchi (E) [2008.4.1 –]

Kazuya Misao (A) [2008.4.1 –]

Hirotada Okawa (A) [2007.4.1 –]

Maiko Kouriki (E) [2007.4.1 –]

Kentaro Tanabe (A) [2007.4.1 –]

Yuichiro Nakai (E) [2007.4.1 –]

Atsushi Naruko (A) [2007.4.1 –]

Tatsuhiro Misumi (E) [2007.4.1 –]

Takahiro Himura (C) [2007.4.1 –]

Takanori Sugimoto (C) [2007.4.1 –]

Sugure Tanzawa (A) [2005.4.1 –]

Masaki Murata (E) [2006.4.1 –]

Noriaki Ogawa (E) [2006.4.1 –]

Daisuke Yamauchi (A) [2006.4.1 –]

Junichi Aoi (A) [2006.4.1 –]

Hiroyuki Yoshidsumi (C) [2006.4.1 –]

Kuniyasu Saitoh (C) [2008.4.1 –]

Chihiro Nakajima (C) [2007.4.1 –]

Mitsuhisa Ohta (E) [2005.4.1 –]

Kohta Murase (A) [2005.4.1 –]

Hiroaki Ueda (C) [2005.4.1 –]

Hiroshi Ohki (C) [2005.4.1 –]

Tetsuya Mitsudo (C) [2006.7.1 –]

Atsushi Kawarada (C) [2006.7.1 –]

Ph.D Awarded

Hiroaki Ueda
Study on various phases emerging from magnon Bose-Einstein condensation (C)
(supervisor: Keisuke Totsuka)

Chihiro Nakajima
Molecular Transport through a Bottleneck Driven by External Force (C)
(supervisor: Hisao Hayakawa)

Mitsuhisa Ohta
Classification of Supersymmetric Solutions in Supergravity (E)
(supervisor: Hiroshi Kunitomo)

Kohta Murase
High-Energy Phenomena in Extreme Astrophysical Objects and the Origin of High-Energy Cosmic Rays (A)
(supervisor: Shigehiro Nagataki)

Chapter 2

Research Activities

2.1 Research Summary

Astrophysics and Cosmology Group

Braneworld

A. Flachi and T. Tanaka considered the Casimir effect between two parallel plates localized on a brane. They argued that to properly compute the contribution to the Casimir energy due to any higher dimensional field, it is necessary to take into account the localization properties of the Kaluza-Klein modes.

T. Tanaka in collaboration with N. Tanahashi investigated the holography in the Karch-Randall (KR) braneworld model by constructing time-symmetric initial data of black holes floating in the bulk. They compared it with its holographic dual, which is described by four-dimensional self-gravitating conformal field theory (CFT) in asymptotically AdS_4 spacetime. They found that the phase structures and characteristic values between the two theories agree well. To study further the four-dimensional CFT side, T. Tanaka and A. Flachi in collaboration with K. Kashiyama and N. Tanahashi analyzed the effects of the back reaction due to a CFT on a AdS-Schwarzschild black hole spacetime. They studied the geometry numerically approximating the CFT by a radiation fluid. They found a sequence of configurations without a horizon in thermal equilibrium (CFT stars), followed by a sequence of configurations with a horizon. These sequences perfectly match with a sequence of five-dimensional floating black holes followed by a sequence of brane localized black holes.

IR loop effects during inflation

T. Tanaka in collaboration with Y. Urakawa studied various aspects of IR divergences during inflation. A naive computation of the correlation functions of fluctuations generated during inflation suffers from logarithmic divergences in the infrared (IR) limit. They proposed one way to solve this IR divergence problem in the single-field inflation model. The key observation is that the variables that are commonly used in describing fluctuations are influenced by what we cannot observe. Introducing a new perturbation variable which mimics what we actually observe, they proposed a new prescription to solve the time evolution of perturbation in which this leakage of information from the unobservable region of the universe is shut off. They gave a proof that IR divergences are absent as long as we follow this new scheme. They also showed that the secular growth of the amplitude of perturbation is also suppressed. They further extended the discussions to a multi field inflation model and showed that, as long as one considers the case that the non-linear interaction acts for a finite time duration, observable fluctuations are free from IR divergences even in the multi field model. In contrast to the single field model, to discuss observables, it turned out to be necessary to take into account the effects of quantum decoherence which pick up a unique history of the universe from various possibilities contained in initial quantum state set naturally in the early stage of the universe.

Non-gaussianity from inflation

F. Arroja and T. Tanaka in collaboration with S. Mizuno and K. Koyama computed the tree-level connected four-point function of the primordial curvature perturbation for a fairly general minimally coupled single field inflationary model, where the inflaton's Lagrangian is a general function of the scalar field and its first derivatives. They also showed that higher-order actions for cosmological perturbations in the multi-field DBI-inflation model are obtained by a Lorentz boost from the rest frame of the brane to the frame where the brane is moving. At the third order, the interaction Hamiltonian arises purely by the boost from the second-order action in the rest frame of the brane. The boost acts on the adiabatic and entropy modes in the same way, and thus, there exists a symmetry between the adiabatic and entropy modes. However, at fourth order this symmetry is broken due to the intrinsic fourth-order action in the rest frame and the difference between the Lagrangian and the interaction Hamiltonian. Therefore, the momentum dependence of the purely adiabatic component and the components including the entropic contributions are different in the four-point function. This suggests that the trispectrum can distinguish the multi-field DBI-inflation model from the single field DBI-inflation model.

Cosmology in higher-dimensional gravity

M. Sasaki and his collaborators studied cosmology of the Einstein-Yang-Mills theory in ten dimensions with a quadratic term in the Yang-Mills field strength. They obtained analytically a class of cosmological solutions in which the extra dimensions are static and the scale factor of the four-dimensional Friedmann-Lemaitre-Robertson-Walker metric is an exponential function of time. This means that the model can explain inflation. Then they looked for solutions that describe dynamical compactification of the extra dimensions. It is found that there indeed exists a solution describing dynamical compactification with the extra dimensions undergoing damped oscillations and approaching the static metric.

Inflation and primordial black holes

M. Sasaki and I. Zaballa studied the effect on the primordial cosmological perturbations of a sharp transition from inflationary to a radiation and matter dominated epoch respectively. It is found that for a certain range of scales inside the horizon at the end of inflation, the amplitude of the perturbations are enhanced relative to the superhorizon scales. This enhancement may lead to the overproduction of primordial black holes, and therefore constrain the dynamics of the transitions that take place at the end of inflation.

High-dimension numerical relativity

Since a possibility of black hole (BH) formation in particle accelerators was pointed out, studies for BHs in higher-dimensional spacetimes have been accelerated. If our space is a 3-brane in large or warped extra dimensions, the Planck energy could be of $O(\mathrm{TeV})$ that may be accessible with huge particle accelerators like the Large Hadron Collider (LHC). In the presence of the extra dimensions, mini BHs may be produced in the accelerators and its evidence may be detected. Since BH formation is highly nonlinear gravitational phenomena, the unique method for clarifying the formation process and cross section for the BH formation is numerical relativity. M. Shibata with H. Yoshino developed a new numerical code, *SACRA-ND*, by which simulation may be performed for the asymptotically flat spacetime with any dimensionality, and performed numerical-relativity simulations for rotating black holes for 5–8 dimensions. They found that for the rapidly rotating case, the black hole is dynamically unstable against bar-like deformation irrespective of the dimensionality. They also showed that the unstable black hole spontaneously emits gravitational waves, spins down, and eventually relaxes to a stable state in which the black hole is rotating more slowly than the initial one. M. Shibata with K. Nakao, H. Abe, and Y. Yoshino also derived a semi-analytic solution of non-rotating black hole in the maximum slicing for arbitrary dimensions, which can be used for a test of a high-dimensional numerical-relativity code.

Black hole at collider

A. Flachi, M. Sasaki and T. Tanaka considered the evaporation of rotating micro black holes produced in highly energetic particle collisions, taking into account the polarization due to the coupling between the spin of the emitted particles and the angular momentum of the black hole. They found that the effect of rotation shows up in the helicity dependent angular distribution significantly. By using this effect, there is a possibility to determine the axis of rotation for each black hole formed, suggesting a way to improve the statistics.

Time evolution of holographic superconductor

S. Kinoshita in collaboration with N. Tanahashi and K. Murata studied non-equilibrium condensation process in a holographic superconductor. In this model, when the temperature is smaller than a critical temperature, there are two black hole solutions: the Reissner-Nordström-AdS black hole (RN-AdS BH) and a black hole with a scalar hair (hairy BH). They numerically solved time evolutions of the Einstein-Maxwell-charged scalar system in the asymptotically AdS spacetime, and showed that the hairy BHs are the final states for the instability of the low temperature RN-AdS BHs.

Gravitational self force in black hole perturbation

N. Sago with L. Barack developed a numerical code to calculate the gravitational self force on a point mass orbiting a Schwarzschild black hole. Using this code, they computed the conservative self-force correction to the precession rate of small eccentric orbits. Also, in collaboration with L. Barack and T. Damour, Sago found a gauge-invariant relation between the correction to the precession rate and the dimensionless gravitational potential, which can be used to compare with the results of the post-Newtonian theory, and to explore both weak-field and strong-field aspects of the Effective One Body formalism.

General relativistic magnetohydrodynamic simulation of gamma-ray bursts

The mechanism of the central engine of long gamma-ray bursts (GRBs) is still unknown. One of the most promising scenarios of the GRBs is a collapsar model: A fast rotating black hole is born at the center of the massive star as a result of gravitational collapse, and then a relativistic jet is launched from the black hole with a help of magnetic fields. Then the jet is observed as a GRB. Since the system of the central region of massive stars and its dynamics are complicated, it is important and necessary to perform realistic numerical simulations by supercomputers for complete understanding of the mechanism of GRBs. In the simulation, strong gravitation and magnetic fields have to be treated properly. S. Nagataki has succeeded in developing a two/three-dimensional General Relativistic Magnetohydro dynamic code in the fixed Kerr spacetime that is tuned so that it is applicable to supercomputers.

Ultra-High energy cosmic rays

Ultra-High Energy cosmic Rays (UHECRs), whose energy amounts to 10^{20}eV, are one of the most fascinating phenomena of astronomy and astrophysics. It is still unsolved where they are produced, and thus, the origin of UHECRs is one of the most fascinating mysteries of astrophysics and astronomy in 21st century. Recent observations tell us that the composition of UHECRs is hadronic, so they suffer from magnetic fields in space. Numerical study of propagation of UHECRs in the universe is necessary to interpret the observations such as arrival direction of UHECRs and to discuss the spatial correlation between arrival direction and possible source candidates. K. Kotera, D. Allard, J. Aoi, K. Murase, Y. Dubois, and S. Nagataki studied propagation of UHE-Nuclei (from proton to iron) in a galaxy cluster with magnetic fields. They estimated how much UHECRs in a galaxy cluster suffer from magnetic bending and produce secondaries (gamma-rays and neutrinos) during propagation. We concluded that these secondaries can be detected by current/future satellites and telescopes.

Very high-energy gamma-rays from GRBs

It is proved by Fermi Satellite that gamma-ray bursts

(GRBs) can emit very high-energy (GeV) gamma-rays. K. Murase, K. Toma, R. Yamazaki, K. Ioka, and S. Nagataki studied high-energy gamma-ray afterglow emission from GRBs in the prior emission model, which is proposed to explain the plateau phase of the X-ray afterglow. This model predicts the high-energy gamma-ray emission when the prompt GRB photons from the main flow are up-scattered by relativistic electrons accelerated at the external shock due to the prior flow. The expected spectrum has the peak of $\sim$ 10–100 GeV at around the end time of the plateau phase for typical GRBs, and high-energy gamma-rays from nearby and/or energetic GRBs can be detected by the current and future Cherenkov telescopes such as MAGIC, VERITAS, CTA and possibly Fermi. Multiwavelength observations by ground-based optical telescopes as well as Fermi and/or Swift satellites are important to constrain the model. Such external inverse-Compton emission may even lead to GeV-TeV gamma-ray signals with the delay time of 10-100 s, only if the plateau phase is short lived.

Double neutron star and black hole-neutron star binaries

The final phase of compact binary systems composed of neutron star (NS) and/or black hole (BH) is among the most promising source for kilo-meter-size laserinterferometric gravitational-wave detectors. The merger of NS-NS or BH-NS binaries is also a likely progenitor of the central engine of short gamma-ray bursts (GRBs). To accurately predict gravitational waveforms in the late inspiral and merger phases of these binaries as well as to clarify the merger process for studying the merger hypothesis for the short GRBs, it is necessary to solve Einstein's equation as well as the hydro/magnetohydrodynamic equations taking into account a realistic microphysics for NSs. The unique theoretical approach to this issue is numerical relativity, in which all these equations are solved numerically. M. Shibata, K. Kiuchi, & K. Kyutoku, with K. Taniguchi & Y. Sekiguchi, performed numerical simulations for NS-NS and BH-NS binaries in the framework of numerical relativity changing mass and equations of state for a wide range. For NS-NS binaries, they clarified the dependence of gravitational waveforms on the equations of state and masses of NSs, in particular for the case that a BH is formed after the merger. For BH-NS binaries, they developed a numerical-relativity code for computing quasiequilibrium circular orbits with arbitrary mass, spin, and equation of state, that can be employed as the initial condition of numerical-relativity simulation. Subsequently, they performed numerical simulations for a variety of equations of state with nonspinning BH and quantitatively clarified that gravitational-wave frequency at the onset of tidal disruption of NS depends strongly on the equation of state. These imply that detection of gravitational waves will lead to constraining equations of state of nuclear matter. For the case that NS is tidally disrupted by nonspinning BH, a disk of mass ~ 0.01–$0.1 M_\odot$ may be formed. The formed BH-disk system was shown to have a favorable property for the short GRB.

L. Baiotti and M. Shibata performed several simulations for NS-NS binary using two different numerical-relativity codes (*SACRA* and *Whisky*), and compared the results for the first time in this field. These two results agree well with each other, and this confirms the reliability of the results of numerical-relativity simulations.

Condensed Matter and Statistical Dynamics Group

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 nanophysics, granular physics, nonlinear rheology in glassy materials, biomechanics, and system biology. This academic year, Hayakawa has organized an international long-term workshop " Frontiers in Nonequilibrium Physics -Fundamental Theory, Glassy & Granular Materials and Computational Physics-" and the symposium of YKIS2009 "Frontiers in Nonequilibrium Physics".

Jamming transition for sheared granular materials
Jamming transition is an athermal and a rigidity transition. Otsuki and Hayakawa intensively verified the validity of a universal scaling law for the jamming transition of frictionless granular materials which they found last year. Both authors have been invited in many occasions.

Nonequilibrium dynamics of nano-particles:
Physics of nano-paryicles is strongly affected by thermal fluctuation and the boundary condition. Saitoh and Hayakawa investigated deposition of nanoclusters on a surface and found an interesting wetting transition. Nakajima and Hayakawa studied motion of molecules driven by external field, and found that there is a jamming transition which is affected by details of interaction form of molecules.

Long-range correlations for sheared liquids
Sheared dense liquids approach nonequilibrium steady states under the balance of viscous heating and dissipations. One of characteristics for such systems are the existence of the long-range correlations. Based on fluctuating hydrodynamics, Otsuki and Hayakawa developed an unified theory of the long-range correlation and the long-range correlations. The validity of their theory has been confirmed by their extensive simulation.

Experiment of granular gas under microgravity environment
Granular gas is not easy achieved in usual experiments, but it can be obtained under microgravity environment. Tatsumi, Murayama, Hayakawa and Sano performed such an experiment at Komaki airport and finally published its result in JFM. This study was used as the main part of thesis of Dr. Tatsumi, Univ. Tokyo.long-range correlation and the long-range correlations. The validity of their theory has been confirmed by their extensive simulation.

Evolution of living organisms
Murase organized international and interdisciplinary workshop entitled "What is Evolution?" in cooperation with Asia-Pacific Center for Theoretical Physics (APCTP) in Korea, International Institute for Advanced Studies at Kyoto, and Institute of Economic Research of the Kyoto University. The year 2009 is the bicentennial of Charles Darwin's birth. In addition, it is the bicentennial since Jean-Baptiste Lamarck published the book "Zoological Philosophy". It is, therefore, timely to coorganize this workshop. Murase considered evolution as multiphase dynamical processes involving Darwinian natural selection and Lamarckian inheritance of acquired character. Disease such as cancer and Alzheimer's Diseases can be viewed as microevolution at the cellular and intracellular level, respectively. This implies the double-edged sword of evolution itself.

Dynaimcs and mechanics of biological filaments and their networks driven out of equilibrium
Studies on thin elastic objects in viscous fluids offer particularly interesting oppotunities to understand a variety of forms of filaments and polymers found in molecular and cellular biology. (1) Using dynamic simulations and scaling arguments, Wada, Alexander-Katz, and Netz studied internal friction of globuler proteins and of condensed DNA filaments, in order to nail down its physical origin. Their resutls are in good agreement with data obtained from DNA micro-manipulation experiments. (2) Wada and Netz investigated thoroughly the swimming hydrodynamics of a filamentous bacterium Sprioplasma using elastohydrodynamic simulations and analytic arguments. Various parameters characterizing the bacterial cell shape are shown to be optimized for achieving its maximal motiliy. (3) Combining numerical and analytical approaches, Wada and Netz explored a nonlinear regime of twist transport in a semifleixlble polymer chain. Twist transport couples with writhing of the chain, and there is a dynamical transition from simple axial spinning to plectoneme-dominated regime where the effective rotational friction decreases nonlinearly. (4) Finally, Wada and Tanaka examiend effective elasticity of composite networks of semiflexilbe polymers within linear elasticity theory. They showed that effective elastic modulus can be size-dependent due to mutual couplings between components with different mechanical properties. These results will be useful to understand unique mechanical properties found in biological celluar cytoskeletons and tissues.

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 electron systems, physics of the iron-based- and the cuprate superconductors, and exotic phenomena in low-dimensional quantum magnetism.

Charge Properties in Cuprate High-T_c Superconductors: Charge occupations and its dynamics are crucial for understanding the mechanism of high-temperature superconductivity in copper oxides. Tohyama and his collaborators examined nuclear quadrupole resonance (NQR) frequency sensitive to charge occupation in each copper-oxyge plane in multilayered cuprates. The ^{63}Cu NQR frequency is calculated in the cluster model by the exact diagonalization method. The charge imbalance between the outer plane with apical oxygen and the inner plane without in three-layered cuprate is estimated by comparing our results with the experimental NQR frequency. The obtained results show that the NQR frequency is a useful quantity for estimating the charge imbalance in the multilayered cuprates. Tohyama and his collaborators also examined the influence of nickel impurity in cuprates on the distribution of hole carriers by performing numerically exact diagonalization calculations for a model consisting of copper, nickel, and oxygen orbitals. Using realistic parameters for the system, they found that a hole is predominantly bound to oxygen orbitals around the nickel impurity forming the Zhang-Rice doublet. This imposes strong restrictions on modeling nickel-substituted cuprates. They also proposed a resonant inelastic x-ray scattering experiment for nickel-K edge to confirm hole binding around the nickel impurity.

Short-Range Antiferromagnetic Correlation Effect on Pseudogap in High-Tc Cuprates: Recent quantum oscillation observations reported the presence of a small electron pocket in the underdoped cuprate high-temperature superconductors. From the observed oscillation period, it was found that the Fermi surface consists of small pockets. Further detailed analysis of the sign change of the Hall coefficient, it was found that the negative Hall coefficient is not associated with vortices but with the electronic properties. Contrary to the quantum oscillation results, any electron pocket has never been observed in angle resolved photoemission spectroscopy (ARPES). In ARPES, an arc-like truncated Fermi surface has been observed in the underdoped cuprates. So there is inconsistency between these two experiments. Morinari investigated the effect of short-range antiferromagnetic correlations on the psuedogap phase. For the description of the pseudogap phase, the Hamiltonian describing a d-density wave correlation is assumed which has the same Hamiltonian as that for a system of composite particles consisting of a doped hole and a skyrmion spin texture. It was found that for moderate d-density wave correlations an electron pocket appears but such an electron pocket is unstable against antiferromagnetic fluctuations. When the antiferromagnetic correlation length becomes comparable to the lattice constant, the electron pocket feature is smeared out. The Hall resistance was calculated with including the electron band and the hole band using a finite temperature formula, and the result was in good agreement with the experiment.

Interlayer Magnetoresistance in Iron-Based Superconductors: Iron-based superconductors are layered high-temperature superconductors first reported in 2008. Contrary to other superconductors, the system has several hole and electron Fermi surfaces with comparable sizes. For the study of superconductivity, determination of the Fermi surface topology plays an important role to make clear the basic electronic structure of a superconductor. For layered compounds, angle-resolved photoemission spectroscopy (ARPES) can be used to study the Fermi surface but ARPES measurements are sensitive to surface conditions. On the other hand, magnetic quantum oscillations provide information about the Fermi surface area perpendicular to the applied magnetic field. Although the Fermi surface areas determined by magnetic quantum oscillations are bulk electronic properties, this technique does not provide direct information about the Fermi surface topology. Morinari, Tohyama, and their collaborators proposed interlayer magnetoresistance experiments to probe the bulk Fermi surface topology. The interlayer magnetoresistance was calculated using the band structure provided by first principles calculations. They demonstrated that the interlayer magnetoresistance is useful to extract information about Fermi surface topology even for a multi-Fermi surface case. In particular it was predicted that the change of the Fermi surface topology accompanied by the antiferromagnetic transition can be detected by the interlayer magnetoresistance measurement.

Modeling the Antiferromagnetic Phase in Iron Pnictides: Kaneshita, Morinari, and Tohyama examined electronic states of antiferromagnetic phase in iron pnictides by mean-field calculations of the optical conductivity. They found that a five-band model exhibiting a small magnetic moment, inconsistent with the first-principles calculations, reproduces well the excitation spectra characterized by a multipeak structure emerging below the Néel temperature at low energy, together with an almost temperature-independent structure at high energy. Investigating the interlayer magnetoresistance for this model, they also predicted its characteristic field dependence reflecting the Fermi surface. This work was selected as a research highlight of NPG Asia Materials (doi:10.1038/asiamat.2010.42).

Induced Order in Nonequivalent Two-Leg Hubbard Ladder: Motivated by the presence of different orders in multilayered high-temperature superconductors, Yoshizumi, Tohyama, and Morinari examined a model consisting of nonequivalent two Hubbard chains coupled by interchain hopping by using the density-matrix renormalization group and a mean-field theory. As an example, we considered a system with noninteracting chain without order and a Hubbard chain with strong antiferromagnetic (AF) spin-density-wave correlation. They found that the magnitude of the interchain hopping controls the strength of induced AF correlation as well as that of original one. It was also found that the induced AF correlation decreases with increasing the magnitude of the original correlation.

Bipolaron in the t-J Model Coupled to Longitudinal and Transverse Quantum Lattice Vibrations: Tohyama and his collaborators explored the influence of two different polarizations of quantum oxygen vibrations on the spacial symmetry of the bound magnetic bipolaron in the context of the t-J model by using exact diagonalization within a limited functional space. Linear as well as quadratic electron-phonon coupling to transverse polarization stabilize d-wave symmetry. The existence of a magnetic background is essential for the formation of a d-wave bipolaron state. With increasing linear electron-phonon coupling to longitudinal polarization the symmetry of a d-wave bipolaron state changes to a p-wave. Bipolaron develops a large anisotropic effective mass.

Phase Diagram of Three-Dimensional Quantum Helimagnets: In a class of frustrated magnets, the existence of completing interactions stabilizes such non-collinear magnetic structures as a spiral one (helimagnet) and sometimes exhibit an interesting cross effect between electric polarization and magnetization. A quasi one-dimensional compound $LiCuVO_4$ is one of such helimagnetic materials which has been studied extensively. These helimagnets are interesting in its own right since it has been predicted theoretically that various unconventional phases dubbed multipolar phases are realized in one-dimensional helimagnets. Therefore, these helimagnetic materials are playgrounds to realize the condensation of multi-magnon (bosons) bound states and the consequent exotic superfluids (multipolar phases). Although the investigation of the effects of three-dimensional couplings is indispensable in view of the experimental observation of such unconventional phases, most studies have concentrated solely on one-dimensional systems. Ueda and Totsuka considered a simple model of three-dimensional quantum helimagnets by using the dilute-Bose-gas technique and mapped out the phase diagram containing at least two unconventional phases ('fan' and 'spin-nematic') as well as the standard conical phase. Moreover, they considered the low-energy physics of the nematic phase by using an effective Ginzburg-Landau-type model derived microscopically from the original model.

Spin Supersolids on Body-Centered Cubic (bcc) Lattice: Since the pioneering work of Matsubara and Matsuda, the analogy between quantum spin systems and lattice boson systems has been used extensively. In 1970s, one the basis of the mean-field analysis done for the effective spin model, the existence of an interesting phase, where superfluid (off-diagonal) long-range order and (diagonal) order in the boson density coexist (i.e. supersolid), in ^{4}He has been predicted. In order to see how quantum fluctuations affect the above mean-field results , Ueda and Totsuka investigated anisotropic spin-S systems on a bcc lattice by a combined use of the dilute-Bose-gas approximation and the $1/S$-expansion to conclude that the supersolid phase in ^{4}He predicted by Liu and Fisher some time ago might be washed away by quantum fluctuations.

Effects of Anisotropic Interactions in Two-Dimensional Shastry-Sutherland Model: The quasi-two-dimensional compound $SrCu_2(BO_3)_2$ has a geometrically unique structure and is known to exhibit many interesting properties e.g. magnetization plateaus and an almost flat magnetic dispersion. Although the simplest theoretical model (Shastry-Suterland model) already captured several features of the compound, many things are yet to be fully understood. Among those open questions are the full phase diagram in magnetic fields and the behavior of the ESR spectra in magnetic phases (e.g. plateau phases). Romhányi, Totsuka and Penc developed a unifying approach to these problems based on the bond-operator mean-field theory and mapped out the phase diagrams for various types of anisotropies and different directions of the applied fields.

Matrix-Product-State Approach to Supersymmetric Valence-Bond-Solid Model: The valence-bond-solid (VBS) model is a paradigmatic model for the gapped spin-liquids in one dimension. Recently, it has been pointed out that one can construct an exactly solvable generalization of the VBS model containing hole (fermionic) degrees of freedom. Hasebe and Totsuka investigated its ground-state properties (e.g. string correlations, etc.) by using the matrix-product-state formalism.

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 2009.

Nuclear structure and reaction

One of the goals of nuclear physics is to construct a unified comprehensive microscopic framework which can describe i) nuclear structure properties , ii) nuclear excitations (the variety of nuclear collective phenomena), and iii) nuclear reactions (fusion and fission). Recently, various new phenomena have been discovered in a region of unstable nuclei far from the stability line due to the progress of experimental facilities such as the RI beam factory. In theoretical studies of nuclear structure, it is desired to understand these phenomena of exotic nuclei and to provide theoretical predictions.

For researches on nuclear reactions, Ichikawa and his collaborators investigated deep-subbarrier fusion reactions, especially for steep-falloff phenomena of fusion cross sections at extremely low incident energies. They proposed an extension of the standard coupled-channel model, in order to describe smooth transitions from the sudden two-body to the adiabatic one-body systems. It was found that the quantum tunneling in the density overlap region of colliding two nuclei is responsible for the steep-falloff phenomena.

Ichikawa and his collaborators investigated possibilities of the non-1n channel for the cold-fusion reactions in order to synthesize the superheavy nuclei. They extended the fusion-by-diffusion model to the non-1n reaction channels and estimated those in the worst-case scenario. It was shown that the possibilities of the non-1n reaction channel are small under the actual experimental condition in the ^{70}Zr+^{209}Bi reaction.

For structure of light-weight nuclei, Kanada-En'yo and her collaborators investigated structure of excited states in p-shell and sd-shell regions based on calculations with the AMD method. In particular, cluster structures in neutron-rich nuclei were focused. They studied the structures of C and Ne isotopes and suggested possible appearance of developed cluster states in excited states near the corresponding threshold energy. It was found that α-cluster states and 2α cluster states may often appear in neutron-rich nuclei as well as stable nuclei. In neutron-rich nuclei near the drip line, "dineutron correlations", which are the strong spatial correlations between two neutrons coupling to spin zero, is one of the recent key issues.

Kanada-En'yo, Feldmeier and their collaborators investigated spatial correlations of spin-zero neutron pairs in ^{6}He and ^{8}He by analyzing two-neutron density of microscopic wave functions obtained by AMD. Results suggest the dineutron correlations at the surface of the neutron-rich He isotopes. It was found that the dineutron correlations are weaker in the ground state of ^{8}He than in ^{6}He but again pronounced in the excited state(0_2^+) of ^{8}He.

Hadron structure and dynamics

Production of hyperon resonances induced by kaon on deuteron target: Yamagata-Sekihara, Jido and Sekihara studied $K^-d \to Y^*N$ reactions based on coupled channels chiral dynamics to investigate the kaon induced production of hyperon resonances. The notable feature of this reaction is that the hyperon resonances located below the $\bar{K}N$ threshold, such as the $\Lambda(1405)$ and $\Sigma(1385)$ resonances, can be produced by the $\bar{K}N$ channel with help of nuclear effects. Having showed the πY invariant-mass spectra, they found the resonance peaks corresponding to the $\Lambda(1405)$ and $\Sigma(1385)$ at 1420 and 1385 MeV, respectively, with different angle dependences. They also estimated the background contributions of $K^-d \to \pi Y n$ coming form pion exchange, in order to make further comparison with the past experimental spectra and ones which will be observed in J-PARC.

Possible quantum numbers of the pentaquark $\Theta^+(1540)$ in QCD sum rules: Jido and his collaborators investigated the pentaquark $\Theta^+(1540)$ state by employing the QCD sum rules technique for the states with strangeness $S=+1$ and $(IJ^P) = (0,1/2^\pm)$, $(1,1/2^\pm)$, $(0,3/2^\pm)$, $(1,3/2^\pm)$. Throughout the calculation, emphasis was laid on the establishment of a valid Borel window, which corresponds to a region of the Borel mass, where the operator product expansion converges and the presumed ground state pole dominates the sum rules. Such a Borel window was achieved by constructing the sum rules from the difference of two independent correlators and by calculating the operator product expansion up to dimension 14. Furthermore, they discussed the possibility of the contamination of the sum rules by possible KN scattering states. As a result, they concluded that the $(0,3/2^+)$ state was the most probable candidate for the experimentally observed $\Theta^+(1540)$, while the states with $(0,1/2^-)$, $(1,1/2^-)$, $(1,3/2^+)$ were found to be at somewhat higher mass regions.

The NJL-jet model for quark fragmentation function: Quark fragmentation functions are studied in the framework of the NJL-model for hadrons. Concentrating on the pion fragmentation, Yazaki and his collaborators first find why the elementary (lowest order) fragmentation process is completely inadequate to describe the empirical data, although the "crossed" process describes the quark distribution function reasonably well. Taking into account cascade-like processes in a generalized jet-model approach, they obtain a reasonable description of the fragmentation function without introducing ad hoc parameters.

Hadronic interactions from SU(2) lattice QCD: Toru T. Takahashi and Yoshiko Kanada-En'yo investigated hadron-hadron interactions from Bethe-Salpeter amplitudes in SU(2) lattice QCD to clarify the essentials in hadronic interaction. In SU(2) QCD, an iso-scalar spin-0 diquark is the ground-state "baryon", and the bosons exchanged among them are restricted as compared to the SU(3) case, which makes the situation much simpler. They concentrated on S-wave scattering states of two scalar diquarks. Evaluating different flavor combinations with various quark masses, they tried to find out the ingredients in hadronic interactions. Between two scalar diquarks ($uC\gamma_5 d$, the lightest baryon in SU(2) system), they observed repulsion in short-range region, even though the quark masses are not very light. They defined and evaluated the "quark-exchange part" in the interaction, which is induced by adding quark-exchange diagrams, or equivalently, by introducing Pauli blocking among some of quarks. The repulsive force in short-distance region was found to arise only from the "quark-exchange part", and disappear when quark-exchange diagrams are omitted. They found that the strength of repulsion grows in light quark-mass regime and its quark-mass dependence is qualitatively consistent with the constituent-quark model picture that a color-magnetic interaction among quarks is the origin of repulsion. They also found a universal long-range attractive force, which enters in any flavor channels of two scalar diquarks and whose interaction range and strength are quark-mass independent.

Proton emission off nuclei induced by kaons in flight: Yamagata-Sekihara and her collaborators studied the (K^-, p) reaction on nuclei with a 1 GeV/c momentum kaon beam, paying special attention to the region of emitted protons having kinetic energy above 600 MeV, which was used to claim a deeply attractive kaon nucleus optical potential around 150-200 MeV. The simulation method, which they have adopted, offers flexibility to account for processes other than kaon quasielastic scattering, such as K^- absorption by one and two nucleons producing hyperons, and allows consideration of final-state interactions of the K^-, the p, and all other primary and secondary particles on their way out of the nucleus, as well as the weak decay of the produced hyperons into πN. They found a limited sensitivity of the cross section to the strength of the kaon optical potential and it is difficult to deduce the strength from the existing data.

$\Lambda(1405)$*-induced non-mesonic decay in kaonic nuclei:* Jido and Kanada-En'yo in collaboration with Sekihara investigated non-mesonic decay of kaonic nuclei under a $\Lambda(1405)$ doorway picture where the $\bar{K}$ absorptions in nuclei take place through the $\Lambda(1405)$ resonance. Calculating $\Lambda(1405)N$ to YN transitions in one-meson exchange, they found that the non-mesonic decay ratio $\Gamma_{\Lambda N}/\Gamma_{\Sigma^0 N}$ depends strongly on the ratio of the couplings $\Lambda(1405)$-$\bar{K}N$ and $\Lambda(1405)$-$\pi\Sigma$. Especially a larger $\Lambda(1405)$-$\bar{K}N$ coupling leads to enhancement of the decay to ΛN. Using the chiral unitary approach for description of the $\bar{K}N$ amplitudes, they obtained $\Gamma_{\Lambda N}/\Gamma_{\Sigma^0 N} \approx 1.2$ almost independently of the nucleon density, and find the total two-nucleon absorption of the $\bar{K}$ in uniform nuclear matter to be 22 MeV at the normal density.

Formaion of ϕ mesic nuclei: Yamagata-Sekihara and her collaborators disscussed the structure and formation of the ϕ mesic nuclei to investigate the experimental feasibility of the formation of ϕ mesic nuclei, which are considered to be very interesting to deduce ϕ meson properties at finite density. They considered $(\bar{p}, \phi)$, (γ, p) and (π^-, n) reactions to produce a ϕ-meson inside the nucleus and evaluate the effects of its medium modifications to the reaction cross sections. They found that it may be possible to see peak structures in the reaction spectra for strong attractive ϕ meson nucleus potential cases.

The $a_1(1260)$ as a $\rho\pi$ resonance in nuclear matter: Jido and Luis Roca, who was a visitor of YITP, in collaboration with D. Cabrera and R. Rapp, studied the properties of the $a_1(1260)$ axial-vector resonance in a cold nuclear medium. In the vacuum, the $a_1(1260)$ resonance is generated dynamically from the interactions of a pseudoscalar and vector meson ($\rho\pi$ and $\bar{K}K^*$) in a coupled channel chiral unitary approach. Medium effects were implemented through the modification of the ρ and π propagators at finite nuclear density from well established microscopic many-body calculations. The in-medium pion spectral function accounts for the coupling to N-hole and Δ-hole excitations including short range correlations, whereas the in-medium ρ incorporates modifications of its virtual pion cloud as well as direct resonance-hole excitations. The resulting in-medium $a_1(1260)$ exhibits significant broadening with increasing density as reflected in the $\rho\pi$ scattering amplitude. The possible relation of their results with partial restoration of chiral symmetry in nuclear matter was discussed in terms of in-medium Weinberg sum rules.

Pion-nucleus potential and possibility of s-wave pion condensate in neutron stars revisited: While the charge chemical potential exceeds the pion mass in relativistic mean-field (RMF) models, s-wave negative pion condensate is expected to be suppressed by the pion-nucleus potential. Recent observation of deeply bound pionic atoms elucidated the details of the pion-nucleus potential including the s-wave potential. Jido and Ohnishi in collaboration with Sekihara and Tsubakihara discussed the possibility of s-wave pion condensate in neutron stars based on the experimentally suggested pion-nucleon potential and confirmed the above expectation. By using the proton fraction in neutron star matter in RMF, the pion potential in nuclear matter is obtained as a function of baryon density, and the in-medium pion energy is found to be larger than the charge chemical potential in most of the combinations of the pion optical potential and the RMF parameter sets. The density and proton fraction dependence of the optical potential should be investigated further.

QCD matter and phase diagram

Spectral function of the vector mesons in an AdS/QCD model: Fukushima and his collaborators, Fujita, Misumi, and Murata calculated the spectral functions of the vector mesons at finite temperature using a AdS/QCD model called the soft-wall model. They found that the delta-function peaks at zero temperature are gradually broadened in the spectral shape as a function of the energy, which is caused by the IR boundary condition at the horizon of the five-dimensional blackhole. They addressed an intuitive interpretation of the results as the absorption effects into the blackhole that corresponds to hot QCD matter in $(3+1)$ dimensions, that is, the vector mesons melt into a QCD medium. Fukushima and his collaborators with Kikuchi joining later in the collaboration further calculated the spectral functions of the axial-vector mesons, the scalar mesons, and the pseudo-scalar mesons and confirmed that their results are qualitatively in agreement with the trend seen in the lattice-QCD simulations.

QCD phase transition with the functional renormalization group equation: Fukushima and Kamikado, in a collaboration with Klein at Technische Universität München investigated the order of the chiral phase transition in QCD on the basis of the universality argument. This research was motivated by a possibility that the universality class of the chiral phase transition could be the same as a three-dimensional scalar theory with $U(N_f) \times U(N_f)$ symmetry since QCD instanton excitations are suppressed at high temperature. They analyzed the $O(N)$ and $U(2) \times U(2)$ scalar theories specifically using the functional renormalization group (FRG) equation. They found that the flow equations of coupling parameters derived from the FRG formalism reproduce the ε-expansion results. They also calculated the flow of the effective potential numerically. From the shape change of the effective potential they confirmed that the order of the phase transition in the $U(2) \times U(2)$ scalar theory is certainly of first order. They also discussed the relationship between the fixed-point and flow structure of coupling parameters and the order of the phase transition.

Strong coupling lattice study for the QCD phase diagram: Miura and Ohnishi in collaboration with Nakano and Kawamoto investigated the QCD phase diagram at finite temperature and quark chemical potential by using the strong coupling expansion in lattice QCD. They derived the analytic expression of the effective potential which describes the chiral phase transition, and studied the finite lattice-coupling effects on the phase diagram. They invented the Extended Hubbard-Stratonovich Transformation and proposed a relevant mean-field approximation scheme to evaluate finite coupling effects as modifications of constituent quark mass and chemical potential. The phase diagram evolved to the empirical shape via suppression of quark mass and chemical potential as well as their cancellations. In the context of this phase diagram evolution they pointed out that a Partially Chiral Restored Phase could be realized in dense QCD matter.

QCD in a strong magnetic field: Ruggieri and Fukushima, in collaboration with Gatto, performed the first self-consistent study, in the literature, about the two-flavor Nambu–Jona Lasinio model with the Polyakov loop (PNJL model) in the presence of a strong magnetic field, and a chiral chemical potential μ_5 which mimics the effect of imbalanced chirality due to QCD instanton and/or sphaleron transitions. They firstly focused on the properties of chiral symmetry breaking and deconfinement crossover under the strong magnetic field. Then they discussed the role of μ_5 on the phase structure. Finally they self-consistently computed the chirality charge, the electric current, and their susceptibility, which are all relevant to the Chiral Magnetic Effect (CME). Their central result is that the current susceptibility, which is related to the observable in heavy-ion collision experiments, are strongly enhanced at the chiral phase transition. Ruggieri and Fukushima continued the investigation of the CME and showed that, beside the anomaly-induced term, the CME current has a non-anomalous correction also which comes from interaction effects and expressed in terms of the current susceptibility. They have found that the correction is characteristically dependent on the number of quark flavors. The numerically estimated correction turn out to be a minor effect on heavy-ion collision experiments but could be testable in the lattice-QCD simulation.

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 accurately described by the Standard Model (SM) with $SU(3) \times SU(2) \times U(1)$ gauge group. However, this model cannot be a complete 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 one of the main topics, since this 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 existence of supersymmetry is highly expected, since this solves the hierarchy problem of the SM and unifies naturally the gauge couplings of the SM at a high energy scale, which suggests the existence of the Grand Unified Theory (GUT) of gauge fields and matters. On the other hand, however, supersymmetry is not observed in current experiments, and it is highly desired to find a natural way to reconcile this experimental fact with the theoretical requirement by finding an appropriate mechanism of spontaneous breaking of supersymmetry without destroying the desirable features. Supergravity, that is 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. Recently, a new method based on the duality between gravity and gauge theory has emerged from the study of string theory. This new method analyzes QCD in terms of gravity or string theory, and can relatively easily derive some results which are difficult to obtain directly from gauge theory per se.

It is yet not known how to incorporate the general relativity into the principle of quantum mechanics. Application of standard quantization procedure to the general relativity just leads to a problematic theory. It rather seems that a consistent theory of quantum gravity requires a new notion of space-time, which replaces the classical space-time notion that is a continuous smooth manifold. Non-commutative space-time (or fuzzy space more generally) is a candidate, which actually has been found 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 necessary 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 way of compactification determines the contents of gauge theory and matters in low energy, and finding realistic compactifications is an important topic. This is studied by the group members, accompanied by the study of the mathematical structures of compactification. However, practically infinite possibilities exist as compactification, 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 studied by the group members.

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 some topics in condensed matter physics and integrable systems, which have helped to widen the perspectives of field theory and particle physics.

Particle phenomenology and supersymmetry

— *dynamical supersymmetry breaking* —
In collaboration with Takahashi, Yanagida, Yonekura (Tokyo), *Izawa* investigated dynamical supersymmetry breaking in supersymmetric QCD with runaway-type potentials. That opened up a new possibility of dynamical supersymmetry breaking based on superconformal fixed points in vector-like models with singlets. Namely, by embedding the models into conformal field theories at high energies, the runaway potential is stabilized by strong quantum corrections to the potential. Although the quantum corrections are large, they can be controlled due to superconformal symmetry of the theories.

— *lepton flavor violation* —
Neutrino oscillation experiments disclosed that neutrinos are massive and mix each other. This fact clearly indicates that lepton flavour is violated in nature. *Shimomura* worked on the lepton flavor violation (LFV) in supersymmetric models, in particular, the analysis of FLV of charged leptons in Minimal Supersymmetric Standard

Model with Seesaw mechanism. He showed that the decay of sleptons into the neutralino and a lepton is sensitive to small FLV couplings when the mass difference of these particles is smaller than the mass of tau. He showed useful relations between branching ratios of LFV tau decays and the lifetime of the slepton.

— *10D super Yang-Mills theory* —
With Choi, Kobayashi, Maruyama, *Murata*, *Nakai*, *Ohki*, and *Sakai* studied 10D super Yang-Mills theory with the gauge groups E_6, E_7 and E_8. They considered the torus/orbifold compacfitication with magnetic fluxes and Wilson lines. The theories lead to interesting models in 4D with three families of quarks and leptons, whose profiles in extra dimensions are quasi-localized because of magnetic fluxes.

— *AdS/QCD model* —
In order to analyze the heavy quark dynamics at finite temperature, *Misumi* and *Murata* with collaborators constructed a new AdS/QCD model, based on the soft-wall model. As a matter of fact, the resulting spectral shape and the associated mass shift and width broadening are all in qualitative agreement with the lattice calculations.

QCD and lattice QCD

— *lattice fermions* —
Misumi and his collaborator studied properties of minimally doubled lattice fermions, which contain only two species doubling and are expected to apply to lattice QCD simulations. They generalized the Creutz-type fermion and revealed discrete symmetries possessed by it. They extended minimally doubled fermions to higher dimensions, where the range of parameters for minimal-doubling gets narrower with the dimensions increasing.

Quantum gravity

— *noncommutative space-time* —
Sasakura worked on the QFT in the noncommutative space-time with sl(2,R) Lie algebraic noncommutativity. This noncommutative field theory is known to be derived from the three-dimensional quantum gravity coupled with spinless particles. In collaboration with *Sasai*, he has checked the Cutkosky rule of the one-loop self-energy diagrams to study unitarity of the noncommutative QFT. They have shown that the Cutkosky rule holds if the mass of the scalar field is smaller than the reciprocal of the noncommutative scale.

— *noncommutative field theory* —
Sasai tested the possibility of deriving noncommutative field theories from topological theories with which spinning particles are coupled, for example, Chern-Simons theory with gauge group $ISO(3)$ (vanishing cosmological constant) or $SO(4)$ ($SO(3,1)$) (positive (negative) cosmological constant). He showed that Turaev-Viro model with which scalar particles are coupled reproduces the Wilson line observables of $SO(4)$ Chern-Simons theory.

— *tensor model* —
The tensor model is known to give an interesting model of quantum gravity with the idea of emergent space-time and gravity. A key ingredient of the general relativity is the diffeomorphism symmetry. Indeed *Sasakura* has shown that the diffeomorphism symmetry is also emergent when space-time is emergent in the tensor model.

String theory

— *heterotic supergravity* —
Kunitomo and *Ohta* analyzed the $AdS_3 \times \mathscr{M}_7$ type supersymmetric solutions, including non-trivial fluxes, of the Killing spinor equations in the heterotic supergravity. They classified these solutions by their G-structures and intrinsic torsions, for the cases that the number of Killing supinors N are equal to $1,2,3$ and 4. They found that the solutions cannot have non-trivial warp factor and the seven dimensional manifold $\mathscr{M}_7$ is charactrized by G_2 ($SU(3)$)-structures for $N = 1$ (2) case and $SU(2)$-structure for $N = 3$ and 4 cases. These cases were further classified using their nontrivial torsions. They also showed, including the leading α'-corrections, that the integrability conditions of the Killing spinor equations imply all the field equations if the Bianchi identities are imposed.

— *superstring field theory* —
Kugo, *Kunitomo*, *Kohriki* and *Murata* investigated the gauge fixing procedure of Modified cubic superstring field theory. This theory has the residual symmetry associated with the kernel of picture changing operators. They constructed the projection operators which project out the kernel of picture changing operators from the space of string fields. They also rewrote the known gauge fixing procedure for the Ramond sector using the Batalin-Vilkovisky formalism and applied the same method on the Neveu-Schwarz sector.

—*Montonen-Olive duality* —
Terashima with Tai and Hashimoto (RIKEN) investigated M2-brane effective actions and its implication to the Montonen-Olive duality. They derived 4-dimensional $N = 4$ $U(N)$ supersymmetric Yang-Mills theory from certain 3-dimensional Chern-Simons-matter theory with product gauge group $U(N)^{2n}$ in a scaling limit in which the corresponding orbifold becomes a torus. A part of the $SL(2,Z)$ duality of the 4-dimensional Yang-Mills theory was shown to be realized via the M2-brane action.

— *ABJM theory* —
Terashima and *Yagi* constructed a new classical solution in the ABJM theory corresponding to M5-branes with a non-zero self-dual three form flux. This is an M-theory lift of the D4-brane solution expressed as a non-commutative plane in the three dimensional super Yang-Mills theory. The solution is closely related with the three-algebra. The corresponding configuration of the M5-brane satisfies the equations of motion in the single M5-brane action. The tension of the M5-brane solution in the ABJM action agreed with the one computed from the single M5-brane action.

— *holographic duality* —
The Kerr/CFT correspondence is a conjectural holographic duality between an extremal black hole and a chiral 2d CFT. *Ogawa* and *Terashima* with Azeyanagi (Ky-

oto) researched the behavior of the Kerr/CFT black hole from the stringy duality point of view.

— elliptic genera —

The elliptic genus in sting theory is known to count the number of its BPS states. *Eguchi*, with Hikami decomposed the elliptic genera of various hyperKähler and Calabi-Yau manifolds into representations of world-sheet N=4 and N=2 superconformal algebras. They have shown that decomposition contains a finite sum over massless (BPS) representations together with an infinite sum over massive (non-BPS) representations whose multiplicities grow like (square root of) an exponential. In the context of compactified string theory the exponents are identified as the entropy of the back hole.

— AGT relations —

The AGT relations between the 4d $N = 4$ SU(2) SUSY gauge theory and the 2d Liouville theory were analyzed by using the approach of matrix model introduced by Dijkgraaf and Vafa. *Eguchi* and *Maruyoshi* have shown that the spectral curve of the matrix model reproduces the M-theory curve of SU(2) Seiberg-Witten theory and also recovers correctly its free-energy and discriminants in the range of flavours $2 \le N_f \le 4$.

— conformal invariant boundary conditions —

Hosomichi worked (together with Bourgine and Kostov at CEA Saclay) on the anisotropic boundary conditions for the dilute O(n) loop model with the methods of 2D quantum gravity, and solved the problem exactly on a dynamical lattice using the correspondence with a large N matrix model. The method involves formulating the disk two-point functions with ordinary and anisotropic boundary conditions as loop correlators in the matrix model, and then analysing the loop equations for these correlators in the scaling limit. The solution reproduces the boundary phase diagram and the boundary critical exponents obtained recently by Dubail, Jacobsen and Saleur. Moreover, the solution was also found to describe the bulk and the boundary deformations away from the anisotropic special transitions.

Condensed matter physics

— gauge theory and graphene —

Great attention has recently been directed to graphene, an atomic layer of graphite, which supports "Dirac fermions" as charge carriers and which thus is of interest to particle physicists as well. Of particular interest is bilayer graphene which has a unique property that its band gap is externally tunable. *Shizuya* examined some tunable properties of the nearly-degenerate pseudo-zero-mode Landau levels, specific to bilayer graphene, and pointed out that an interplay of the Coulomb interaction and an in-plane field leads to rich spectra of collective excitations, orbital-pseudospin waves. He also studied Coulombic many-body corrections to cyclotron resonance in graphene and its bilayers and pointed out the need for renormalization, and examined its consequences, in comparison with some recent experiments.

Integrable systems

— discrete quantum mechanics —

Schrödinger equation is the most fundamental and basic equation in micro-physics, in particular, for the explanation of the atomic and molecular spectra. At further smaller scale, as Heisenberg pointed out, a certain fundamental length is expected to play a role. Some years ago Odake (Shinshu) and *Sasaki* proposed 'discrete' quantum mechanics, in which the Schrödinger equation is a difference instead of a differential equation. They presented many exactly solvable examples which have the (q)-Askey scheme of hypergeometric orthogonal polynomials as the main parts of the eigenfunctions. These exactly solvable theories were made one by one specifically. Now they constructed a unified theory of exactly and quasi-exactly solvable discrete quantum mechanics, which covers most of the known ones and some new ones.

— exceptional orthogonal polynomials —

The eigenfunctions of solvable quantum mechanics usually consist of orthogonal polynomials times the ground-state wavefunction, which provides the orthogonality weight function of the corresponding orthogonal polynomials. Due to Bochner's theorem, it was firmly believed until recently, that only the classical polynomials, the Hermite, Lguerre and Jacobi polynomials satisfy the second order differential equations and thus could be the only solutions of Schrödinger equations. By allowing the orthogonal polynomials to start at degree ℓ ($\ell = 1, 2, \ldots$), instead of degree zero constant term, Odake and *Sasaki* constructed four families of infinitely many exceptional orthogonal polynomials as solutions of exactly solvable quantum mechanics. They are called J1, J2 X_ℓ Jacobi and L1, L2 X_ℓ Laguerre polynomials. The X_ℓ Jacobi polynomials are global solutions of a Fuchsian differential equation with $3 + \ell$ regular singularities. It should be stressed that global solutions of a Fuchsian differential equations with more than four regular singularities had been utterly unknown. They also constructed exceptional continuous Hahn, Wilson and Askey-Wilson polynomials.

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)."

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.

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

1. Jul. 21 – Aug. 21, 2009: "YKIS2009: Frontiers in Nonequilibrium Physics — Fundamental theory, glassy & granular materials, computational physics —"
   http://www.yukawa.kyoto-u.ac.jp/contents/seminar/archive/2009/ykis2009/Welcome.html
   Chairman: Hisao Hayakawa

2. Sep. 28 – Nov. 1, 2009: "Branes, Strings and Black Holes"
   http://www.yukawa.kyoto-u.ac.jp/contents/seminar/archive/2009/yitp-t-09-01/bsbh/
   Chairman: Tohru Eguchi

3. Jan. 18 – Mar. 19, 2010: "New Frontiers in QCD 2010 — Exotic Hadron Systems and Dense Matter —"
   http://www2.yukawa.kyoto-u.ac.jp/ nfqcd10/
   Chairman: Akira Ohnishi

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

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 four international programs of this molecule-type as listed below;

1. Oct. 11 – 26, 2009: "Role of local structures in high-temperature superconductors"
   Core members: Giniyat Khaliullin, Michiyasu Mori, Takami Tohyama

2. Nov. 2 – 20, 2009: "Algebraic aspect of chiral symmetry for the study of excited baryons"
   Core members: Veljko Dmitrasinovic, Atsushi Hosaka, Daisuke Jido

3. Jan. 10 – 25, 2010: "Lattice QCD at Finite Density"
   Core members: Philippe de Forcrand, Atsushi Nakamura, Kenji Fukushima

4. Mar. 15 – 28, 2010: "The non-Gaussian universe"
   Core members: David Wands, David Langlois, Kazuya Koyama, Misao Sasaki, Takahiro Tanaka

Organization

The executive committee was organized in the Yukawa Institute to run the whole program. The committee members are;
Akira Ohnishi (chair), Taichiro Kugo (vice-chair), Tohru Eguchi, Kenichi Shizuya, Misao Sasaki, Takami Tohyama, Hisao Hayakawa, Takahiro Tanaka, Kenji Fukushima, Hiroshi Kunitomo, Teiji Kunihiro, Koichi Yazaki.

One special duty professor, one associate professor and three postdocs were hired to enhance the research activities at the Yukawa Institute.

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

2.2 Research Highlights

Deconfinement and chiral symmetry restoration in a strong magnetic field

Marco Ruggieri (YITP)

Quantum Chromodynamics (QCD) is the universally accepted theory of strong interactions. The study of the QCD vacuum, and of its modifications under the influence of external factors, is one of the most attractive topics of modern physics. One of the best strategies to overcome the difficulty to study the non-perturbative aspects of QCD, is offered by Lattice simulations. At vanishing quark chemical potential, it is almost established that two crossovers take place in a narrow range of temperature; one for quark *deconfinement*, and another one for the (approximate) *restoration of chiral symmetry* [1].

From both the theoretical and the phenomenological point of view, it is very interesting to understand how deconfinement and chiral symmetry restoration are affected by a strong magnetic field, see for example [2]. Beside the use of Lattice simulations, an alternative way to grasp the main qualitative aspects of the QCD phase transitions in a strong magnetic field is the use of models, which share some of the symmetries of the QCD Lagrangian. Among them, the Nambu-Jona Lasinio (NJL) model is very popular. In this model, the QCD gluon-mediated interaction among quarks is replaced by a 4-fermion interaction [3],

$$\mathscr{L}_I = G\left[(\bar{\psi}\psi)^2 + (i\bar{\psi}\gamma_5\boldsymbol{\tau}\psi)^2\right] ; \qquad (1)$$

the numerical value of the coupling constant, as well as of other parameters of the model, are fixed to reproduce some hadron properties in the vacuum. Beside the interaction specified in (1), to study confinement-deconfinement transition it is customary to add a background gluon field, $A_0 = iA_4$, which is related to the expectation value of the Polyakov loop, $L = \mathrm{Tr}_c \exp\left(i\beta\lambda_a A_4^a\right)/3$, where $\beta = 1/T$. The background field is coupled in a gauge-invariant way to quarks, via the QCD covariant derivative [4].

In Fig. 2.1, I show one of the main results of my calculations, namely the phase diagram of the model in the magnetic field/temperature plane, at zero baryon chemical potential, for two degenerate massive flavors. Temperature is measured in units of the critical temperature at zero field, namely $T_c = 185$ MeV for the upper panel, and $T_c = 175$ MeV for the lower panel; magnetic field strength, eB, is measured in units of the squared pion mass in the vacuum, m_π^2. To give an order of magnitude estimate of the relevant eB scale, in non-central Pb-Pb collisions at the center of mass energy $\sqrt{s_{nn}} = 4.5$ TeV, $eB \approx 15m_\pi^2$ according to [6] ($eB = m_\pi^2 \to B \approx 2.2\times10^{14}$ Tesla).

In the upper panel, the dependence of the NJL coupling on the Polyakov loop is kept into account, as suggested in [5]. On the other hand, in the lower panel, this dependence is neglected. T_χ, T_L correspond to chiral symmetry restoration and deconfinement temperature, respectively. The grey shaded region can be called *constituent quark phase* (CQP), since deconfinement already took place, but chiral symmetry is still broken spontaneously, thus giving a large mass to the deconfined quarks. As it is clear from the figure, neglecting the interplay among the NJL coupling and the Polyakov loop, the window for the CQP occupies a considerable portion of the phase diagram. On the other hand, when the aforementioned interplay is kept into account, the CQP window shrinks. The latter scenario is in better agreement with the most recent Lattice results [7].

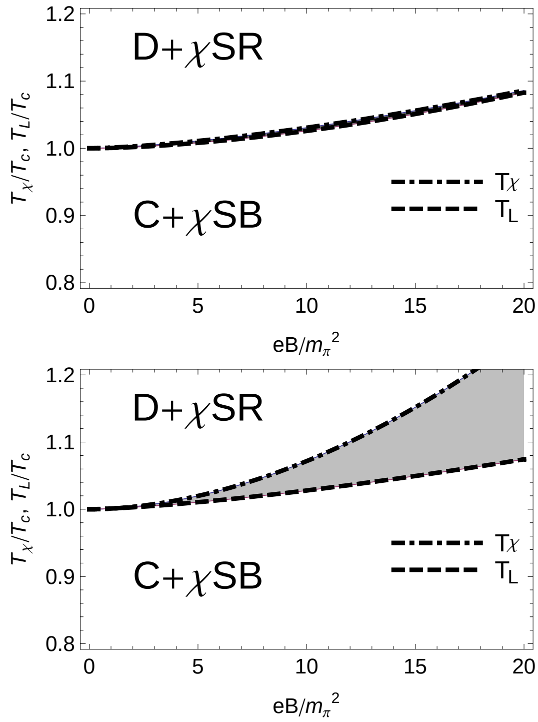


Figure 2.1: Phase diagram in the $eB - T$ plane. See the text for details.

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Exceptionnal Orthogonal Polynomials

Ryu Sasaki (YITP)

New Discovery An infinitely many family of *exceptional (X_ℓ) Jacobi polynomials* $\{P_{\ell,n}(x)\}$, $\ell = 1,2,\ldots$, was discovered recently as the eigenfunctions of exactly solvable quantum mechanics [1]. After Hermite, Laguerre and Jacobi, orthogonal polynomials satisfying a second order differential equations were not discovered for almost 150 years! The X_ℓ Jacobi polynomials also provide *global solutions* of a *Fuchsian differential equations with* $3+\ell$ *regular singularities*. The Fuchsian differential eq. with 3 regular singularities are well known and the Gauss hypergeometric function provides the global solutions. It should be stressed that the global solutions of Fuchsian equations with *more than 4* regular singularities were utterly unknown until the present discovery. These new polynomials are called exceptional, since the lowest degree polynomial $P_{\ell,0}(x)$ is of degree ℓ, instead of a constant.

Let us start with the **General Structure of one-dimensional Quantum Mechanics**. The problem is to find the complete set of eigenvalues and eigenfunctions for a given Hamiltonian $\mathscr{H}$, $\mathscr{H}\phi_n(x) = \mathscr{E}_n\phi_n(x)$, $n = 0,1,\ldots$. We have assumed that the system has *only discrete spectrum*. By adjusting the potential, we can set the groundstate energy to be zero $0 = \mathscr{E}_0$. The Hamiltonian is *positive semi-definite* and can be *factorised*: $\mathscr{H} = \mathscr{A}^\dagger\mathscr{A}$, $\mathscr{A} = d/dx - dw(x)/dx$, $\mathscr{A}\phi_0 = 0$, in which $w(x)$ is the logarithm of the groundstate wavefunction $0 < \phi_0(x) = e^{w(x)}$. It is easy to see that the *first associated Hamiltonian* $\mathscr{H}^{[1]} = \mathscr{A}\mathscr{A}^\dagger$, is essentially *iso-spectral* with the original Hamiltonian $\mathscr{H}$: $\mathscr{H}^{[1]}\phi_n^{[1]}(x) = \mathscr{E}_n\phi_n^{[1]}(x)$, $\phi_n^{[1]}(x) \stackrel{\text{def}}{=} \mathscr{A}\phi_n(x)$, $\phi_n(x) = (\mathscr{A}/\mathscr{E}_n)\phi_n^{[1]}(x)$, $n = 1,2,\ldots$,. By subtracting the groundstate energy $\mathscr{E}_1$ from the first associated Hamiltonian $\mathscr{H}^{[1]}$, it can be factorised again: $\mathscr{H}^{[1]} = \mathscr{A}^{[1]\dagger}\mathscr{A}^{[1]}$. This process can go on indefinitely to provide an infinite family of iso-spectral Hamiltonian systems, which are depicted in Fig. 1.

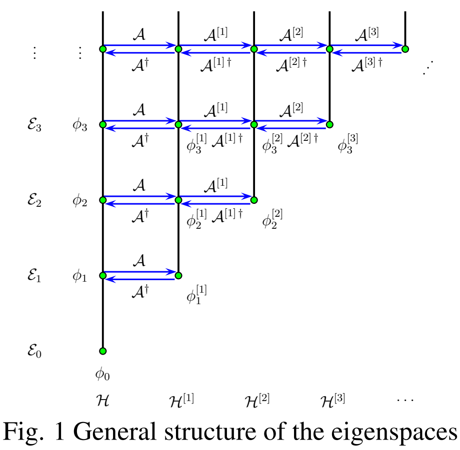

Fig. 1 General structure of the eigenspaces

A *sufficient condition for exact solvability* is called **shape invariance** [2]. Let us denote by $\boldsymbol{\lambda} = (a,b,\ldots)$ the set of parameters in the Hamiltonian $\mathscr{H}(\boldsymbol{\lambda})$. The shape invariance simply means that the first associated Hamiltonian $\mathscr{H}^{[1]}$ has the same form as the original one with a shift of parameters $\boldsymbol{\delta}$:

$$\mathscr{A}(\boldsymbol{\lambda})\mathscr{A}(\boldsymbol{\lambda})^\dagger = \mathscr{A}(\boldsymbol{\lambda}+\boldsymbol{\delta})^\dagger\mathscr{A}(\boldsymbol{\lambda}+\boldsymbol{\delta}) + \mathscr{E}_1(\boldsymbol{\lambda}). \quad (1)$$

Then the eigenvalues and eigenfunctions are given by

$$\mathscr{E}_n(\boldsymbol{\lambda}) = \sum_{s=0}^{n-1}\mathscr{E}_1(\boldsymbol{\lambda}^{[s]}), \quad \boldsymbol{\lambda}^{[s]} \stackrel{\text{def}}{=} \boldsymbol{\lambda} + s\boldsymbol{\delta}, \quad (2)$$

$$\phi_n(x;\boldsymbol{\lambda}) \propto \mathscr{A}(\boldsymbol{\lambda})^\dagger \cdots \mathscr{A}(\boldsymbol{\lambda}^{[n-1]})^\dagger\phi_0(x;\boldsymbol{\lambda}^{[n]}). \quad (3)$$

A simple example is the *Pöschl-Teller* potential:

$$\mathscr{H}(\boldsymbol{\lambda}) = -\frac{d^2}{dx^2} + \frac{g(g-1)}{\sin^2 x} + \frac{h(h-1)}{\cos^2 x} - (g+h)^2, \quad (4)$$

$$w(x;\boldsymbol{\lambda}) = g\log\sin x + h\log\cos x, \quad 0 < x < \pi/2,$$

$$\boldsymbol{\lambda} = (g,h),\ \boldsymbol{\delta} = (1,1),\ \mathscr{E}_n(\boldsymbol{\lambda}) = 4n(n+g+h),\ \eta \stackrel{\text{def}}{=} \cos 2x,$$

$$\phi_n(x;\boldsymbol{\lambda}) = e^{w(x;\boldsymbol{\lambda})}P_n^{[g-1/2,h-1/2]}(\eta), \quad n = 0,1,\ldots, \quad (5)$$

in which $P_n^{[\alpha,\beta]}(x)$ is the Jacobi polynomial.

The Hamltonian of the **exceptional** (X_ℓ) **Jacobi polynomials** is a simple deformation of the Pöschl-Teller potentia in terms of a degree ℓ Jacobi polynomial $\xi_\ell(\eta;\boldsymbol{\lambda})$:

$$w_\ell(x;\boldsymbol{\lambda}) = w(x;\boldsymbol{\lambda}+\ell\boldsymbol{\delta}) + \log\frac{\xi_\ell(\eta;\boldsymbol{\lambda}+\boldsymbol{\delta})}{\xi_\ell(\eta;\boldsymbol{\lambda})} \quad (6)$$

$$\xi_\ell(\eta;\boldsymbol{\lambda}) \stackrel{\text{def}}{=} P_\ell^{(g+\ell-3/2,-h-\ell-1/2)}(\eta), \quad (7)$$

$$\mathscr{H}_\ell(\boldsymbol{\lambda}) = -d^2/dx^2 + (\partial_x w_\ell(x;\boldsymbol{\lambda}))^2 + \partial_x^2 w_\ell(x;\boldsymbol{\lambda}), \quad (8)$$

whose shape invariance can be directly verified. The eigenvalues and the eigenfunctions are, $\mathscr{E}_{\ell,n}(g,h) = 4n(n+g+h+2\ell)$ and

$$\phi_{\ell,n}(x;\boldsymbol{\lambda}) = \psi_\ell(x;\boldsymbol{\lambda})P_{\ell,n}(\eta;\boldsymbol{\lambda}), \quad (9)$$

$$\psi_\ell(x;\boldsymbol{\lambda}) \stackrel{\text{def}}{=} \frac{e^{w(x;\boldsymbol{\lambda}+\ell\boldsymbol{\delta})}}{\xi_\ell(\eta;\boldsymbol{\lambda})}, \quad c_n \stackrel{\text{def}}{=} n+h+1/2,$$

$$P_{\ell,n}(\eta;\boldsymbol{\lambda}) \stackrel{\text{def}}{=} c_n^{-1}\big((h+\frac{1}{2})\xi_\ell(\eta;\boldsymbol{\lambda}+\boldsymbol{\delta})P_n^{(g+\ell-3/2,h+\ell+1/2)}(\eta)$$
$$+ (1+\eta)\xi_\ell(\eta;\boldsymbol{\lambda})\partial_\eta P_n^{(g+\ell-3/2,h+\ell+1/2)}(\eta)\big). \quad (10)$$

It satisfies a Fuchsian equation [3] with $3+\ell$ regular singularities at $\eta = \eta_j$, $j = 1,\ldots,\ell$, which are the zeros of $\xi_\ell(\eta;\boldsymbol{\lambda})$. The exponents are the same at all the extra singularities $\rho = 0,3$. The solution with all $\rho = 0$ is the *global polynomial solution*. The confluent limit of the X_ℓ Jacobi polynomials are the X_ℓ Laguerre polynomials.

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2.3 Publications

2.3.1 YITP preprints (January∼December 2009)

09-1 Seung-il Nam, Hyun-Chul Kim, *Photoproduction of $\Theta^+(1540, 1/2^+)$ reexamined with new theoretical information* (January); Phys. Rev. **D79** 034031 (2009) arXiv:0901.0771v1[hep-ph]

09-2 K. Shizuya, *Pseudo-zero-mode Landau levels and collective excitations in bilayer graphene* (January); arXiv:0901.2803v1[cond-mat.mes-hall]

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09-4 Jiunn-Wei Chen, Kenji Fukushima, Hiroaki Kohyama, Kazuaki Ohnishi, Udit Raha, $U_A(1)$ *Anomaly in Hot and Dense QCD and the Critical Surface* (January); arXiv:0901.2407v1 [hep-ph]

09-5 P.Gubler, D.Jido, T.Kojo, T.Nishikawa, M.Oka, *Spin-3/2 Pentaquark in QCD Sum Rules* (January); arXiv:0902.2049v1[hep-ph]

09-6 Hiroshi Kunitomo, Mitsuhisa Ohta, *Supersymmetric AdS$_3$ solutions in Heterotic Supergravity* (February); arXiv:0902.0655v1[hep-ph]

09-7 Antonino Flachi, Masato Minamitsuji, *Field localization on a brane intersection in anti-de Sitter spacetime* (February); arXiv:0903.0133v1[hep-ph]

09-8 S. Nagataki, *Development of General Relativistic Magnetohydrodynamic Code and its Application to Central Engine of Long Gamma-Ray Bursts* (February); Astrophys. J. **704** 937-950 (2009) arXiv:0902.1908v1 [astro-ph.HE]

09-9 Yuya Sasai, Naoki Sasakura, *The Cutkosky rule of three dimensional noncommutative field theory in Lie algebraic noncommutative spacetime* (February); arXiv:0902.3050v1[hep-th]

09-10 Yuya Sasai, Naoki Sasakura, *Massive particles coupled with 2+1 dimensional gravity and noncommutative field theory* (February); arXiv:0902.3502v1[hep-th]

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09-12 Satoru Odake, Ryu Sasaki, *Crum's Theorem for 'Discrete' Quantum Mechanics* (February); arXiv:0902.2593v1 [math-ph]

09-13 Yoshiko Kanada-En'yo, Nobuo Hinohara, Tadahiro Suhara, Peter Schuck, *Dineutron correlations in quasi two-dimensional systems in a simplified model and possible relation to neutron-rich nuclei* (February); arXiv:0902.3717v1[nucl-th]

09-14 Satoru Odake, Ryu Sasaki, *Unified theory of exactly and quasi-exactly solvable 'Discrete' quantum mechanics: I. Formalism* (February); arXiv:0903.2604v1[math-ph]

09-15 Nobuo Hinohara, Takashi Nakatsukasa, Masayuki Matsuo, Kenichi Matsuyanagi, *Microscopic description of oblate-prolate shape mixing in proton-rich Se isotopes* (March); Phys. Rev. **C80** 014305 (2009) arXiv:0902.3131v2 [nucl-th]

09-16 Chuan-Ren Chen, Mihoko M. Nojiri, Seong Chan Park, Jing Shu, Michihisa Takeuchi, *Dark matter and collider phenomenology of split-UED* (March); arXiv:0903.1971v1[hep-ph]

09-17 Kohta Murase, Hajime Takami, *Implications of Ultra-High-Energy Cosmic Rays for Transient Sources in the Auger Era* (March); arXiv:0810.1813v2[astro-ph]

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09-23 D. Jido, E. Oset, T. Sekihara, *Kaonic production of $\Lambda(1405)$ off deuteron target in chiral dynamics* (April); arXiv:0904.3410v1[nucl-th]

09-24 Takayasu Sekihara, Daisuke Jido, Yoshiko Kanada-En'yo, $\Lambda(1405)$*-induced non-mesonic decay in kaonic nuclei* (April); arXiv:0904.2822v1[nucl-th]

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09-41 Taro Kimura, Tatsuhiro Misumi, *Characters of Lattice Fermions Based on the Hyperdiamond Lattice* (July); arXiv:0907.1371v1[hep-lat]

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09-43 M. Ibe, Izawa K.-I., Y. Nakai, *Studying Gaugino Mass in Semi-Direct Gauge Mediation* (July); Prog. Theor. Phys. **123** 237-255 (2009) arXiv:0907.2970v1[hep-ph]

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09-50 Kang-Sin Choi, Tatsuo Kobayashi, Ryosuke Maruyama, Masaki Murata, Yuichiro Nakai, Hiroshi Ohki, Manabu Sakai, *E6,7,8 Magnetized Extra Dimensional Models* (July); arXiv:0908.0395v1[hep-ph]

09-51 Naoyuki Haba, Kin-ya Oda, Ryo Takahashi, *Invisible Higgs consistent with electroweak data* (August); arXiv:0910.3356v1[hep-ph]

09-52 Satoru Odake, Ryu Sasaki, *Infinitely many shape invariant discrete quantum mechanical systems and new exceptional orthogonal polynomials related to the Wilson and Askey-Wilson polynomials* (September); arXiv:0909.3668v1[math-ph]

09-53 Tadahiro Suhara, Yoshiko Kanada-En'yo, *Quadrupole Deformation β and γ Constraint in a Framework of Antisymmetrized Molecular Dynamics* (September); arXiv:0909.2218v1[nucl-th]

09-54 Yoshiko Kanada-En'yo, *Gamow-Teller transitions from ^{9,11}Li to ^{9,11}Be* (September); Phys. Rev. **C81** 034321 (2010) arXiv:0909.1875v1[nucl-th]

09-55 Takatoshi Ichikawa, Kouichi Hagino, Akira Iwamoto, *Signature of smooth transition from diabatic to adiabatic states in heavy-ion fusion reactions at deep subbarrier energies* (September); arXiv:0909.2298v1[nucl-th]

09-56 Jean-Emile Bourgine, Kazuo Hosomichi, Ivan Kostov, *Boundary transitions of the O(n) model on a dynamical lattice* (September); arXiv:0910.1581v1 [hep-th]

09-57 Seiji Terashima, Futoshi Yagi, *M5-brane Solution in ABJM Theory and Three-algebra* (September);

arXiv:0909.3101v2[hep-th]

09-58 Hiroshi Itoyama, Kazunobu Maruyoshi, Syoji Minato, *Low Energy Processes Associated with Spontaneously Broken N=2 Supersymmetry* (September); arXiv:0909.5486v1[hep-th]

09-59 Masato Taki, *M2-branes Theories without 3+1 Dimensional Parents via Un-Higgsing* (September); arXiv:0910.0370v1[hep-th]

09-60 Kenji Fukushima, Dmitri E. Kharzeev, Harmen J. Warringa, *Electric-current Susceptibility and the Chiral Magnetic Effect* (October); arXiv:0912.2961v1[hep-ph]

09-61 unused no., ();

09-62 Tatsuo Kobayashi, Yuichiro Nakai, Ryo Takahashi, *Fine Tuning in General Gauge Mediation* (October); arXiv:0910.3477v1[hep-ph]

09-63 Kazumi Kashiyama, Norihiro Tanahashi, Antonino Flachi, Takahiro Tanaka, *Quantum Back Reaction to asymptotically AdS Black Holes* (October); JHEP **2010** 099 (2010) arXiv:0910.5376v1[gr-qc]

09-64 C. A. S. Young, R. Zegers, *Dorey's Rule and the q-Characters of Simply-Laced Quantum Affine Algebras* (October); arXiv:0910.4477v1[math.QA]

09-65 Naoki Sasakura, *Emergent general relativity in the tensor models possessing Gaussian classical solutions* (November); arXiv:0911.1170v1 [hep-th]

09-66 K. Shizuya, *Many-body corrections to cyclotron resonance in monolayer and bilayer graphene* (November); arXiv:0911.1543v1[cond-mat.mes-hall]

09-67 D. Cabrera, D. Jido, R. Rapp, L. Roca, *The a_1(1260) as a $\rho\pi$ resonance in nuclear matter* (November); arXiv:0911.1235v1[nucl-th]

09-68 P.Gubler, D.Jido, T.Kojo, T.Nishikawa, M.Oka, *Possible quantum numbers of the pentaquark* $\Theta^+(1540)$ *in QCD sum rules* (November); Phys. Rev. **D80** 114030 (2009) arXiv:0911.2547v1[hep-ph]

09-69 Satoru Odake, Ryu Sasaki, *Infinitely many shape invariant potentials and cubic identities of the Laguerre and Jacobi polynomials* (November); J. Math. Phys. **51** 053513 (2010) arXiv:0911.1585v1[math-ph]

09-70 Choon-Lin Ho, Satoru Odake, Ryu Sasaki, *Properties of the exceptional (X_ℓ) Laguerre and Jacobi polynomials* (November); arXiv:0912.5447v1[math-ph]

09-71 Ignacio Zaballa, Misao Sasaki, *Boosted perturbations at the end of inflation* (November); arXiv:0911.2069v1[astro-ph.CO]

09-72 Mitsutoshi Fujita, Kenji Fukushima, Toru Kikuchi, Tatsuhiro Misumi, Masaki Murata, *Melting Spectral Functions of the Scalar and Vector Mesons in a Holographic QCD Model* (November); Phys. Rev. **D81** 065024 (2010) arXiv:0911.2298v1 [hep-ph]

09-73 Kimitake Hayasaki, Keitaro Takahashi, Yuuiti Sendouda, Shigehiro Nagataki, *Rapid Merger of Binary Primordial Black Holes* (November); arXiv:0909.1738v1[astro-ph.CO]

09-74 Satoru Odake, Ryu Sasaki, *Another set of infinitely many exceptional (X_ℓ) Laguerre polynomials* (November); Phys. Lett. **B684** 173-176 (2010) arXiv:0911.3442v1[math-ph]

09-75 Hiroshi Itoyama, Kazunobu Maruyoshi, Takeshi Oota, *Notes on the Quiver Matrix Model and 2d-4d Conformal Connection* (November); arXiv:0911.4244v1[hep-th]

09-76 Antonio Enea Romano, *Testing (in)homogeneity with redshift spherical shell mass mn(z)* (November); arXiv:0911.2927v1[astro-ph.CO]

09-77 Youngman Kim, Tatsuhiro Misumi, Ik Jae Shin, *Holographic phase transition of QCD with backreaction of flavors* (November); arXiv:0911.3205v1 [hep-ph]

09-78 K. Sumiyoshi, C. Ishizuka, A. Ohnishi, S. Yamada, H. Suzuki, *Emergence of hyperons in failed supernovae: trigger of the black hole formation* (November); Astrophys. J. Lett. **690** L43-L46 (2009) arXiv:0811.4237v1[astro-ph]

09-79 Teiji Kunihiro, Berndt Muller, Akira Ohnishi, Andreas Schafer, *Towards a Theory of Entropy Production in the Little and Big Bang* (November); Prog. Theor. Phys. **121** 555-575 (2009) arXiv:0809.4831v2 [hep-ph]

09-80 K. Tsubakihara, H. Maekawa, H. Matsumiya, A. Ohnishi, *Lambda hypernuclei and neutron star matter in a chiral SU(3) relativistic mean field model with a logarithmic potential* (November); arXiv:0909.5058v1 [nucl-th]

09-81 R.J. Fries, T. Kunihiro, B. Müller, A.Ohnishi, A. Schäfer, *From 0 to 5000 in* 2×10^{-24} *seconds: Entropy production in relativistic heavy-ion collisions* (November); Nucl. Phys. **A830** 519c-522c (2009) arXiv:0906.5293v3[nucl-th]

09-82 Akira Ohnishi, Kohtaroh Miura, Takashi Z. Nakano, Noboru Kawamoto, *Phase diagram and critical point evolution in NLO and NNLO strong coupling lattice QCD* (November); arXiv:0910.1896v1[hep-lat]

09-83 Takashi Z. Nakano, Kohtaroh Miura, Akira Ohnishi, *Effective Potential in the Strong-coupling Lattice QCD with Next-to-Next-to-Leading Order Effects* (November); arXiv:0911.3453v1[hep-lat]

09-84 Tetsuo Hyodo, Daisuke Jido, Atsushi Hosaka , *Meson-baryon nature of* $\Lambda(1405)$ *in chiral dynamics* (November); arXiv:0911.2740v1 [nucl-th]

09-85 Yuko Urakawa, Takahiro Tanaka, *Influence on observation from IR divergence during inflation – Single field inflation –* (November); Prog. Theor. Phys. **122** 779-803 (2009) arXiv:0902.3209v4 [hep-th]

09-86 Yuko Urakawa, Takahiro Tanaka, *Influence on observation from IR divergence during inflation – Multi field inflation –* (November); Prog. Theor. Phys. **122** 1207-1238 (2010) arXiv:0904.4415v2 [hep-th]

09-87 Frederico Arroja, Shuntaro Mizuno, Kazuya Koyama, Takahiro Tanaka, *On the full trispectrum in single field DBI-inflation* (November); Phys. Rev. **D80** 043527 (2009) arXiv:0905.3641v1[hep-th]

09-88 Shuntaro Mizuno, Frederico Arroja, Kazuya Koyama, Takahiro Tanaka, *Lorentz boost and non-*

Gaussianity in multi-field DBI-inflation (November); Phys. Rev. **D80** 023530 (2009) arXiv:0905.4557v2 [hep-th]

09-89 Kent Yagi, Takahiro Tanaka, *Constraining alternative theories of gravity by gravitational waves from precessing eccentric compact binaries with LISA* (November); Phys. Rev. **D81** 064008 (2010) arXiv:0906.4269v2[gr-qc]

09-90 Kent Yagi, Takahiro Tanaka, *DECIGO/BBO as a probe to constrain alternative theories of gravity* (November); arXiv:0908.3283v1[gr-qc]

09-91 Norihiro Tanahashi, Takahiro Tanaka, *Floating Black Hole in the Karch-Randall Model and its Holographic Dual* (November); Prog. Theor. Phys. **123** 369-392 (2010) arXiv:0910.5303v1[gr-qc]

09-92 Tetsuo Hyodo, Daisuke Jido, Atsushi Hosaka, *Origin of resonances in chiral dynamics* (November); arXiv:0909.5531v1[nucl-th]

09-93 E. Kaneshita, T. Morinari, T. Tohyama, *Modeling Antiferromagnetic Phase in Iron Pnictides: Weakly Ordered State* (November); Phys. Rev. Lett. **103** 247202 (2009) arXiv:0909.1081v2[cond-mat.supr-con]

09-94 Tohru Eguchi, Kazunobu Maruyoshi, *Penner Type Matrix Model and Seiberg-Witten Theory* (November); arXiv:0911.4797v1[hep-th]

09-95 K. Shizuya, *Pseudo-zero-mode Landau levels and pseudospin waves in bilayer graphene* (November); arXiv:0912.2198v1[cond-mat.mes-hall]

09-96 Eiji Kaneshita, Tsuneyoshi Nakayama, *Glass-like Thermal-Transport in Symmetry-Broken Clathrates* (November); Europhys. Lett. **86** 56004 (2009) arXiv:0901.2957v2[cond-mat.mtrl-sci]

09-97 Tohru Eguchi, Kazuhiro Hikami, *Superconformal Algebras and Mock Theta Functions 2. Rademacher Expansion for K3 Surface* (November); arXiv:0904.0911v2[math-ph]

09-98 Tohru Eguchi, Kazuhiro Hikami, *N=4 Superconformal Algebra and the Entropy of HyperKahler Manifolds* (November); arXiv:0909.0410v2[hep-th]

09-99 D. H. Correa, C. A. S. Young, *Asymptotic Bethe equations for open boundaries in planar AdS/CFT* (December); arXiv:0912.0627v1 [hep-th]

09-100 Yasuo Fukui, Naoko Furukawa, Thomas M. Dame, Joanne R. Dawson, Hiroaki Yamamoto, Gavin P. Rowell, Felix Aharonian, Werner Hofmann, Emma de Ona Wilhelmi, Tetsuhiro Minamidani, Akiko Kawamura, Norikazu Mizuno, Toshikazu Onishi, Akira Mizuno, Shigehiro Nagataki, *A Peculiar Jet and Arc of Molecular Gas toward the Rich and Young Stellar Cluster Westerlund 2 and a TeV Gamma Ray Source* (December); arXiv:0903.5340v2[astro-ph.HE]

09-101 Yudai Suwa, Kohta Murase, *Probing the central engine of long gamma-ray bursts and hypernovae with gravitational waves and neutrinos* (December); arXiv:0906.3833v2[astro-ph.HE]

09-102 Kohta Murase, Kenji Toma, Ryo Yamazaki, Shigehiro Nagataki, Kunihito Ioka, *High-energy emission as a test of the prior emission model for gamma-ray burst afterglows* (December); Mon. Not. Roy. Astron. Soc. **402** L54 (2010) arXiv:0910.0232v1[astro-ph.HE]

09-103 Yutaka Ohira, Kohta Murase, Ryo Yamazaki, *Escape-limited Model of Cosmic-ray AccelerationRevisited* (December); arXiv:0910.3449v2[astro-ph.HE]

09-104 Asaf Pe'er, Kohta Murase, Peter Mészáros, *Radio Quiet AGNs as Possible Sources of Ultra-high Energy Cosmic Rays* (December); Phys. Rev. **D80** 123018 (2009) arXiv:0911.1776v2[astro-ph.HE]

09-105 K. Kotera, D. Allard, K. Murase, J. Aoi, Y. Dubois, T. Pierog, S. Nagataki, *Propagation of ultrahigh energy nuclei in clusters of galaxies: resulting composition and secondary emissions* (December); Astrophys. J. **707** 370-386 (2009) arXiv:0907.2433v2[astro-ph.HE]

09-106 A. Marshakov, A. Yung, *Strong versus Weak Coupling Confinement in N=2 Supersymmetric QCD* (December); arXiv:0912.1366v1[hep-th]

09-107 Jiunn-Wei Chen, Kenji Fukushima, Hiroaki Kohyama, Kazuaki Ohnishi, Udit Raha, *Model analysis on thermal UV-cutoff effects on the critical boundary in hot QCD* (December); Phys. Rev. **D81** 071501 (2010) arXiv:0912.2099v1 [hep-ph]

09-108 Antonio Enea Romano, *Non singular spherically symmetric matter inhomogeneities cannot locally mimick the cosmological constant for a central observer* (December); arXiv:0912.2866v1astro-ph.CO]

09-109 Antonio Enea Romano, *Mimicking the cosmological constant with matter inhomogeneities: an analytical low redshift study of the solution of the inversion problem* (December); arXiv:0912.4108v3[astro-ph.CO]

09-110 H.T. Cho, A.S. Cornell, Jason Doukas, Wade Naylor, *Black hole quasinormal modes using the asymptotic iteration method* (December); arXiv:0912.2740v1[gr-qc]

09-111 M.Taki, *On AGT Conjecture for Pure Super Yang-Mills and W-algebra* (December); arXiv:0912.4789v1[hep-th]

09-112 Bernard Carr, Kazunori Kohri, Yuuiti Sendouda, Jun'ichi Yokoyama, *New cosmological constraints on primordial black holes* (December); Phys. Rev. **D81** 104019 (2010) arXiv:0912.5297v1[astro-ph.CO]

09-113 K.-I. Izawa, Fuminobu Takahashi, T.T. Yanagida, Kazuya Yonekura, *Runaway Dynamics and Supersymmetry Breaking* (December); Phys. Lett. **B677** 195-196 (2009) arXiv:0902.3854v1[hep-th]

09-114 K.-I. Izawa, *A Note on Quasi-Riemannian Gravity with Higher Derivatives* (December); arXiv:0904.3593v1[hep-th]

09-115 K.-I. Izawa, Fuminobu Takahashi, T.T. Yanagida, Kazuya Yonekura, *Conformal Supersymmetry Breaking in Vector-like Gauge Theories* (December); Phys. Rev. **D80** 085017 (2009) arXiv:0905.1764v2[hep-th]

09-116 H. Wada and Y. Tanaka, *Mechanics and size-*

dependent elasticity of composite networks (December); Europhys. Lett. **87** 58001 (2009)

09-117 Hirofumi Wada, Roland R. Netz, *Plectoneme creation reduces the rotational friction of a polymer* (December); EPL **87** 38001 (2009) arXiv:0910.1501v1[cond-mat.soft]

09-118 Hirofumi Wada and Roland R. Netz, *Hydrodynamics of helical-shaped bacterial motility* (December); Phys. Rev. E80 021921 (2009)

09-119 Alfredo Alexander-Katz, Hirofumi Wada and Roland R. Netz, *Internal Friction and Nonequilibrium Unfolding of Polymeric Globules* (December); Phys. Rev. Lett.**103** 028102 (2009)

09-120 Hong-Ren Jiang, Hirofumi Wada, Natsuhiko Yoshinaga, Masaki Sano, *Manipulation of Colloids by Nonequilibrium Depletion Force in Temperature Gradient* (December); arXiv:0902.4056v2[cond-mat.soft]

09-121 H. Wada, *A semiflexible polymer ring acting as a nano-propeller* (December); Eur. Phys. J. **E28** 11-16 (2009)

09-122 Hiroyuki Abe, Kang-Sin Choi, Tatsuo Kobayashi, Hiroshi Ohki, *Flavor structure from magnetic fluxes and non-Abelian Wilson lines* (December); arXiv:1001.1788[hep-th]

2.3.2 Publications and Talks by Regular Staff (April 2009 — March 2010)

Tohru Eguchi

Journal Papers

1. T. Eguchi and K. Hikami,
   "Superconformal algebras and mock theta functions 2. Rademacher expansion for K3 surface,"
   Commun. Number Theory Phys. 3: 531-554, 2009, YITP-09-97, arXiv:0904.0911 [math-ph].
2. T. Eguchi and K. Hikami,
   "N=4 Superconformal Algebra and the Entropy of HyperKahler Manifolds,"
   JHEP 1002:019,2010, YITP-10-102, arXiv:0909.0410 [hep-th].
3. T. Eguchi and K. Maruyoshi,
   "Penner Type Matrix Model and Seiberg-Witten Theory," JHEP 1002:022,2010, YITP-09-94, arXiv:0911.4797 [hep-th].
4. T. Eguchi and K. Hikami,
   "N=2 Superconformal Algebra and the Entropy of Calabi-Yau Manifolds,"
   Lett.Math.Phys.92:269-297,2010, YITP-10-14, arXiv:1003.1555 [hep-th].

Talks at International Conferences

1. "Superconformal Algebras and Mock Theta Functions," Invited,
   at Sixth International Symposium on QuantumTheory and Symmetries, Kentucky, U.S.A., 7/20-25,2009.
2. "Mock theta functions and entropy of manifolds with reduced holonomoy," Invited,
   5th International conference on flavor physics, Hanoi, Vietnam, 9/24-28,2009.
3. "Penner Type Matrix Model and Seiberg-Witten Theory," Invited, University of Tokyo, Komaba 2/13-14 2010.

Invited Seminars (in Japan)

1. "Einstein and the Mystery of Universe," (in Japanese)
   Public Lecture, Tohoku University, 13 September 2009.
2. "Einstein and the Mystery of Universe," (in Japanese)
   Public Lecture, Keio University, 20 September 2009.
3. "Superstring Theory and Modern Mathematics (in Japanese)
   Colloquium, University of Tokyo, 29 January 2010.

Kenji Fukushima

Journal Papers

1. K. Fukushima, F. Gelis and T. Lappi,
   "Multiparticle correlations in the Schwinger mechanism,"
   Nucl. Phys. **A831** (2009) 184 (31 pages), YITP-09-45, arXiv:0907.4793 [hep-ph].
2. T. Brauner, K. Fukushima and Y. Hidaka,
   "Two-color quark matter: $\mathrm{U}(1)_{\mathrm{A}}$ restoration, superfluidity, and quarkyonic phase,"
   Phys. Rev. **D80** (2009) 074035 (14 pages), YITP-09-44, arXiv:0907.4905 [hep-ph].
3. M. Fujita, T. Kikuchi, K. Fukushima, T. Misumi and M. Murata,
   "Melting spectral functions of the scalar and vector mesons in a holographic QCD model,"
   Phys. Rev. **D81** (2010) 065024 (12 pages), YITP-09-72, arXiv:0911.2298 [hep-ph].
4. A. Andronic, B. Blaschke, P. Braun-Munzinger, J. Cleymans, K. Fukushima, L. McLerran, H. Oeschler, R. Pisarski, K. Redlich, C. Sasaki, H. Satz and J. Stachel,
   "Hadron production in ultra-relativistic nuclear collisions: quarkyonic matter and a triple point in the phase diagram of QCD,"
   Nucl. Phys. **A837** (2010) 65 (22 pages), YITP-10-107, arXiv:0911.4806 [hep-ph].
5. J.W. Chen, K. Fukushima, H. Kohyama, K. Ohnishi and U. Raha,
   "Model analysis on thermal UV-cutoff effects on the critical boundary in hot QCD,"
   Phys. Rev. **D81** (2010) 071501(R) (5 pages), YITP-09-107, arXiv:0912.2099 [hep-ph].
6. K. Fukushima, D. Kharzeev and H. Warringa,
   "Electric-current susceptibility and the chi-

ral magnetic effect,"
Nucl. Phys. **A836** (2010) 311 (26 pages), YITP-09-60, arXiv:0912.2961 [hep-ph].
7. K. Fukushima, D. Kharzeev and H. Warringa,
"Real-time dynamics of the chiral magnetic effect,"
Phys. Rev. Lett. **104** (2010) 212001 (4 pages), YITP-10-108, arXiv:1002.2495 [hep-ph].
8. K. Fukushima, M. Ruggieri and R. Gatto,
"Chiral magnetic effect in the PNJL model,"
Phys. Rev. **D81** (2010) 114031 (12 pages), YITP-10-3, arXiv:1003.0047 [hep-ph].

Talks at International Conferences

1. "From Glasma to Quarkyonic," Invited,
in "Quantum Field Theory in Extreme Environments," Saclay, Paris, France,
April 2009.
2. "Linking center symmetry and chiral symmetry," Invited, Plenary,
in "4th International Symposium on Symmetries in Subatomic Physics," National Taiwan University, Taipei, Taiwan,
June 2009.
3. "Phase diagram from PNJL models," Invited,
in "5th International Workshop on Critical Point and Onset of Deconfinement," BNL, Upton, USA,
June 2009.
4. "QCD Thermodynamics and the Polyakov Loop," Invited,
in "Three-Days of Strong Interactions," Wroclaw Univ., Poland,
July 2009.
5. "QCD phase diagram and thermodynamics from the PNJL model," Invited,
in "Quarks, Hadrons, and the Phase Diagram of QCD," St. Goar, Germany,
September 2009.
6. "Baryon rich state of matter – Quarkyonic phase at NICA energies," Invited,
JINR, Dubna, Russia,
September 2009.

Invited Seminars (Overseas)

1. "Chiral Phase Transition and Axial Anomaly,"
Technische Universität München, Germany, April 2009.
2. "Chiral Magnetic Effect – Some Effective Model Results –,"
Brookhaven National Lab., USA, June 2009.
3. "New Developments in Dense QCD Matter,"
Technische Universität München, Germany, July 2009.
4. "Recent Developments on the QCD Phase Diagram,"
Gyeongju, Korea, August 2009.
5. "Topological P and CP Violation in Heavy-Ion Collisions,"
Changwon, Korea, October 2009 (KPS meeting).

Invited Seminars (in Japan)

1. "Schwinger Mechanism in the LSZ Formalism and Color Glass Condensate,"
Dept. of Phys., Univ. of Tokyo, August 2009 (SAKURA meeting).
2. "Toward Understanding of the Phase Structure of Quark-Gluon Matter,"
Dept. of Phys., Keio Univ., December 2009 (in Japanese).
3. "Topological P and CP Violation in Heavy-Ion Collisions,"
Dept. of Phys., Tokyo Metropolitan Univ., January 2010 (in Japanese).

Hisao Hayakawa

Journal Papers

1. Michio Otsuki and Hisao ,
"Long-time tails in sheared fluids ,"
J. Stat. Mech: Theory and Experiment (2009) L08003 , (8pages).
2. Michio Otsuki and Hisao Hayakawa,
"Critical behaviors of sheared frictionless granular materials near the jamming transition ,"
Phys. Rev. E **80**, 011308 (2009) (12pages).
3. Kuniyasu Saitoh and Hisao ,
"Simulation of depositions of a Lennard-Jones cluster on a crystalline surface "
Prog. Theor. Phys. **122**, 1081-1094 (2009).
4. Michio Otsuki and Hisao Hayakawa,
"Unified description of long-time tails and long-range correlation functions for sheared granular liquids,"

Eur. Phys. J. Special Topics **179**, 179-195 (2009).

5. Michio Otsuki and Hisao Hayakawa,
“ Universal Scaling for the Jamming Transition, ”
Prog. Theor. Phys. **121**, 647-655.
6. Chihiro Nakajima, and Hisao Hayakawa,
“Molecular transport through a bottleneck driven by external force , ”
Prog. Theor. Phys. **122** (2009) pp. 1377-1390.
7. S. Tatsumi, Y. Murayama, H. Hayakawa and M. Sano,
“ Experimental study on the kinetics of granular gases under microgravity, ”
J. Fluid Mech. **641**, 521-539 (2009).

Talks at International Conferences

1. “Fluctuation relations without microscopic reverisibility ,” Invited,
in “YKIS2009 : Frontiers in Nonequilibrium Physics,” YITP, Kyoto, Japan
31 July–2 August 2009.
2. “Fluctuation relations of dissipative systems,” Invited,
in a long-term workshop “Frontiers in Nonequilibrium Physics - Fundamental Theory, Glassy & Granular Materials, and Computational Physics -” YITP, Kyoto, Japan,
21 July–21 August 2009.
3. “Nonequilibrium Mode-coupling Theory for Sheared Granular Liquids,” Invited,
in “IUTAM-ISIMM Symposium on Mathematical Modeling and Physical Instances of Granular Flow, ” Reggio Calabria, Italy,
14–18, September 2009.
4. “Jamming transition of granular materials : A nonequilibrium phase transition from a solid to a liquid and the analogy to the discharge process,” Invited,
in “Cataplexty and structure formation in the emergence and ionization of plasma,” Kyoto University, Kyoto, Japan
15–16, March 2010.

Invited Seminars (Overseas)

1. “Anomalous impact of nanoclusters ”
in Applied Mathematics Seminar at University of Leiceste, UK
12, November 2009.
2. “Scaling laws for jamming transition”
in Applied Mathematics Seminar at University of Leiceste, UK
19, November 2009.
3. “Nonequilibrium Mode-coupling Theory of Sheared Granular Liquids ”
in Kolloquium Theoretische Physik at Konstanz University, Konstanz, Germany
23, November 2009.
4. “Scaling laws for jamming transition” in ETH seminar, ETH, Zurlich, Switzland
24, November 2009.

Invited Seminars (in Japan)

1. “Collision of nanoclusters and 2nd law of thermodynamics,”
Dept. Physics, Hokkaido Univ. Sapporo, 29 June 2009.
2. “Lecture on liquid theory of sheared dissipative particles and fluctuation theorem”
Dept. Phys. Hokkaido Univ. Sapporo, 30 June 2009.
3. “Rheology of jamming transition: divergence of pressure and viscosity,”
at workshop on classical and quantum dynamics: nonequilibrium statistical mechanics, Univ. Tokyo,
12–14 February, 2010.
4. “Lecture on Granular Physics,”
Dept. Engineering Mechanics and Energy, Univ. Tsukuba,
3 March, 2010.

Ken-Iti Izawa

Journal Papers

1. K.-I. Izawa, F. Takahashi, T.T. Yanagida, and K. Yonekura,
“Conformal Supersymmetry Breaking in Vector-like Gauge Theories,”
Phys. Rev. **D80** (2009) 085017 (8 pages), arXiv:0905.1764 [hep-th].
2. M. Ibe, K.-I. Izawa, and Y. Nakai,
“Studying Gaugino Mass in Semi-Direct Gauge Mediation,”
Prog. Theor. Phys. **123** (2010) 237-255, YITP-09-43, arXiv:0907.2970 [hep-ph].
3. K.-I. Izawa, Y. Nakai, and R. Takahashi,
“Nonlinearly Realized Extended Supergravity,”

Phys. Rev. **D82** (2010) 075008 (8 pages), YITP-10-2, arXiv:1003.0740 [hep-ph].

Daisuke Jido

Journal Papers

1. P. Gubler, D. Jido, T. Kojo, T. Nishikawa, M. Oka,
   "Possible quantum numbers of the pentaquark $\Theta^+(1540)$ in QCD sum rules", Phys. Rev. **D80** (2009) 114030 (22 pages), arXiv:0911.2547 [hep-ph], YITP-09-68.
2. D. Jido, E. Oset, T. Sekihara,
   "Kaonic production of $\Lambda(1405)$ off deuteron target in chiral dynamics", Eur. Phys. J. **A42** (2009) 257-268, arXiv:0904.3410 [nucl-th], YITP-09-23.
3. T. Sekihara, D. Jido, Y. Kanada-En'yo,
   "$\Lambda(1405)$-induced non-mesonic decay in kaonic nuclei", Phys. Rev. **C79** (2009) 062201(R) (5 pages), arXiv:0904.2822 [nucl-th], YITP-09-24.
4. P. Gubler, D. Jido, T. Kojo, T. Nishikawa, M. Oka,
   "Spin-3/2 Pentaquark in QCD Sum Rules", Phys. Rev. **D79** (2009) 114011 (9 pages), arXiv:0902.2049 [hep-ph], YITP-09-05.
5. J. Yamagata-Sekihara, D. Jido, H. Nagahiro, S. Hirenzaki,
   "Formation spectra of light kaonic nuclei by in-flight $(\bar{K},N)$ reactions with chiral unitary amplitude", Phys. Rev. **C80** (2009) 045204 (12 pages), arXiv:0812.4359 [nucl-th], YITP-08-95.
6. Hideko Nagahiro, Daisuke Jido, Satoru Hirenzaki,
   "Formation of eta-mesic nuclei by (π,N) reaction and $N^*(1535)$ in medium", Phys. Rev. **C80** (2009) 025205 (13 pages), arXiv:0811.4516 [nucl-th], YITP-08-92.
7. A. Ohnishi, D. Jido, T. Sekihara, K. Tsubakihara,
   "Possibility of an s-wave pion condensate in neutron stars reexamined", Phys. Rev. **C80** (2009) 038202 (4 pages), arXiv:0810.3531 [nucl-th], YITP-08-82.

Books and Proceedings

1. Tetsuo Hyodo, Daisuke Jido, Atshushi Hosaka, "Origin of resonances in chiral dynamics", PoS CD09 (2009) 029. Proceedings for Sixth International Workshop on Chiral Dynamics, Bern, Switzerland, July 6 - 10, 2009.
2. Philipp Gubler, Daisuke Jido, Toru Kojo, Tetsuo Nishikawa, Makoto Oka, "$S = +1$ pentaquarks in QCD sum rules", PoS CD09 (2009) 022. Proceedings for Sixth International Workshop on Chiral Dynamics, Bern, Switzerland, July 6 - 10, 2009.
3. Daisuke Jido, Yoshiko Kanada-En'yo, "A new N^* resonance as a hadronic molecular state", Chinese Physics **C33** (2009) 1312-1317. Proceedings for International Workshop on the Physics of Excited Nucleon (NSTAR2009), Beijing, China, Apr 19 - 22, 2009.
4. A. Hosaka, T. Hyodo, D. Jido, H.-Ch. Kim, H. Nagahiro, S.I. Nam, M. Oka and S. Ozaki, "Reaction dynamics for photoproductions of baryon resonances", Chinese Physics **C33** (2009) 1167-1174. Proceedings for International Workshop on the Physics of Excited Nucleon (NSTAR2009), Beijing, China, Apr 19 - 22, 2009.
5. E. Oset, A. Ramos, S. Sarkar, Bao Xi Sun, M.J. Vicente Vacas, P. Gonzalez, J. Vijande, D. Jido, T. Sekihara, A. Martines-Torres, K. Khemchandani, U.G. Meissner, "Dynamically generated resonances", Chinese Physics **C33** (2009) 1132-1139. Proceedings for International Workshop on the Physics of Excited Nucleon (NSTAR2009), Beijing, China, Apr 19 - 22, 2009.
6. T. Hyodo, D. Jido, A Hosaka, "The nature of baryon resonances in the chiral unitary approach", Eilat2008, Particle and nuclei (PANIC08) (2009) 264-266. Proceedings for 18th International Conference On Particles And Nuclei (PANIC 08), Eilat, Israel, Nov 9 - 14, 2008.
7. E. Oset, L.S. Geng, D. Gamermann, R. Molina, D. Nicmorus, J. Yamagata-Sekihara, H. Nagahiro, S. Hirenzaki, D. Jido, M. Doring, A. Ramos, "Meson and Baryon resonances", Nucl. Phys. **A827** (2009) 255-260. Proceedings for 18th International Conference On Particles And Nuclei (PANIC 08), Eilat, Israel, Nov 9 - 14, 2008.
8. H. Nagahiro, D. Jido, S. Hirenzaki, "Formation of -mesic nuclei by (,N) reaction

and chiral symmetry for baryons", Int. J. Mod. Phys. **E18** (2009) 2202-2206. Proceedings of the Franco-Japanese Symposium "New Paradigms in Nuclear Physics", Paris, France, Sept. 22 - 2 Oct. 2008.

9. Daisuke Jido, Yoshiko Kanada-En'yo "Baryon resonances as hadronic molecule states with kaons", Hyperfine interactions 193, 253-259 (2009), (Springer Netherlands), Proceedings for International Conference on Exotic Atoms (EXA2008), Vienna, Austria, Sep 15 - 18, 2008.

Talks at International Conferences

1. "Partial restoration of chiral symmetry in nuclei ", invited, New Frontiers in QCD 2010 (NFQCD10) – Exotic Hadron Systems and Dense Matter –, 18 January -19 March, 2010, Yukawa Institute for Theoretical Physics, Kyoto, Japan.
2. "Chiral doublet model", Workshop on Algebraic aspect of chiral symmetry for the study of excited baryons, 2-20 November, 2009, Yukawa Institute for Theoretical Physics, Kyoto, Japan.
3. "Recent topics of hadrons in nuclei", invited, keynote talk, Third Joint Meeting of the Nuclear Physics Divisions of the American Physical Society and The Physical Society of Japan, 13-17 October 2009, Waikoloa, Hawaii, USA.
4. "Baryon Resonances as Hadronic Molecular State", invited, US-Japan Joint Workshop on Meson Production Reactions at Jefferson Lab and J-PARC, 11-13 October, 2009, Waikoloa, Hawaii, U.S.A.
5. "The nature of $\Lambda(1405)$ in chiral dynamics", invited, plenary, 10th International conference on Hypernuclear and Strange Particle Physics (Hyp X), 14-18 September, 2009, Tokai, Ibaraki, Japan.
6. "A new N^* resonance as a hadronic molecular state", invited, Workshop on the Physics of Excited Nucleon (NSTAR2009), 19-22 April, 2009, Beijing, China.

Invited Seminars (in Japan)

1. "The structure of $\Lambda(1405)$ in chiral dynamics, (In Japanese)"
Physics Department, Osaka City University, 29 October 2009.

Yoshiko Kanada-En'yo

Journal Papers

1. N. Furutachi, M. Kimura, A. Dote, and Y. Kanada-En'yo,
"Structures of light halo nuclei",
Prog. Theor. Phys. **122**, 865-880 (2009).
2. Yoshiko Kanada-En'yo, Nobuo Hinohara, Tadahiro Suhara, and Peter Schuck,
"Dineutron correlations in quasi-two-dimensional systems in a simplified model, and possible relation to neutron-rich nuclei"
,
Phys. Rev. **C79**, 054305-1-14 (2009).
3. T. Sekihara, D. Jido, and Y. Kanada-En'yo,
"$\Lambda(1405)$-induced nonmesonic decay in kaonic nuclei'
Phys. Rev. **C79**, 062201(R)-1-5 (2009).
4. Yasutaka Taniguchi , Yoshiko Kanada-En'yo, and Masaaki Kimura,
"Cluster structures and superdeformation in 28Si",
Phys. Rev. **C80**, 044316 (2009).
5. Tadahiro Suhara and Yoshiko Kanada-En'yo,
"Quadrupole Deformation β and γ Constraint in a Framework of Antisymmetrized Molecular Dynamics",
Prog. Theor. Phys. **123**, 303-325 (2010).

Books and Proceedings

1. Y. Kanada-En'yo, N. Hinohara, T. Suhara, and P. Schuck,
"Dineutron correlations in nuclear surface",
CERN Proceedings series, 12th international conference on nuclear reaction mechanisms, June 15 - 19 , 2009, Varenna (Italy).
2. Y. Kanada-En'yo and M. Kimura,
"Molecular-orbital structure and non-alpha cluster gas",
Review book chapter 4 edited by Marten Brenner, published by Research Signpost, India.
3. Y. Kanada-En'yo and M. Kimura,
"Cluster structure of Nuetron-rich nuclei studied with Antisymmetrized molecular dynamics model",
Lecture notes in Physics Vol **818**, 129 (2010).

Talks at International Conferences

1. Y. Kanada-En'yo,
   "Dineutron correlations in nuclear surface", 12th international conference on nuclear reaction mechanisms, June 15 - 19 , 2009, Varenna, Italy. (Plenary)

Invited Seminars (in Japan)

1. Lecture series "Cluster structures in Light Unstable Nuclei"(in Japanese)
   24-29 August 2009, Kishima Diara, Nagano.
2. Lecture "A Guide to Particle and Nuclear Physics"(in Japanese),
   Saturday Afternoon Physics 2009, 1 November 2009, Osaka University, Osaka.

Taichi Kugo

Journal Papers

1. Taichiro Kugo and Hideo Nakajima
   Schwinger-Dyson and Bethe-Salpeter approach to Strong Interaction Dynamics and Chiral Symmetry Breaking
   Prog. Theor. Phys. **122** (2009), 273 – 291.

Talks at international Conferences

1. Gauge fixing problem in Superstring Field Theory
   APCTP Focus Program on "Current Trends in String Field Theory", Invited, Dec. 7-18, 2009, Pohang, Korea.

Invited Seminars (in Japan)

1. Electric Dipole Moment of Dyon and 'Electron' (in Japanese)
   2 July 2009, Dept. Physics, Nagoya Univ.
2. Electric and Magnetic Dipole Moments of Monopole Fermions and its Dual Electron (in Japanese)
   9 Feb. 2010, Dept. Physics, Kyushu Univ.

Hiroshi Kunitomo

Journal Papers

1. M. Ohta and H. Kunitomo, "Supersymmetric AdS_3 Solutions in Heterotic Supergravity," Prog. Theor. Phys. **122** (2009) 631-657. arXiv:0902.0655 [hep-th], YITP-09-06.

Takao Morinari

Journal Papers

1. Y. Kurita, M. Kobayashi, T. Morinari, M. Tsubota, and H. Ishihara,
   "Spacetime analog of Bose-Einstein condensates: Bogoliubov-de Gennes formulation,"
   Phys. Rev. A **79**, 114708 (2009).
2. T. Morinari,
   "Pseudogap and Short-Range Antiferromagnetic Correlation Controlled Fermi Surface in Underdoped Cuprates: From Fermi Arc to Electron Pocket,"
   J. Phys. Soc. Jpn. **78**, 54708 (2009).
3. H. Yoshizumi, T. Tohyama, and T. Morinari,
   "Induced Order in Nonequivalent Two-Leg Hubbard Ladder,"
   Prog. Theor. Phys. **122**, 943 (2009).
4. T. Morinari, H. Nakamura, M. Machida, and T. Tohyama,
   "Effect of Fermi Surface Topology on Inter-Layer Magnetoresistance in Layered Multiband Systems: Application to $LaFeAsO_{1-x}F_x$,"
   J. Phys. Soc. Jpn. **78**, 114702 (2009).

Talks at International Conferences

1. "Fermi surface topology effect on inter-layer magnetoresistance in layered multi-band systems: Application to $LaFeAsO_{1-x}F_x$," Invited talk at ICC-IMR workshop on "Physics on Transition Metal Based Superconductors," Institute for Materials Research, Tohoku University,
   24–26 June 2009.

Invited Seminars (in Japan)

1. "$\nu = 5/2$ fractional quantum Hall state and non-Abelian anyons,"
   Kinki University, 24 April 2009.
2. "$\nu = 5/2$ fractional quantum Hall state and non-Abelian anyons,"
   ISSP University of Tokyo, 18 December 2009.

Masatoshi Murase

Talks at international Conferences

1. "What Is Evolution? -Towards A New Synthesis-" Invited, Plenary, in "Workshop

on Evolution: Foundations, Fundamentalals and Disease" HKUST, Hong Kong 8–10 December 2009.

Invited Seminars (in Japan)

1. Evolution, Development and Organization (Series Lecture), September 2009, Department of Physics, Ritsumeikan University
2. Origin and Evolution of Life, March 2010, Hakodate Future University

Shigehiro Nagataki

Journal Papers

1. Hajime Takami, Kohta Murase, Shigehiro Nagataki, Katsuhiko Sato, "Cosmogenic Neutrinos as a Probe of the Transition from Galactic to Extragalactic Cosmic Rasys", Astroparticle Physiscs **31** (2009), 201-211, arXiv:0704.0979.
2. Kohta Murase, Zhang Bing, Keitaro Takahashi, Shigehiro Nagataki, "Possible Effects of Pair Echoes on Gamma-Ray Burst Afterglow Emission", Monthly Notices of the Royal Astronomical Society **396** (2009), 1825-1832, arXiv:0812:0124.
3. Yasuo Fukui et al. (15 authors), "A Peculiar Jet and Arc of Molecular Gas toward the Rich and Young Stellar Cluster Westerlund 2 and a TeV Gamma Ray Source", Publications of Astronomical Society of Japan **61** (2009), L23-L27, arXiv:0903.5340.
4. Shigehiro Nagataki, "Development of a General Relativistic Magnetohydrodynamic Code and Its Application to the Central Engine of Long Gamma-Ray Bursts", The Astrophysical Journal **704** (2009), 937-950, arXiv:0902.1908.
5. Kumiko Kotera, Denis Allard, Kohta Murase, Junichi Aoi, Yohan Dubois, Tangy Peirog, Shigehiro Nagataki, "Propagation of Ultrahigh Energy Nuclei in Clusters of Galaxies: Resulting Composition and Secondary Emissions", The Astrophysical Journal **707** (2009), 370-386, arXiv:0907.2433.
6. Kohta Murase, Kenji Toma, Ryo Yamazaki, Shigehiro Nagataki, Kunihito Ioka, Monthly Notices of the Royal Astronomical Society **402** (2010), L54-L58, arXiv:0910.0232.

Akira Ohnishi

Journal Papers

1. K. Miura, T. Z. Nakano and A. Ohnishi, "Quarkyonic matter in lattice QCD at strong coupling", Prog. Theor. Phys. **122** (2009), pp 1045-1054, YITP-08-49, arXiv:0806.3357 [nucl-th].
2. A. Ohnishi, D. Jido, T. Sekihara, K. Tsubakihara, "Possibility of an s-wave pion condensate in neutron stars reexamined", Phys. Rev. C **80** (2009), 038202 (4 pages), YITP-08-82, KUNS-2164, arXiv:0810.3531 [nucl-th].
3. K. Miura, T. Z. Nakano, A. Ohnishi, N. Kawamoto, "Phase diagram evolution at finite coupling in strong coupling lattice QCD", Phys. Rev. D **80** (2009), 074034 (18 pages), YITP-09-48, arXiv:0907.4245 [hep-lat].
4. P. K. Sahu, K. Tsubakihara, A. Ohnishi, "Nuclear Matter and Finite Nuclei in Effective Chiral Model", Phys. Rev. C **81** (2010), 014002 (8 pages), YITP-10-36, arXiv:0912.1416 [nucl-th].

Books and Proceedings

1. R.J. Fries, T. Kunihiro, B. Müller, A. Ohnishi, A. Schäfer, "From 0 to 5000 in 2×10^{-24} seconds: Entropy production in relativistic heavy-ion collisions", Nucl. Phys. A **830** (2009), pp 519c-522c, YITP-09-81, arXiv:0906.5293 [nucl-th].
2. A. Ohnishi, K. Miura, T.Z. Nakano, K. Kawamoto, "Phase diagram and critical point evolution in NLO and NNLO strong coupling lattice QCD", PoS **LATTICE 2009** (2009), 160 (7 pages), YITP-09-82, arXiv:0910.1896 [hep-lat].

Talks at International Conferences

1. "Hot and dense hadrons in strong coupling lattice QCD", Invited, in "Quarks and Hadrons under Extreme Conditions — AdS/QCD, Lattice QCD, and Physics at RHIC/LHC —", Univ. of Tokyo, May 18-19, 2009.
2. "Phase diagram and critical point evolution in NLO and NNLO strong coupling lattice QCD", in "The XXVII International Symposium on Lattice Field Theory (Lattice 2009)", Beijing, China, July 25-31, 2009.

3. "EOS of hyperonic matter for core collapse supernovae", in "The 10th International Conference on Hypernuclear and Strange Particle Physics (Hyp-X)", Tokai, Japan, Sep. 14-18, 2009.
4. "Phase diagram and nuclear matter in lattice QCD at strong coupling", in "Perturbative and Non-Perturbative aspects of QCD", YITP, Japan, Nov. 24, 2009.
5. "Finite Coupling Effects on the QCD Phase Diagram at Strong Coupling", Invited, in "Harmonies and Surprises on the Lattice (HASUL) — On the occation of the A. Nakamura's 60th birthday) —", Hiroshima, Japan, Mar.13, 2010.

Invited Seminars (in Japan)

1. "Nuclear Astrophysics and Equation of State" (in Japanese), in "Nuclear matter structure from baryon-baryon interaction", Morioka, Japan, Jun. 25-27, 2009.
2. "Physics of Quark-Gluon Plasma" (in Japanese), in "Perspectives of Hadron Physics via RHIC-PHENIX Experiments", Kyoto, Japan, July 3, 2009.
3. "QCD phase diagram and dense matter EOS" (in Japanese), in "From Strangeness to New Hadrons", Osaka, Japan, Dec.11-12, 2009.

Kazuo Hosomichi

Journal Papers

1. J.-E. Bourgine, K. Hosomichi and I. Kostov, "Boundary transitions of the O(n) model on a dynamical lattice," Nucl. Phys. B **832**, 462 (2010) YITP-09-56, arXiv:0910.1581 [hep-th].

Talks at International Conferences

1. "Boundary phenomena in the dilute O(n) matrix model," Invited, Plenary, in "Conformal Field Theory, Integrable Models and Liouville gravity," Landau Institute for Theoretical Physics, Chernogolovka, June 27 – July 2 2009.
2. "Boundary transitions of the O(n) model on a dynamical lattice," Invited, Plenary, in "Facets of Integrability," IPhT Saclay and ENS Paris, 5-7 November 2009.

Invited Seminars (in Japan)

1. "Boundary phenomena in the dilute O(n) matrix model," Dept. Physics, Osaka City Univ., 21 July 2009.
2. "Boundary transitions of the O(n) model on a dynamical lattice," KEK, 10 March 2010.

Misao Sasaki

Journal Papers

1. N. Deruelle, M. Sasaki, Y. Sendouda and D. Yamauchi, Prog. Theor. Phys. **123**, 169 (2010) [arXiv:0908.0679 [hep-th]].
2. H. Kihara, M. Nitta, M. Sasaki, C. M. Yoo and I. Zaballa, Phys. Rev. D **80**, 066004 (2009) [arXiv:0906.4493 [hep-th]].
3. K. Takahashi, A. Naruko, Y. Sendouda, D. Yamauchi, C. M. Yoo and M. Sasaki, JCAP **0910**, 003 (2009) [arXiv:0811.4698 [astro-ph]].
4. A. Flachi, M. Sasaki and T. Tanaka, JHEP **0905**, 031 (2009) [arXiv:0809.1006 [hep-ph]].

Talks at International Conferences

1. "Non-Gaussianity from multi-brid inflation," Invited, in "Focus week on non-Gaussianities in the sky," IPMU, Kashiwa, 6–10 April 2009.
2. "Non-Gaussian Curvature Perturbations from Multi-Brid Inflation," Invited, in "4th Sahkarov Symposium on Physics," Lebedev Institute, Moscow, 18–23 May 2009.
3. "Non-gaussianity from inflation," Invited, in "The Unity of the Universe," Portsmouth University, Portsmouth, 29 June – 1 July 2009.
4. "A thought on conformal frames," Invited, in Tufts Institute of Cosmology 20th Anniversary, "Challenges in Theoretical Cosmology," Talloires, France, 2–5 September 2009.
5. "Theory of cosmological perturbations," Invited lectures, in Corfu Summer Institute 2009, "Particles Astroparticles Cosmology and Strings 2nd Week," Corfu, Greece, 6–13 September 2009.
6. "Non-Gaussianity from Inflation," Invited, in 11th Italian-Korean Symposium on Relativistic Astrophysics "The Sun, the Stars,

the Universe and General Relativity," Sogang University, Seoul, Korea, 2–4 November, 2009.
7. "On physical equivalence of conformal frames," Invited, in "Cosmology, the Quantum Vacuum, and Zeta Function," Autonomous University of Barcelona, Barcelona, Spain, 8–10 March, 2010.

Invited Seminars (Overseas)

1. "A thought on conformal frames," APCTP, Pohang, Korea, 20 September 2009.
2. "Observational equivalence of conformally related frames," Lorentz Center, Leiden, Netherland, 12 March 2010.

Ryu Sasaki

Journal Papers

1. S. Odake and R. Sasaki,
"Unified theory of exactly and quasi-exactly solvable 'Discrete' quantum mechanics: I. Formalism," J. Math. Phys. **51** (2010) 083502 (24 pages), YITP-09-14, `arXiv:0903.2604[math-ph]`.
2. S. Odake and R. Sasaki,
"Crum's Theorem for 'Discrete' Quantum Mechanics," Prog. Theor. Phys. **122** (2009) 1067-1079. YITP-09-12 `arXiv:0902.2593[math-ph]`.
3. S. Odake and R. Sasaki,
"Infinitely many shape invariant potentials and new orthogonal polynomials," Phys. Lett. **B679** (2009) 414-417, YITP-09-36, `arXiv:0906.0142[math-ph]`.
4. S. Odake and R. Sasaki,
"Infinitely many shape invariant discrete quantum mechanical systems and new exceptional orthogonal polynomials related to the Wilson and the Askey-Wilson polynomials," Phys. Lett. **B682** (2009) 130-136, YITP-09-52, `arXiv:0909.3668[math-ph]`.
5. S. Odake and R. Sasaki,
"Infinitely many shape invariant potentials and cubic identities of the Laguerre and Jacobi polynomials." J. Math. Phys. **51** (2010) 053513, YITP-09-69, `arXiv:0911.1585[math-ph]`.
6. S. Odake and R. Sasaki,
"Another set of infinitely many exceptional (X_ℓ) Laguerre polynomials," Phys. Lett. **B684** (2010) 173-176. YITP-09-74, `arXiv:0911.3442[math-ph]`

Books and Proceedings

1. Ryu Sasaki,
"Utility of Mathematics for Physicists" (in Japanese),
Suuri Kagaku, (2010) No. 3, (Main editor).

Talks at International Conferences

1. "Exactly and Quasi-Exactly Solvable 'Discrete' Quantum Mechanics," Invited, Plenary,
in "Robin Bullough Memorial Symposium," Dept. Math. Manchester Univ.,
10–11 June 2009.

Invited Seminars (Overseas)

1. "Exactly Solvable Birth and Death Processes," Department of Mathematical Sciences, Univ. Durham, UK, 5 June 2009.
2. "Exactly Solvable Birth and Death Processes," Taipei String Group Seminar, Dept. Phys. National Taiwan Univ. Taipei, Taiwan, 21 Aug. 2009
3. "Exactly solvable quantum mechanics," Dept. Electr. Phys. National Chiao-Tung Univ. Hsinchu, Taiwan, 10 Dec. 2009.

Invited Seminars (in Japan)

1. "Exceptional orthogonal polynomials," Numazu Seminar, Numazu National Coll. of Technology, 10 March 2010.

Naoki Sasakura

Journal Papers

1. Y. Sasai and N. Sasakura,
"The Cutkosky rule of three dimensional noncommutative field theory in Lie algebraic noncommutative spacetime," JHEP **0906**, 013 (2009).
2. N. Sasakura,
"Gauge fixing in the tensor model and emergence of local gauge symmetries," Prog. Theor. Phys. **122**, 309 (2009).

Books and Proceedings

1. N. Sasakura, “Emergent General Relativity and Local Translation Symmetry in Tensor Models,” AIP Conf. Proc. **1196**, 248 (2009).
2. N. Sasakura, “Tensor Models as Theory of Dynamical Fuzzy Spaces and General Relativity,” AIP Conf. Proc. **1243**, 76 (2010).

Talks at International Conferences

1. “Emergent General Relativity and local translation symmetry in the tensor models,” in “The Planck Scale,” XXV Max Born Symposium, Wroclaw, Poland, 29 Jun - 3 July 2009.
2. “Tensor models as theory of dynamical fuzzy spaces and general relativity,” Invited, in “8th International Workshop Lie Theory and Its Applications in Physics (LT-8),” Varna, Bulgaria, 15-21 Jun 2009.

Invited Seminars (Overseas)

1. “Personal overview of QFT on $sl(2,R)$ spacetime and 3-dim gravity,” Institute for Theoretical Physics, University of Wroclaw, Poland, 24 June 2009.

Invited Seminars (in Japan)

1. “Toward microscopic theory of spacetime – Approach through fuzzy space –”, Dept. Physics, Nagoya Univ., 29 July 2009.

Masaru Shibata

Journal Papers

1. K. Kyutoku, M. Shibata, and K. Taniguchi, “Quasiequilibrium states of black hole-neutron star binaries in the moving-puncture framework,” Phys. Rev. D **79** (2009) 124018 (13 pages).
2. J.S. Read, C. Markakis, M. Shibata, K. Uryū, J.C. Creigton, and J.L. Friedman, “Measuring the neutron star equation of state with gravitational wave observation,” Phys. Rev. D **79** (2009) 124033 (12 pages).
3. K. Kiuchi, Y.-I. Sekiguchi, M. Shibata, and K. Taniguchi, “Longterm general relativistic simulation of binary neutron stars collapsing to a black hole,” Phys. Rev. D **80** (2009) 064037 (27 pages).
4. H. Yoshino and M. Shibata, “Higher-dimensional numerical relativity: Formulation and code tests,” Phys. Rev. D **80** (2009) 084025 (17 pages).
5. K. Nakao, H. Abe, H. Yoshino, and M. Shibata, “Maximal slicing of D-dimensional spherically symmetric vacuum spacetime ,” Phys. Rev. D **80** (2009) 084028 (10 pages).
6. K. Uryū, F. Limousin, J.L. Friedman, E. Gourgoulhon, and M. Shibata, “Non-conformally flat initial data for binary compact objects ,” Phys. Rev. D **80** (2009) 124004 (23 pages).
7. M. Shibata and H. Yoshino, “Nonaxisymmetric instability of rapidly rotating black hole in five dimensions,” Phys. Rev. D **81** (2010) 021501 (5 pages).

Talks at International Conferences

1. “Numerical Relativity” Invited, in “The 58th Fujihara Seminar: World-wide network of gravitational wave observation”, Hayama, 27–29 May, 2009.
2. “Fully General Relativistic MHD Simulation for the merger of Binary Neutron Stars” Invited, in “Astronum 2009: 4th International Conference on Numerical Modeling of Space Plasma Flows”, Chamonix, France, 29 June–3 July, 2009.
3. “Numerical simulations for binary merger in Japan” Invited, in “Microphysics in Computational Relativistic Astrophysics: MICRA2009”, Copenhagen, Denmark, 24–28 August, 2009.
4. “Simulation for neutron star-neutron star and black hole-neutron star binaries” Invited, in “Computational General Relativistic Astrophysics”, Princeton, USA, 22–24 October, 2009.
5. “3+1 and N+1 formalisms of numerical relativity” Invited, in “2009 International School on Numerical Relativity and Gravitation”, Seoul, Korea, 7–11 December, 2009.

Invited Seminars (Overseas)

1. ”Numerical Relativity: Solving the issues in general relativity,”

Department of Astronomy and Astrophysics, University of Valencia, Spain, 1 April 2010.

Invited Seminars (in Japan)

1. "Merger of binary neutron stars,"
   Mini Symposium on Nuclear Astro physics, YITP, Kyoto University, 25 January 2010.
2. "Current status and prospect of numerical relativity,"
   Workshop on *The origin of matter and structure of the universe*, the University of Tokyo, 16 March 2010.

Ken-ichi Shizuya

Journal Papers

1. K. Shizuya, "Pseudo-zero-mode Landau levels and collective excitations in bilayer graphene," Phys. Rev. **B 79** (2009) 165402 1-11, arXiv:0901.2803 [cond-mat], YITP-09-20.
2. K. Shizuya, "Pseudo-zero-mode Landau levels and pseudospin waves in bilayer graphene," Physica **E 42** (2010) 736 - 739.
3. K. Shizuya, "Many-body corrections to cyclotron resonance in monolayer and bilayer graphene," Phys. Rev. **B 81** (2010) 075407 1-10, arXiv:0911.1543 [cond-mat], YITP-09-66.

Books and Proceedings

1. K. Shizuya, "Green's functions and wave equations - along with quantum mechanics and field theory -" (in Japanese), Mathematical Science No. 561 (2009) 51 - 56.
2. K. Shizuya, "Scale anomaly, asymptotic freedom and supersymmetry" (in Japanese), Mathematical Science (Jan. 2010 special issue), 112 - 119.

Invited Seminars (in Japan)

1. "Graphene - New common ground between particle physics and condensed-matter physics -" , in workshop"Methods and Applications of Mathematical Science", Tohoku Gakuin University, March 26 (2010).

Takahiro Tanaka

Journal Papers

1. Kazumi Kashiyama, Norihiro Tanahashi, Antonino Flachi and Takahiro Tanaka
   Quantum black reaction to asymptotically AdS black holes.
   JHEP **1001** (2010) 099 1–23. arXiv:0910.5376 [gr-qc], YITP-09-91.
2. Norihiro Tanahashi and Takahiro Tanaka
   Floating Black Hole in the Karch-Randall Model and its Holographic Dual.
   Prog. Theor. Phys. **123** (2010) 369–392. arXiv:0910.5303 [gr-qc], YITP-09-63.
3. Kent Yagi and Takahiro Tanaka
   Constraining alternative theories of gravity by gravitational waves from precessing eccentric compact binaries with LISA.
   Phys. Rev. D **81** (2010) 064008-1–27 [Erratum-ibid. D **81** (2010) 109902]. arXiv:0906.4269 [gr-qc], YITP-09-90.
4. Antonino Flachi and Takahiro Tanaka
   Casimir Effect on the brane.
   Phys. Rev. D **80** (2009) 124022 arXiv:0906.2898 [hep-th], YITP-09-28.
5. Shuntaro Mizuno, Frederico Arroja, Kazuya Koyama and Takahiro Tanaka
   Lorentz boost and non-Gaussianity in multi-field DBI-inflation.
   Phys. Rev. D **80** (2009) 023530-1–10. arXiv:0905.4557 [hep-th], YITP-09-88.
6. Frederico Arroja, Shuntaro Mizuno, Kazuya Koyama and Takahiro Tanaka
   On the full trispectrum in single field DBI-inflation.
   Phys. Rev. D **80** (2009) 043527-1–14. arXiv:0905.3641 [hep-th], YITP-09-87.
7. Yuko Urakawa and Takahiro Tanaka
   Influence on observation from IR divergence during inflation – Multi field inflation –.
   Prog. Theor. Phys. **122** (2010) 1207–1238. arXiv:0904.4415 [hep-th], YITP-09-86.
8. Yuko Urakawa and Takahiro Tanaka
   Influence on Observation from IR Divergence during Inflation. I.
   Prog. Theor. Phys. **122** (2009) 779–803 arXiv:0902.3209 [hep-th], YITP-09-85.

Talks at international Conferences

1. Spin-2 ghost in brane gravity.
   Invited 20-21 Nov. 2009, International

Workshop on Dark Matter, Dark Energy and Matter-Antimatter Asymmetry, Hsinchu, Taiwan

2. Constraint on higher dimensional gravity theory from black holes.
   Invited 7-11 Dec. 2009, International School on Numerical Relativity and Gravitation APCTP, Seoul, Korea

3. Stability of ultra-spinning black holes.
   Invited 18-20 Sep. 2009, Future Prospects and Possibilities of Gravity Research, APCTP, Pohang, Korea

4. Instability of ultra-spinning higher dimensional black holes.
   Invited 24-26 Sep. 2009, 2009 NIMS-APCTP Joint International workshop "String Theory and Cosmology - Quantum Gravity Dark Energy and Dark Matter", Yusong, Korea

5. Floating Black Holes in Braneworld.
   Invited 17 Aug. - 12 Sep. 2009, Extended Workshop on DM, LHC and Cosmology The KIAS-KAIST-YITP Joint Workshop at KIAS, Daejon, Korea

6. Black Holes localized on the brane.
   Invited 22-24 July 2009, Holographic Cosmology, Perimeter institute, Kanada

7. Black Holes localized on the brane.
   Invited 25-30 May 2009, Frontiers in Black Hole Physics at Dubna, Dubna, Russia

8. Efficient diagrammatic computation method for higher order correlation function.
   6-10 April 2009, Focus week on non-Gaussianities in the sky, IPMU, Japan

Invited Seminars (Overseas)

1. Brane Localized Black Holes and Classical BH evaporation conjecture.
   26 Nov. 2009, National Tsing Hua univ., Hsinchu, Taiwan

2. Floating Black Holes in Braneworld.
   27 Oct. 2009, univ. Texas Austin, US

Invited Seminars (in Japan)

1. Direct test of general relativity and black hole spacetime using gravitational waves.
   21 March 2010, Annual meating of Physical Society of Japan, Okayama univ.
2. Classical BH evaporation conjecture.
   28 Jan. 2010, Physics Department, Nagoya univ.
3. Brane Black Holes.
   24 Dec. 2009, Frontiers of Research on Higher Dimensional Black Holes, YITP, Kyoto.
4. Non-linear evolution of denisty perturbation during inflation and non-Gaussianity in cosmic microwave background
   29 July, Enreiso-no-kai, Hokkaido univ.

Seiji Terashima

Journal Papers

1. K. Hashimoto, T. Tai and S. Terashima, "Toward a Proof of Montonen-Olive Duality via Multiple M2-branes,"
   JHEP **0904** (2009) 025 (27 pages), YITP-08-75, arXiv:0809.2137 [hep-th].
2. T. Azeyanagi, N. Ogawa and S. Terashima, "Holographic Duals of Kaluza-Klein Black Holes,"
   JHEP **0904** (2009) 061 (17 pages), YITP-08-88, arXiv:0811.4177 [hep-th].
3. T. Azeyanagi, N. Ogawa and S. Terashima, "The Kerr/CFT Correspondence and String Theory,"
   Phys. Rev. D **79** (2009) 106009 (14 pages), YITP-08-99, arXiv:0812.4883 [hep-th].
4. T. Azeyanagi, G. Compere, N. Ogawa Y. Tachikawa and S. Terashima,
   "Higher-Derivative Corrections to the Asymptotic Virasoro Symmetry of 4d Extremal Black Holes,"
   Prog. Theor. Phys. **122** (2009) 355-384 YITP-09-20, arXiv:0903.4176 [hep-th].
5. K. Maruyoshi, M. Taki, S. Terashima and F. Yagi,
   "New Seiberg Dualities from N=2 Dualities,"
   JHEP **0909** (2009) 086 (28 pages), YITP-09-40, arXiv:0907.2625 [hep-th].

6. S. Terashima and F. Yagi, "M5-brane Solution in ABJM Theory and Three-algebra," JHEP **0912** (2009) 059 (23 pages), YITP-09-57, arXiv:0909.3101 [hep-th].

Invited Seminars (in Japan)

1. "M5-brane Solution in ABJM Theory and Three-algebra," Dept. Physics, Kyushu Univ., 4 November 2009.
2. "On S-duality of N=2 SUSY gauge theories," JPS annual meeting, Okayama U., 23 March 2010.

Takami Tohyama

Journal Papers

1. P. Prelovsek, I. Sega and T. Tohyama, "Analysis of the transport properties of iron pnictides: Spin-fluctuation scenario," Phys. Rev. B **80** (2009) 014517, (6 pages), arXiv:0905.4153 [cond-mat].
2. H. Yoshizumi, T. Tohyama and T. Morinari, "Induced order in nonequivalent two-leg Hubbard ladder," Prog. Theor. Phys. Suppl. **122** (2009) 943-951, arXiv:0903.1697 [cond-mat].
3. T. Morinari, H. Nakamura, M. Machida and T. Tohyama, "Effect of Fermi surface topology on inter-layer magnetoresistance in layered multiband systems: Application to $LaFeAsO_{1-x}F_x$," J. Phys. Soc. Jpn. **78** (2009) 114702 (7 pages), arXiv:0906.3354 [cond-mat].
4. L. Vidmar, J. Bonca, S. Maekawa and T. Tohyama, "Bipolaron in the t-J model coupled to longitudinal or transverse quantum lattice vibrations," Phys. Rev. Lett. **103** (2009) 186401, (4 pages), arXiv:0908.3119 [cond-mat].
5. M. Mori, N. Afzal Shooshtary, T. Tohyama and S. Maekawa, "Nuclear quadrupole resonance frequency in multi-layered cuprates," J. Phys. Soc. Jpn. **78** (2009) 123704 (4 pages), arXiv:0908.3721 [cond-mat].
6. E. Kaneshita, T. Morinari and T. Tohyama, "Modeling the antiferromagnetic phase in iron pnictides: Weakly ordered state," Phys. Rev. Lett. **103** (2009) 247202, (4 pages), arXiv:0909.1081 [cond-mat].
7. K. Tsutsui, A. Toyama, T. Tohyama and S. Maekawa, "Exact diagonalization calculations of hole binding around Ni impurities in Ni-substituted cuprate superconductors," Phys. Rev. B **80** (2009) 224519, (5 pages), arXiv:0908.3535 [cond-mat].
8. T. Morinari, E. Kaneshita and T. Tohyama, "Fermi surface topology effect on interlayer magnetoresistance with in-plane magnetic field in layered multiband system: Application to FeAs-based superconductors," Physica C **420** (2010) 95-97.
9. T. Morinari, H. Himura and T. Tohyama, "Interlayer magnetoresistance theory for layered Dirac fermion systems: Application to alpha-$(BEDT\text{-}TTF)_2I_3$," Physica E **42** (2010) 763-766.

Talks at International Conferences

1. "Dynamical DMRG study of one-dimensional Hubbard-Holstein model," Invited, in "Croatian-Japanese Workshop on Materials Science," Zagreb, CROATIA, 29–30 June 2009.
2. "Origin of spatial variation of pairing gap in Bi-based high-T_c cuprates," Invited, in "NATO Advanced Research Workshop on "Physical Properties of Nanosystems"," Yalta, UKURAINA, 28 September –2 October 2009.
3. "Dynamical DMRG study of frustrated and electron-phonon coupled systems," Invited, in "Gorden Godfrey Workshop on "Spins and Strong Correlations"," Sydney, AUSTRALIA, 26–29 October 2009.
4. "Effect of Fermi surface topology on interlayer magnetoresistance in layered multiband systems: Application to iron pnictides," in "Joint IMR International Symposium High Magnetic Field Spin Science in 100T VI "Application of High Magnetic Field for Condensed Matter and Material Science"," Sendai, JAPAN, 7–9 December 2009.

Talks at domenstic Conferences (Invited)

1. “Theory of resonant inelastic x-ray scattering,”
   in “Symposium of JPS meeting,” Kumamoto Univ.,
   25 September 2009.
2. “Optical excitations in Mott insulators coupled to phonons,”
   in “YITP conference on ”Photo-induced phenomena in correlated electron systems”,” Kyoto Univ.,
   10–12 December 2009.

Invited Seminars (Overseas)

1. ”Resonant Inelastic X-ray Scattering in Cuprates,”
   Department of Physics, New South Wales University, Sydney, Australia, 11 November 2009.
2. ”Spin and Charge Dynamics Ruled by the Antiferromagnetic Order in Iron Pnictides,”
   Josph Stephan Institute, Ljubliana, Slovania, 25 Febrary 2010.

Invited Seminars (in Japan)

1. “Development of dynamical DMRG and its applications to 1D strongly correlated electron systems,”
   Dept. Physics, Osaka Univ., 25 December 2009.

Keisuke Totsuka

Journal Papers

1. H-T. Ueda and K. Totsuka,
   “Magnon Bose-Einstein condensation and various phases of three-dimensonal quantum helimagnets under high magnetic field”
   Phys.Rev. B, **80** (2009) 014417 (9 pages).
2. H-T.. Ueda, K. Totsuka, and T. Momoi
   “Dilute-bose-gas approach to ground state phases of 3D quantum helimagnets under high magnetic field”
   J.Phys. conf. series, **200** (2010) 022067 (4 pages).
3. H-T. Ueda and K. Totsuka,
   “Supersolid phase of three-dimensional spin- and hardcore-boson models”
   Phys.Rev. B, **81** (2010) 054442 (16 pages).

Talks at International Conferences

1. “Possible featureless spin-liquid phases in high magnetic fields”,
   in “Topological Order: from QUantum Hall Systems to Magnetic Materials”, Max-Planck Institute for Physics of Complex Systems, Dresden, Germany
   29 June–24 July 2009.
2. “Supersymmetric VBS models–hidden order and dynamics”,
   in “Workshop on Matrix Product State Formulation and Density Matrix Renormalization Group Simulations, Kobe, Japan
   12–13 August 2009.

Talks at Other Conferences and Workshops

1. “A boson-pairing approach to physics of spin-nematic phases”,
   in Autumn Meeting of the Physical Society of Japan’, Kumamoto University, Japan
   26 September 2009.
2. “Magnon-pair condensation and magnetic orders in 3D helimagnets”, in annual meeting of the project “Novel States of Matter Induced by Frustration”, Institute of Solid State Physics, Japan
   7-9 January 2009.

Hirofumi Wada

Journal Papers

1. H-R. Jiang, H. Wada, N. Yoshinaga and M. Sano
   “Manipulation of colloids by nonequilibrium depletion force in a temperature gradient,”
   Phys. Rev. Lett. **102** (2009) 208301.
2. A. Alexander-Katz, H. Wada, R. R. Netz
   “Internal friction and nonequilibrium unfolding of polymeric globules,”
   Phys. Rev. Lett. **103** (2009) 208102.
3. H. Wada and R. R. Netz
   “Hydrodynamics of helical-shaped bacterial motility,”
   Phys. Rev. E **80** (2009) 021921.
4. H. Wada and R. R. Netz
   “Plectoneme creation reduces the rotational friction of a polymer,”
   EPL **87** (2009) 38001; *Erratum* EPL **88** (2009) 49901.
5. H. Wada and Y. Tanaka
   “Mechanics and size-dependent elasticity of

composite networks,"
EPL **87** (2009) 58001.

Talks at International Conferences

1. "Rotating a polymer at nonequilibrium," Invited,
   in "Driven Microfluidic Systems," Atlantic Center for Atomistic Modeling, University College Dublin, Ireland,
   20–22 May 2009.

Invited Seminars (Overseas)

1. "Driven hydrodynamics of a rotating semiflexible polymer,"
   Ecole Polytechnique Fdrale de Lausanne (EPFL), Switzerland, 26 May 2009.

2.3.3 Publications and Talks by Research Fellows and Graduate Students (April 2009– March 2010)

Junichi Aoi

Journal Papers

1. J. Aoi, K. Murase, K. Takahashi, K. Ioka, S. Nagataki, "Can We Probe the Lorentz Factor of Gamma-ray Bursts from GeV-TeV Spectra Integrated Over Internal Shocks?", The Astrophysical Journal **722** (2010) 440-451. arXiv:0904.4878 [astro-ph], YITP-09-34.
2. K. Kotera, D. Allard, K. Murase, J. Aoi, Y.Dubois, T. Pierog, S. Nagataki, "Propagation of Ultrahigh Energy Nuclei in Clusters of Galaxies: Resulting Composition and Secondary Emissions", The Astrophysical Journal **707** (2009) 370-386. arXiv:0907.2433 [astro-ph], YITP-09-105.

Talks at International Conferences

1. "Can we probe the Lorentz factor of gamma-ray bursts from GeV-TeV spectra integrated over internal shocks?", "TeV Particle Astrophysics 2009", Plenary, SLAC National Accelerator Laboratory, USA, 13–17 July 2009

Takatoshi Ichikawa

Journal Papers

1. T. Ichikawa, K. Hagino, and A. Iwamoto, "Signature of Smooth Transition from Sudden to Adiabatic States in Heavy-Ion Fusion Reactions at Deep Sub-Barrier Energies," Phys. Rev. Lett. **103** (2009) 201701, YITP-09-55, arXiv::0909.2298[nucl-th].
2. A. Shrivastava, A. Navin, A. Lemasson, K. Ramachandran, V. Nanal, M. Rejmund, K. Hagino, T. Ichikawa, S. Bhattacharyya, A. Chatterjee, S. Kailas, K. Mahata, V. V. Parkar, R. G. Pillay, and P. C. Rout, "Exploring Fusion at Extreme Sub-Barrier Energies with Weakly Bound Nuclei," Phys. Rev. Lett. **103** (2009) 232702.

Talks at International Conferences

1. "Quantitative Estimation for Assigning the Reaction Channel ^{209}Bi(^{70}Zn, n)^{278}113," Plenary, in "Study of the Superheavy Element at RIKEN," RIKEN Nishina Center, Japan, 21 January 2010.

Invited Seminars (in Japan)

1. "Origin of the narrow, single peak in the fission-fragment mass distribution for ^{258}Fm," Dept. Physics, Tsukuba Univ., 25 September 2009.

Koutarou Kyutoku

Journal Papers

1. K. Kyutoku, M. Shibata and K. Taniguchi, "Quasiequilibrium states of blak hole-neutron star binaries in the moving-puncture framework," Phys. Rev. D **79** (2009) 124018, arXiv:0906.0889 [gr-qc].

Talks at International Conferences

1. "Quasiequilibrium states of black hole-neutron star binaries with realistic equations of state," in "Japan Physical Society," Konan University, 10–13 September 2009.

Marco Ruggieri

Journal Papers

1. K. Fukushima, M. Ruggieri and R. Gatto, "Chiral magnetic effect in the PNJL model," Phys. Rev. D **81**, 114031 (2010) [arXiv:1003.0047 [hep-ph]].
2. K. Fukushima and M. Ruggieri, "Dielectric correction to the Chiral Magnetic Effect," Phys. Rev. D **82**, 054001 (2010) [arXiv:1004.2769 [hep-ph]].

3. M. Ruggieri and R. Gatto,
   "Dressed Polyakov loop and phase diagram of hot quark matter under magnetic field,"
   Phys. Rev. D **82**, 054027 (2010) [arXiv:1007.0790 [hep-ph]].

Talks at International Conferences

1. "Phase diagram of hot quark matter under magnetic field,"
   Invited talk given at conference "QCD @ Work 2010: International Workshop on QCD - Theory and Experiment", Martina Franca, Valle d'Itria, Italy, 20-23 Jun 2010.
2. "QCD in a strong magnetic background,"
   Invited talk given at conference "The many faces of QCD," Ghent, Belgium, 1-5 Nov 2010.

Invited Seminars (Overseas)

1. "QCD in strong magnetic fields,"
   Department of Physics, Bari University, Italy, 18 December 2009.
2. "Deconfinement in a strong magnetic background,"
   Department of Physics, Genoa University, Italy, 9 November 2010.

Invited Seminars (in Japan)

1. "Q-balls,"
   Tokyo University of Science, 27 November 2009.
2. "Inhomogeneous Color Superconductivity,"
   Tokyo University of Science, 19 May 2010.

Shigetoshi Sota

Books and Proceedings

1. S. Sota and T. Tohyama, "Low-temperature density matrix renormalization group study on spin-1/2 frustrated spin chains," Journal of Physics: Conference Series **200** (2010) 012191 (4 pages).

Talks at International Conferences

1. "Low-temperature density matrix renormalization group method and its application to low-dimensional frustrated spin systems," in "Workshop on Matrix Product State Formulation and Density Matrix Renormalization Group Simulations (MPS and DMRG)," Oxford Kobe Institute, Kobe, 12–13 August 2009.
2. " Low-temperature density matrix renormalization group study on spin-1/2 zigzag XY chains," in "March Meeting 2010," Portland, Oregon, USA, 15–19 March 2010.

Toru T. Takahashi

Journal Papers

1. T. T. Takahashi and M. Oka,
   "Low-lying Lambda Baryons with spin 1/2 in Two-flavor Lattice QCD",
   Phys. Rev. **D81** (2010) 034505, arXiv:0910.0686 [hep-lat].
2. G. Erkol, M. Oka and T. T. Takahashi,
   "Axial Charges of Octet Baryons in Two-flavor Lattice QCD",
   Phys. Lett. **B686** (2010) 36, arXiv:0911.2447 [hep-lat].
3. T. T. Takahashi and Y. Kanada-En'yo,
   "Hadron-hadron interaction from SU(2) lattice QCD",
   Phys. Rev. **D82** (2010) 094506, arXiv:0912.0691 [hep-lat].

Books and Proceedings

1. T. T. Takahashi and T. Kunihiro,
   "Axial charges of N(1535) and N(1650) in two-flavor lattice QCD",
   Proceedings of the workshop "NSTAR2009", Beijing, April 19-22, 2009, Chinese Phys. **C33(12)** (2009) 1233.
2. T. T. Takahashi, M. Oka and G. Erkol,
   "Pseudoscalar-Meson Octet-Baryon Coupling Constants from two-flavor Lattice QCD",
   Proceedings of the 10th International Conference on Hypernuclear and Strange Particle Physics (HYP-X), Tokai, Ibaraki, Japan, 14-18 Sep 2009, Nucl. Phys. **A835** (2010)346, arXiv:0912.1000 [hep-lat].
3. T. T. Takahashi and M. Oka,
   "Two-flavor lattice QCD study of Lambda(1405)",
   Proceedings of the 27th International Symposium on Lattice Field Theory (Lattice 2009), Beijing, China, 25-31 Jul 2009, PoS LAT2009:108,2009, arXiv:0911.2542 [hep-lat].
4. M. Oka, G. Erkol and T. T. Takahashi,
   "Recent QCD results on the strange hadron systems",

Proceedings of the 6th International Workshop on Chiral Dynamics, CD09, Bern, Switzerland, July 6-10, 2009, PoS CD09:021,2009.

Talks at International Conferences

1. "Two-flavor lattice QCD study of Lambda(1405)",
   in 27th International Symposium on Lattice Field Theory (Lattice 2009),
   Beijing, China, 25-31 Jul 2009.
2. "Lambda(1405) from lattice QCD", Invited, in "New Frontiers in QCD 2010 (NFQCD10)",
   Kyoto, Japan, 18 Jan to 19 Mar, 2010.
3. "Hadronic interactions via lattice-QCD", Invited,
   in QCD from the Bound States' Perspective, ECT*,
   Italy, August 2-6, 2010.

Junko Yamagata-Sekihara

Journal Papers

1. J. Yamagata-Sekihara, D. Cabrera, M. J. Vicente Vacas and S. Hirenzaki, "Formation of ϕ Mesic Nuclei," Prog. Theor. Phys. **124** (2010) 147-162. arXiv:1001.2235 [nucl-th].
2. V. K. Magas, J. Yamagata-Sekihara, S. Hirenzaki, E. Oset and A. Ramos, "Proton emission off nuclei induced by kaons in flight," Phys. Rev. C **81** (2010) 024609 arXiv:0911.3614 [nucl-th].

Talks at International Conferences

1. "Production of hyperon resonances induced by kaon on deuteron target,"
   in "Third Joint Meeting of the Nuclear Physics Divisions of the American Physical Society and The Physical Society of Japan," Hilton Waikoloa Village. Hawaii's Big Island, USA
   13–17 October 2009.

Daisuke Yamauchi

Journal Papers

1. N. Deruelle, M. Sasaki, Y. Sendouda and D. Yamauchi,
   "Hamiltonian formulation of f(Riemann) theories of gravity,"
   Prog. Theor. Phys. **123**, 169 (2010) [arXiv:0908.0679 [hep-th]].
2. K. Takahashi, A. Naruko, Y. Sendouda, D. Yamauchi, C.-M. Yoo and M. Sasaki,
   "Non-Gaussianity in Cosmic Microwave Background Temperature Fluctuations from Cosmic (Super-)Strings,"
   JCAP **0910**, 003 (2009) [arXiv:0811.4698 [astro-ph]].

Talks at International Conferences

1. "Evolutionary effects in one-bubble open inflation for string landscape",
   12th Marcel Grossmann Meeting, Paris, France,
   7–12 July 2009
2. "Skewness in CMB temperature fluctuations from bended cosmic (super-)strings,"
   in "Japan Physical Society Meeting", Okayama University, Japan
   9–12 September 2009
3. "Non-Gaussianity in CMB temperature fluctuations from bended (super-)strings",
   Stanford Institute for Theoretical Physics, America,
   19 October 2009
4. "Skewness in CMB temperature fluctuations from bended (super-)strings",
   The 19th Workshop on General Relativity and Gravitation in Japan at Rikkyo University, Tokyo, Japan,
   30 November– 4 December 2009
5. "Non-Gaussianity in CMB temperature fluctuations from bended (super-)strings",
   "The non-Gaussian Universe" workshop at Yukawa Institute for Theoretical Physics, Japan,
   15–28 March 2010

2.4 Seminars, Colloquia and Lectures

▷ 2009.4.1 — 2010.3.31

4.3 Sean Murray (Centre for Particle Physics Phenomenology, Universite Catholique de Louvain, Belgium) : Fuzzy spaces and bundles

4.6 Hans Feldmeier (GSI / YITP) : YITP Colloquium: Shells, clusters, and halos - Concepts to solve the nuclear many-body problem

4.8 Kazunobu Maruyoshi (YITP): Quiver gauge theory and extended electric-magnetic duality

4.8 Serguey Petcov (SISSA/INFN, Italy and INRNE, Bulgaria): Neutrino Mixing, Leptonic CP-Violation, Leptogenesis and Lepton Flavour Violation

4.15 Domenico Orlando (IPMU) : Quantum Crystals and Topological Strings

4.15 Elias Kiritsis (University of Crete, Greece): Improved Holographic QCD

4.15 Naoki Yoshioka (YITP, Kyoto Univ.): Size scaling and bursting activity in thermally activated breakdown

4.15 Hirotaka Yoshino (University of Alberta, Canada): On non-existence of Randall-Sundrum II black holes

4.16 Philippe Sindzingre (LPTMC, Universite Pierre et Marie Curie): Phase diagram of J1-J2-J3 model of spin-1/2 on the square lattice

4.16-17 Hans Feldmeier (GSI/YITP) : Modern aspects of nuclear structure

4.22 Hayato Shiba (Graduate School of Science, Kyoto University): Heterogeneities, critical dynamics, and defect diffusion in 2D melting

4.22-23 Teruhiko Kawano (University of Tokyo) : F-theory and Grand Unification

4.24 Masao Nagasawa (University of Zurich): Is the quantum mechanics the only one theory? quantum physics and stochastic processes

4.27 Shunsuke Furukawa (RIKEN): Quantum Entanglement in Tomonaga-Luttinger Liquids

5.8 Junko Yamagata-Sekihara (YITP, Kyoto University ☒): Structure and formation of kaon-nucleus systems

5.12 Kazuo Hosomichi (YITP, Kyoto Univ.): YITP Colloquium: Random matrices – toy models of strings –

5.13 Masato Taki (YITP, Kyoto Univ.): Microscopic Approach of N=1 Gauge Theories and Whitham Hierarchy

5.13 Ryu Sasaki (YITP, Kyoto University): Exactly Solvable Birth and Death Processes

5.14 Leor Barack (University of Southampton): GCOE/YITP Seminar: Gravitational self-force (with application to extreme-mass-ratio binary inspirals)

5.20 Eigo Shintani (YITP, Kyoto Univ.): Recent works in JLQCD collaboration

5.20 Tomoko Mizuguchi (Kyushu Univ.): Glass Transition and Polyamorphism in a simple monatomic system

5.26 Carsten Rott (Ohio State University): Indirect Searches for Dark Matter with IceCube

5.27 Ryo Takahashi (YITP, Kyoto Univ.): Top Yukawa Deviation in Extra Dimension

5.28 Jose Riera (University of Rosario): Correlated multi-orbital models for superconducting Fe-pnictices

6.1-2 Fuminobu Takahashi (IPMU, University of Tokyo): Cosmic rays and Dark Matter

6.2 Fuminobu Takahashi (IPMU, University of Tokyo): Cosmic-ray anomalies as a probe of dark matter

6.3 Yukinori Yasui (Osaka City Univ.): Higher-dimensional Kerr Geometry

6.3 Tethuaki Itoh (Graduate School of Human and Enviromental Studies, Kyoto University): Spin liquid, spin-gap phase, and superconductivity under pressure, in organic triangular Mott insulators $X[Pd(dmit)_2]_2$

6.3 Satoshi Yukawa (Graduate School of Science, Osaka University): Interfacial effects on Ising thermal transport

6.10 Sanefumi Moriyama (Nagoya Univ. / YITP): Serre Relation and Higher Grade Generators of the AdS/CFT Yangian Symmetry

6.17 Shigeki Matsumoto (Univ. of Toyama): Will a WIMP dark matter overcome the Nightmare scenario?

6.17 Hideki Kobayashi (Graduate School of Engineering, Kyoto University):Tumbling motion of a single chain in shear flow: Crossover between shear-dominant motion and fluctuation-dominant motion

6.22 Jure Kokalj (Jozef Stefan Institute): GCOE/YITP Seminar: Combination of FTLM and DMRG for dynamics at finite temperature

6.24 Laszlo Feher (Budapest, RMKI & Szeged U.): GCOE/YITP Seminar: On the duality between the hyperbolic Sutherland and the rational Ruijsenaars-Schneider models

6.25 Fabio Scardigli(National Taiwan University): Dissipation and quantization for composite systems

7.1 Yoshida Kentaroh(Graduate School of Science, Kyoto University): On gravity duals for NR CFTs

7.7 Kazuharu Bamba (National Tsing Hua University): Phantom crossing in $F(R)$ gravity

7.8 Tomio Petrosky (Center for Complex Quantum Systems, The University of Texas at Austin): Quasi-Bound States in Continuum in Low Dimensional Nano-devise

7.15 Anna Bodrova (Moscow State University): GCOE/YITP Seminar: Aggregation & Fragmentation Kinetics in Granular Gases

7.16 Massimiliano de Pasquale (Mullard Space Science Laboratory (UCL)): Physical properties of Gamma-Ray Burst outflows: a study of Swift observations

7.21 Isaac Goldhirsch (Tel Aviv University): Coarse graining applied to a physical experiment

7.21 Takatoshi Ichikawa (YITP, Kyoto): Origin of the narrow, single peak in the fission-fragment mass distribution for ^{258}Fm

7.22 Kazuki Sakurai (KEK): LHC signature of SUSY models with non-universal sfermion masses

7.23 Tsutomu Yanagida (IPMU): Dark Matter and PAMELA/Fermi Anomalies

8.3 N. Dorey (DAMTP, Cambridge Univ.): Spiky Strings and Spin Chains

8.5 Yoshinori Takahashi (University of Hyogo): Progress in the theory of itinerant-electron magnetism in the past 7 decades – Efforts to overcome the difficulties in the SCR theory

8.5 Takashi Shimomura (Valencia U. & Valencia U., IFIC): Measuring Lepton Flavour Violation at LHC with Long-Lived Slepton in the Coannihilation Region

8.5 Feng-Shou Zhang (Beijing Normal University): Shell correction energy and the entrance channel effect on the formation of superheavy nuclei

8.6 Giovanni Jona-Lasinio (University of Rome): Analogies in Theoretical Physics

8.14 Stefan Luding (University of Twente, the Netherlands): Advanced numerical methods for hard sphere granular systems

8.19 Yu Nakayama (Univ. of California, Berkeley): Forbidden Landscape from Holography

8.20 E.C.G. Sudarshan(The University of Texas at Austin): Unstable Quantum Systems

8.25 Hock-Seng Goh (U.California, Berkeley): Twin Higgs and Lepton Number Violation at the LHC

8.28 Jorge Martin Camalich (Instituto de Fisica Corpuscular (IFIC), University of Valencia, Spain): Properties of hyperons in covariant chiral perturbation theory

9.9 Masahito Yamazaki (Univ. of Tokyo): Developments in wall crossing phenomena

9.18 M.V. Sadovskii (Russian Academy of Sciences): Multiple Bands – A Key to High -Temperature Superconductivity in Iron Arsenides?

10.1 Kazuo Tsushima (Jefferson Laboratory): J/ψ property in nuclear medium

10.7 Satoshi Okuzumi (Graduate School of Human and Environmental Studies,Kyoto University): Electric charging of dust particles/aggregates in a weakly ionized plasma and its significance in dust coagulation in protoplanetary disks

10.9 Piljin Yi (KIAS): Topics in D4-D8 Holographic QCD

10.9 Tadashi Takayanagi (IPMU): Holographic Insulator/Superconductor Phase Transition at Zero Temperature

10.13 Bernard de Wit (Utrecht Univ.): BPS horizons and higher-derivative couplings in

4 and 5 dimensions

10.13 Seok Kim (Seoul National Univ.): The superconformal index for N=6 Chern-Simons theory

10.13 Giniyat Khaliullin (Max Planck Institute for Solid State Research): Mott insulators in the strong spin-orbit coupling limit

10.14 Gary Horowitz (University of California, Santa Barbara): YITP Colloquium: The Remarkable Power of General Relativity

10.14-15 Shuichi Murakami(Tokyo Institute of Technology): Berry-phase phenomena in condensed materials and topological insulators

10.15 Gary Horowitz (UC, Santa Barbara): Recent Progress in Holographic Superconductors

10.15 Shuichi Murakami (Tokyo Institute of Technology): Novel physics of edge states in 2D quantum spin Hall systems

10.15 Hong Liu (MIT): From black holes to strange metals

10.15 Jan de Boer (Univ. of Amsterdam): Quantum Aspects of Black Holes

10.15 Shankar P. Das (Jawaharlal Nehru University): Time dependent correlations in a supercooled liquid from nonlinear fluctuating hydrodynamics.

10.20 Joseph Marsano (Caltech): F-Theory and GUTs

10.20 Taizan Watari (IPMU): Flavor Structure in F-theory

10.20 Takuji Ishikawa (Graduate School of Engineering, Tohoku Univ.): Suspension dynamics of swimming micro-organisms

10.21 J.Maharana (Inst. of Physics, Bhubaneswar): Toroidal compactification of type IIB theory with fluxes

10.22 Kentaro Yoshida (Kyoto Univ.): Schrödinger symmetry and gravity duals for NRCFTs

10.22 Yoichi Kazama (U. Tokyo, Komaba): Quantum Superparticle in AdS_5xS^5

10.28 Hiroaki Kanno (Nagoya Univ.): Combinatorics and instanton partition function in higher dimensions

10.28 Romuald Janik (Jagiellonian Univ.): 4-loop twist two operators, BFKL, integrability and strings

10.28 Masatoshi Ichikawa (Graduate School of Science, Kyoto University):Force between colloidal particles in a nematic liquid crystal studied by optical tweezers

10.28 Marco Ruggieri (YITP, Kyoto Univ.):Probing the QCD vacuum with an abelian chromomagnetic field

10.29 Michael Kiermaier (Princeton Univ.): MHV vertex expansions for N=4 SYM

11.9 Tomohiro Harada (Rikkyo University): Loop quantum gravity: an insight into spacetime singularity

11.10 O.Cepas (Institut Neel): Towards a phase diagram for the Kagome antiferromagnet with Dzyaloshinskii-Moriya interactions?

11.11 Dmitri Kazakov (JINR, Dubna & ITEP, Moscow): Infrared Safe Observables in N=4 Super Yang-Mills Theory

11.11 Akihiro Ishibashi (KEK): Black holes in modified self-dual gravity

11.11 Victor Steinberg (Weizmann Institute of Science): Single vesicle dynamics in various flows

11.13 Rainer J. Fries (Texas A & M / RBRC): Hard Probes in Heavy Ion Collisions: Jet Chemistry and Tomography

11.18 Sergey Fedoruk (JINR, Dubna): Superconformal Calogero models as a gauged matrix mechanics

11.19 Yohei Masada (National Astronomical Observatory of Japan): Impact of magnetic Prandtl number on Magnetorotational Instability - Current Research Status of MRI -

11.24 Volodia Belinski (International Network of Centers for Relativistic Astrophysics (ICRANET)): On the equilibrium configuration of two Reissner-Nordstrom objects and repulsive gravity

11.25 Andrei Marshakov (YITP/ITEP): Supersymmetric gauge theories, integrability and conformal blocks

11.30 Ansgar Liebsch (Institute of Solid State Research, Research Center Juelich): Fermi-liquid, non-Fermi-liquid, and Mott phases in iron pnictides and cuprates

11.30 Andrei Marshakov (YITP/ITEP): YITP Colloquium: Supersymmetric QCD: towards understanding of confinement

12.2 Harald Fritzsch (Munich U. / KEK): Flavor Mixing, Neutrino Masses and Neutrino Oscillations

12.2 Michiko Shimokawa (Setsunan University):Fractal pattern of coffee on milk

12.9 Masaki Asano (Tohoku Univ.): General WIMP search at ILC

12.10 David Jenkins (The University of York): Insights into molecular configurations in 24Mg and 28Si from heavy ion radiative capture

12.14 Ferenc Kun(University of Debrecen): Slip avalanches in a fiber bundle model

12.14-15 Masayasu Harada(Nogoya University) : Chiral Effective Theories in QCD and Hadron Physics

12.15 M. Harada (Nagoya University): Effects of vector - axial-vector mixing to dilepton spectrum in hot and/or dense matter

12.16 Junya Yagi (Rutgers Univ.): Chiral Algebras of (0,2) Models: Beyond Perturbation Theory

12.16 Hajime Susa (Konan University): Generation of magnetic field by First Stars

12.17-18 Tomohiro Sasamoto (Chiba University): Nonequilibrium statistical mechanical models in 1D

12.21 Keiji Saito (University of Tokyo): Thermal Conduction in 3D Nonlinear Systems and Related Topics

12.28 Takeshi Morita (Tata Institute): One dimensional Large-N gauge theory in a 1/D expansion

1.6 Shigeki Matsumoto (Univ. of Toyama): What do we learn from the CDMSII experiment?

1.7 Yutaka Hosotani (Osaka University): Stable Higgs Bosons as Cold Dark Matter

1.8 Peter Moller (Los Alamos National Laboratory): ACCURACY AND PREDICTIVE POWER OF NUCLEAR STRUCTURE MODELS. IMPLICATIONS FOR STABILITY OF NEUTRON-RICH AND SUPER-HEAVY NUCLEI

1.13 C. Young (YITP): Boundaries and Integrability in N=4 SYM

1.13 Takahiro Sagawa (The University of Tokyo): Information Thermodynamics

1.15 Tom Kibble (Imperial College, London): GCOE/YITP Lecture: Topological Defects in Cosmology and Condensed Matter

1.19 Masaru Shibata (YITP): YITP Colloquium: Numerical Relativity: Solving the issues in general relativity

1.20 S.Das (Kentucky Univ.): DILATON COSMOLOGIES AND THEIR GAUGE THEORY DUALS

1.27 Takaaki Nomura (Saitama Univ.): Gauge-Higgs unification model with $S2/Z_2$ orbifold

1.27 Michiyasu Mori (IMR, Tohoku University): Enhancement of pairing gap in cuprates by apical and dopant oxygens

1.28 Yasuhiro Sekino (Okayama Institute of Quantum Physics): FRW/CFT Duality: Holographic Formulation of Eternal Inflation and its Applications

2.2 Dmitry Prokhorov (KASI): ICM, SZE, ICS, NTE, NEI, ETC

2.4 Shin Nakamura (Kyoto University): AdS / CFT correspondence and its application to stationary non-equilibrium physics

2.9 Rafi Blumenfeld (Earth Science and Engineering, Imperial College London, UK & Cavendish Laboratory, Cambridge University, UK): Stress transmission and incipient yield flow in dense granular materials

2.10 Kazunori Shima (Saitama Inst. of Technology): Nonlinear Supersymmetric General Relativity Theory and Low Energy Particle Physics

2.18 Julien Deseigne (CEA. France): Herds of mechanical circular sheep : an experimental reality

2.24 Shuichi Yokoyama (The University of Tokyo): A Monopole Index for N=4 Chern-Simons Theories

3.3 Katsuo Tokushuku (KEK): First collisions at LHC

3.3 Ryo Suzuki (Trinity College Dublin): Exploring TBA in the mirror AdS_5xS^5

3.8-9 Takashi Okamura (Kwansei Gakuin University): gauge/gravity correspondence for relativists

3.9 Takashi Okamura (Kwansei Gakuin University): vortex lattice for a holographic superconductor

3.15 Igor Shovkovy (Arizona State University): YITP Colloquium: Relativistic Dynamics and Spontaneous Symmetry Breaking in Graphene

3.17 David Wands (University of Portsmouth/YITP): YITP Colloquium: Primordial perturbations from cosmological inflation

3.17 John C. Wells (Ritsumeikan University):

A model for elastohydrodynamic collision of spheres in liquid

3.18-19 David Wands (Portsmouth Univ. & Yukawa Institute): Cosmological perturbations

3.29 Bernard Carr (Queen Mary University of London/RESCEU): NEW COSMOLOGICAL CONSTRAINTS ON PRIMORDIAL BLACK HOLES

3.30 Hiroaki Matsueda (Sendai National College of Technology): Recent development of density matrix renormalization group method - Entanglement structure inherent in tensor networks -

3.30 Kenji Harada (Graduate School of Informatics, Kyoto University): Multi-scale entanglement renormalization for frustrated quantum magnets

2.5 Visitors (2009)

Atom-type Visitors

Yoshida, Shinsuke (N)
Niigata University
2010.02.15 — 2010.03.15

Shima, Kazunari (E)
Saitama Institute of Texhnology
2010.02.01 — 2010.02.16

Shima, Kazunari (E)
Saitama Institute of Texhnology
2010.03.03 — 2010.03.17

Visitors

Moriyama, Sanefumi (E)
Nagoya University
2009.04.01 — 2010.03.31

Petcov, Serguey (E)
SISSA/INFN, INRNE, IPMU, Univ. of Tokyo
2009.04.07 — 2009.04.09

Kiritsis, Elias (E)
University of Crete
2009.04.12 — 2009.04.19

Rodriguez, Yeinzon (A)
Universidad Antonio Narino
2009.04.12 — 2009.04.25

Domenico, Orlando (E)
IPMU, Univ. of Tokyo
2009.04.14 — 2009.04.18

Sindzingre, Philippe (C)
LPTMC, Universite Pierre et Marie Curie
2009.04.15 — 2009.04.19

Radke, Thomas (A)
Albert Einstein Institute
2009.04.15 — 2009.04.22

Kimura, Tetsuji (E)
KEK
2009.04.21 — 2009.04.24

Kawano, Teruhiko (E)
Graduate School of Science, University of Tokyo
2009.04.22 — 2009.04.23

Nagasawa, Masao (E)
University of Zurich
2009.04.23 — 2009.04.25

Furukawa, Shunsuke (C)
RIKEN
2009.04.27 — 2009.04.28

Barack, Leor (A)
University of Southampton
2009.05.02 — 2009.05.21

Mizuguchi, Tomoko (C)
Kyushu University
2009.05.06 — 2009.07.20

Kanno, Hiroaki (E)
Nagoya University
2009.05.14 — 2009.05.14

Marquet, Cyrille (N)
Columbia University
2009.05.20 — 2009.05.24

Rott, Carsten (A)
Ohio State University
2009.05.25 — 2009.05.26

Riera, Jose (C)
University of Rosario
2009.05.27 — 2009.05.29

Takahashi, Fuminobu (E)
IPMU, University of Tokyo
2009.06.01 — 2009.06.02

Hayasaki, Kimitake (A)
Hokkaido University
2009.06.15 — 2009.06.24

Matsumoto, Shigeki (E)
Univ. of Toyama
2009.06.17 — 2009.06.18

Feher, Laszlo (E)
Inst.for Particle & Nucl.Phys.,Hungarian Academy Sciences
2009.06.17 — 2009.07.10

Kokalj, Jure (C)
Jozef Stephan Institute
2009.06.20 — 2009.07.20

Scardigli, Fabio (A)
National Taiwan University
2009.06.23 — 2009.06.29

Hikami, Kazuhiro (E)
Naruto University of Education
2009.07.02 — 2009.07.03

Bodrova, Anna (C)
Lomonosov Moscow State Univ.
2009.07.06 — 2009.09.12

De Pasquale, Massimiliano (A)
Mullard Space Science Laboratory, University College London
2009.07.13 — 2009.07.19
Lin, Hung-Miao (A)
National Central University,Taiwan
2009.07.16 — 2009.07.19
Sekiguchi, Yuichiro (A)
NAOJ
2009.07.22 — 2009.07.24
Kiuchi, Kenta (A)
Waseda Univ.
2009.07.22 — 2009.07.24
Roca Zamora, Luis (N)
University of Murcia
2009.07.25 — 2009.08.31
Dorey, Nicholas (E)
Cambridge University
2009.08.03 — 2009.08.11
Shimomura, Takashi (E)
Valencia U. & Valencia U., IFIC
2009.08.03 — 2009.08.13
Nakayama, Yu (E)
University of California, Berkeley
2009.08.17 — 2009.08.23
Hirenzaki, Satoru (N)
Nara Women's Univ.
2009.08.25 — 2009.08.25
Ikeno, Natsumi (N)
Nara Women's Univ.
2009.08.25 — 2009.08.25
Nagahiro, Hideko (N)
Nara Women's Univ.
2009.08.25 — 2009.08.25
Hikami, Kazuhiro (E)
Naruto University of Education
2009.08.31 — 2009.09.01
Hirenzaki, Satoru (N)
Nara Women's Univ.
2009.09.01 — 2009.09.02
Ikeno, Natsumi (N)
Nara Women's Univ.
2009.09.01 — 2009.09.02
Nagahiro, Hideko (N)
Nara Women's Univ.
2009.09.01 — 2009.09.02
Itahashi, Kenta (N)
RIKEN
2009.09.01 — 2009.09.02
Gal, Avraham (N)
Racah Inst. of Physics, The Hebrew Univ.
2009.09.02 — 2009.09.13
Hayano, Ryugo (N)
Univ.of Tokyo
2009.09.02 — 2009.09.02
Hayasaki, Kimitake (A)
Hokkaido Univ.
2009.09.06 — 2009.09.10
Taormina, Anne (E)
University of Durham
2009.09.07 — 2009.09.27
Yamazaki, Masahito (E)
Univ. of Tokyo
2009.09.08 — 2009.09.10
Sadovskii, Michael V. (C)
Institute for Electrophysics, Russian Academy of Sciences
2009.09.13 — 2009.09.24
Khaliullin,Giniyat (C)
Max Planck Institute for Solid State Research
2009.10.11 — 2009.10.26
Mori, Michiyasu (C)
IMR, Tohoku University
2009.10.13 — 2009.10.24
Ho, Choon-Lin (E)
Tamkang Univ.
2009.10.13 — 2009.10.29
Maharana, Jnanadeva (E)
Inst. of Physics, Bhubaneswar
2009.10.18 — 2009.10.24
Cui, Xiahong (A)
Peking Univ.
2009.10.20 — 2009.12.11
Zhang, Ying-li (A)
Shanghai Normal Univ.
2009.10.22 — 2010.01.19
Dmitrasinovic, Veljko (N)
Vinca Institute
2009.11.02 — 2009.11.20
Odintsov, Sergey (A)
IEEC
2009.11.04 — 2009.11.04
Hikami, Kazuhiro (E)
Naruto University of Education
2009.11.05 — 2009.11.06
Fries, Rainer J. (N)
Texas A & M / RBRC
2009.11.12 — 2009.11.15
Nomura, Takaaki (E)
Saitama University
2009.11.13 — 2009.11.27

Gelis, Francois (N)
CEA, Saclay
2009.11.14 — 2009.11.29
Ishimori, Hajime (E)
Niigata University
2009.11.16 — 2009.11.21
Fedoruk, Sergey (E)
KEK / JINR, Dubna
2009.11.17 — 2009.11.19
Yoo, Chul-Moon (A)
Asia Pacific Center for Theoretical Physics
2009.11.24 — 2009.11.27
Liebsch, Ansgar (A)
Institute of Solid State Research
2009.11.29 — 2009.12.06
Prelovsek, Peter (C)
Jozsef Stefan Institute
2009.11.30 — 2009.12.05
Fritzsch, Harald (E)
University of Munich/ KEK
2009.12.01 — 2009.12.03
Cornell, Alan (A)
University of the Witwatersrand
2009.12.05 — 2009.12.15
Harada, Masayasu (N)
Graduate School of Science, Nogoya University
2009.12.13 — 2009.12.15
Schuck, Peter (N)
Institute for Nuclear Physics
2009.12.13 — 2009.12.17
Takamizu, Yuichi (A)
RESCEU, Univ.of Tokyo
2009.12.14 — 2009.12.15
Yoshino, Yutaka (A)
University of Alberta
2009.12.14 — 2009.12.30
Sasamoto, Tomohiro (A)
Faculty of Science, Chiba University
2009.12.16 — 2009.12.18
Aoyama, Shigeyoshi (N)
Niigata University
2009.12.16 — 2009.12.18
Iizuka, Norihiro (E)
CERN
2009.12.18 — 2009.12.30
Kanno, Sugumi (A)
Durham University
2009.12.22 — 2010.01.18
Morita, Takeshi (E)
TIFR
2009.12.23 — 2009.12.31
Shigemori, Masaki (E)
University of Amsterdam
2009.12.24 — 2009.12.27
Yoshino, Yutaka (A)
University of Alberta
2010.01.04 — 2010.01.11
Fonseca, Jose (A)
Univ. of Portsmouth
2010.01.04 — 2010.03.28
Kibble, Thomas Walter Bannerman (A)
Imperial College
2010.01.05 — 2010.01.23
Prokhorov, Dmitry (A)
KASI
2010.01.06 — 2010.02.07
Iwamoto, Akira (N)
Juntendo University
2010.01.07 — 2010.01.09
Möller, Peter (N)
Los Alamos National Laboratory
2010.01.07 — 2010.01.14
De Forcrand, Philippe (N)
Institute for Theoretical Physics, ETH Zurich
2010.01.10 — 2010.01.25
De Felice, Antonio (A)
Tokyo University of Science
2010.01.15 — 2010.01.30
Das, Sumit (E)
University of Kentucky
2010.01.18 — 2010.01.21
Takamizu, Yuichi (A)
RESCEU, Univ.of Tokyo
2010.01.19 — 2010.01.21
Sekino, Yasuhiro (A)
Okayama Institute of Quantum Physics
2010.01.25 — 2010.01.30
Hayasaki, Kimitake (A)
Hokkaido Univ.
2010.02.08 — 2010.03.10
Hut, Piet (A)
Institute for Advance Study, Princeton
2010.02.10 — 2010.02.17
Honma, Yoshinori (E)
KEK/SOKENDAI
2010.02.15 — 2010.02.19
Zhang, Sen (E)
KEK/SOKENDAI
2010.02.15 — 2010.02.19

Hikami, Kazuhiro (E)
Naruto University of Education
2010.02.22 — 2010.02.23
Yoo, Chul-Moon (A)
Asia Pacific Center for Theoretical Physics
2010.02.22 — 2010.03.05
Okazaki, Atsuo (A)
Hokkai-Gakuen University
2010.02.24 — 2010.02.26
Okuda, Takuya (E)
Perimeter Institute for Theoretical Physics
2010.02.24 — 2010.03.03
Morozov, Andrey (E)
ITEP
2010.02.26 — 2010.03.06
Morozov, Alexey (E)
ITEP
2010.02.26 — 2010.03.06
Wyllard, Niclas (E)
Chalmers University of Technology
2010.02.27 — 2010.03.13
Park, Jaemo (E)
POSTECH
2010.02.28 — 2010.03.03
Teschner, Joerg (E)
DESY
2010.02.28 — 2010.03.03
Shatashvili, Samson L (E)
Trinity College Dublin
2010.02.28 — 2010.03.04
Suzuki, Ryo (E)
Trinity College Dublin
2010.02.28 — 2010.03.05
Lee, Sungjay (E)
Korea Institute for Advanced Study
2010.02.28 — 2010.03.08
Steer, Daniele Ann (A)
Universite Paris 7
2010.03.06 — 2010.03.27
Hasebe, Kazuki (C)
Takuma National College of Technology
2010.03.10 — 2010.03.12
Frolov, Andrei (A)
Simon Fraser University
2010.03.14 — 2010.03.21
Koyama, Kazuya (A)
University 繆 of Portsmouth
2010.03.14 — 2010.03.28
Langlois, David (A)
Universite Paris 7
2010.03.15 — 2010.03.26
Takahashi, Fuminobu (A)
IPMU
2010.03.15 — 2010.03.28
Nomura, Takaaki (E)
Saitama University
2010.03.17 — 2010.03.19
Yoo, Chul-Moon (A)
Asia Pacific Center for Theoretical Physics
2010.03.18 — 2010.03.25
Tommaso, Gianantonio (A)
University of Bonn
2010.03.21 — 2010.03.29
Komatsu, Eiichiro (A)
University of Texas
2010.03.21 — 2010.03.27
Kim, Sooa (A)
Korea Astronomy and Space Science Institute
2010.03.22 — 2010.03.31
Yamaguchi, Masahide (A)
Aoyama Gakuin
2010.03.23 — 2010.03.27
Takahashi, Tomo (A)
Saga University
2010.03.23 — 2010.03.28
De Felice, Antonio (A)
Tokyo University of Science
2010.03.23 — 2010.03.28
Urakawa, Yuko (A)
Waseda University
2010.03.24 — 2010.03.28
Byrnes, Christian (A)
University of Bielefeld
2010.03.24 — 2010.03.28
Kamada, Kohei (A)
University of Tokyo
2010.03.24 — 2010.03.27
Yokoyama, Shuichiro (A)
Nagoya University
2010.03.24 — 2010.03.28
Carr, Bernard John (A)
Queen Mary, University of London
2010.03.29 — 2010.03.31

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. See page 20 for details.

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 2009.

Yukawa International Seminar (YKIS2009)

YKIS2009 : Frontiers in Nonequilibrium Physics - Fundamental theory, Glasses & Granular Materials, and Computational Physics

Jul 21 - Aug 21, 2009, Chaired by Hisao Hayakawa, 134 participants (48 from abroad)
For details see http://www2.yukawa.kyoto-u.ac.jp/ ykis2009/

Nishinomiya-Yukawa Symposium 2009

New Frontiers in QCD 2010 - Exotic Hadron Systems and Dense Matter -

Jan 18 - Mar 19, 2010, Chaired by Akira Ohnishi, 191 participants (73 from overseas)
For details, see http://www.stcm_workshop. mp.es.osaka-u.ac.jp/

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.

▷ 2009.4.1 — 2010.3.31

Here is the list of workshops with the dates, the names of organizers, the number of participants, the proceedings and the url's.

YITP-W-09-01
Non-Linear Cosmological Perturbation, Apr 13 - Apr 24, 2009. T. Tanaka, K. Koyama, S. Mukohyama, F. Takahashi, M. Sasaki, *26-participants,* Soryuushiron Kenkyuu 117-3
http://www2.yukawa.kyoto-u.ac.jp/t̃anaka/Molecule/NLCP.html

YITP-W-09-02
Development of nuclean structure models from the view point of nuclear force, May 20 - May 22, 2009. N. Itagaki, T. Otsuka, K. Kato, T. Myo, Y. Kanada-Enyo, S. Fujii, K. Yabana, H. Nakada, *45-participants,* Soryuushiron Kenkyuu 117-3
http://www.yukawa.kyoto-u.ac.jp/contents/seminar/archive/2009/yitp-w-09-02/

YITP-W-09-03
Massless Dirac particles in organic conductorand new development, Jul 2 - Jul 3, 2009. T. Morinari, T. Tohyama, Y. Suzumura, A. Kobayashi, N. Tajima, *53-participants,*
http://www.yukawa.kyoto-u.ac.jp/contents/seminar/archive/2009/yitp-w-09-03/

YITP-W-09-04
Field theory and string theory, Jul 6 - Jul 10, 2009. T. Takayanagi, M. Sakamoto, Y. Imamura, M. Kato, S. Sugimoto, K. Hashimoto, S. Moriyama, M. Hamanaka, N. Ohta, H. Kunitomo, S. Terashima, *117-participants,* Soryuushiron Kenkyuu 117-6
http://www.yukawa.kyoto-u.ac.jp/contents/seminar/archive/2009/yitp-w-09-04/

YITP-W-09-05
Summer School on Astronomy and Astrophysics 2009, Jul 27 - Jul 30, 2009. K. Kamada, W. Kokuyama, H. Motohashi, T. Sato, d. Takei, S. Konami, S. Masuda, K. Takahashi, A. Hayafuji, Y. Suwa, T. Enoto, M. Nakashima, *358-participants,*
http://www.astro-wakate.org/ss2009/

YITP-W-09-06
49 Summer School for Young Biophysics Researchers, Jul 31 - Aug 3, 2009. H. Tamate, K. Tamura, T. Tsukamoto, Y. Nagahata, M. Nomura, T. Uematsu, Y. Yamashita, S. Kita, K. Miyamura, D. Ito, *90-participants,* Bussei Kenkyuu 94-2

YITP-W-09-07
Symposium on Frontiers in Nonequilibrium Physics - Fundamental theory, Glasses & Granular Materials, and Computational Physics, Jul 31 - Aug 1, 2009. H. Hayakawa, *84-participants,* Prog. Theor. Phys., Suppl. 184

YITP-W-09-08
Summer Institute 2009, Aug 13 - Aug 20, 2009. T. Kobayashi, M. Bando, J. Kubo, H. Terao, R. Kurimoto, K. Hamaguchi, M. Yamaguchi, H. Nakano, K.W. Choi, M. Tanimoto, T. Kugo, *63-participants,*
http://k2.sci.u-toyama.ac.jp/SI2009/

YITP-W-09-09
The 54th Summer Seminar for young researchers of condensed-matter physics, Aug 21 - Aug 25, 2009. K. Shitara, A. Terasawa, T. Kuroiwa, A. Toyoda, S. Abe, S. Fukushima, R. Noguchi, Y. Yamaki, K. Hasegawa, M. Hosoda, K. Suzuki, S. Nemoto, Y. Abe, T. Baba, K. Igarashi, S.

Kobayashi, R. Akashi, *182-participants,* Bussei Kenkyuu 93-6
http://www.stat.phys.titech.ac.jp/summerschool2009/ss2009/index.html

YITP-W-09-10
YONUPA Summer School 2009, Aug 24 - Aug 29, 2009. K. Kawashima, H. Kitamoto, Y. Kondo, S. Izumoto, H. Ishimori, T. Houri, M. Kohriki, K. Asaka, t. Nishinaka, T. Miwa, H. Noda, H. Ohno, H. Fukuoka, Y. Fujii, Yuka Yasue, S. Yoshida, Y. Sakai K. Itagaki, *246-participants,* Soryuushiron Kenkyuu 117-5
http://www.th.phys.titech.ac.jp/sansha09/

YITP-W-09-11
Science of Science Education, Aug 26 - Aug 28, 2009. M. Kikuchi, H. Sato, K. Taniguchi, H. Kawakatsu, Y. Matsuda, A. Yasuda, M. Bando, H. Aoyama, *100-participants,* Soryuushiron Kenkyuu 117-4, Bussei Kenkyuu 93-4
http://www.science-ed.net/

YITP-W-09-12
Thermal Quantum Field Theory and Their Applications, Sep 3 - Sep 5, 2009. M. Tachibana, M. Mine, S. Abe, M. Asakawa, K. Iida, T. Inagaki, M. Okumura, A. Ohnishi, M. Sakagami, C. Nonaka,S. Muroya, *102-participants,* Soryuushiron Kenkyuu 118-1
http://www.yukawa.kyoto-u.ac.jp/contents/seminar/archive/2009/yitp-w-09-12/

YITP-W-09-13
Econophysics Joint Conference, Sep 8 - Sep 9, 2009. A. Ishikawa, K. Yagi, H. Aoyama, A. Sato, W. Souma, Y. Ikeda, H. Takayasu, J. Maskawa, Y. Fujiwara, M. Tanaka, M. Takayasu, H. Iyetomi, *83-participants,* Soryuushiron Kenkyuu 117-5, Bussei Kenkyuu 93-5
http://www.yukawa.kyoto-u.ac.jp/contents/seminar/archive/2009/yitp-w-09-13/

YITP-W-09-14
What is Evolution? Bicentennial of Charles Darwin's Birth, Oct 15 - Oct 18, 2009. M. Murase, K. Nishimura, T. Ohno, I. Tsuda, *65-participants,* Bussei Kenkyuu 94-1
http://www.yukawa.kyoto-u.ac.jp/contents/seminar/archive/2009/yitp-w-09-14/

YITP-W-09-15
KIAS-KAIST-YITP Joint Workshop: Extended Workshop on "dark matter, LHC and cosmology", Aug 27 - Sep 4, 2009. P. Ko, P. Yi, S. Scopel, M. Dress, D. Chung, K.W.Choi, S.Y. Choi, E.J.Chun, S.K.Kim, M. Sasaki, *83-participants,*
http://workshop.kias.re.kr/hepph09dm/frame1.htm

YITP-W-09-16
Nishina Memorial Symposium on "Symmetry Breaking in Particle Physics, Oct 27, 2009. T. Hatsuda, K. Shizuya, T. Eguchi, Y. Hosotani, K. Higashijima, H. Hayakawa, *78-participants,*
http://www.yukawa.kyoto-u.ac.jp/contents/seminar/archive/2009/yitp-w-09-16/

YITP-W-09-17
Dualities and Scales in Quantum Sciences, Nov 4 - Nov 6, 2009. I. Ojima, H. Hayakawa, A. Hosita, A. Shimizu, R. Sasaki, S. Tanimura, I. Tsutsui, M. Hotta, *77-participants,*
http://www.yukawa.kyoto-u.ac.jp/ftp/ps/workshop/program/yitp-w-09-17.pdf

YITP-W-09-18
Frontiers in astrophysical magnetohydrodynamic simulation, Nov 16 - Nov 18, 2009. T. Yokoyama, T. Terasawa, M. Shibata, S. Inutsuka, T. Suzuki, K. Ohsuga, Y. Kojima, R. Matsumoto, M. Takahashi, *60-participants,*
http://www.yukawa.kyoto-u.ac.jp/contents/seminar/archive/2009/yitp-w-09-18/

YITP-W-09-19
Photoinduced Phenomena in Correlated Electron Systems, Dec 10 - Dec 11, 2009. S. Iwai, S. Ishihara, H. Okamoto, T. Tohyama, K. Yonemitsu, *43-participants,* Bussei Kenkyuu 94-2
http://www.yukawa.kyoto-u.ac.jp/contents/seminar/archive/2009/yitp-w-09-19/

YITP-W-09-20
Black holes in Higher Dimensions, Dec 24 - Dec 26, 2009. T. Takayanagi, T. Tanaka, A. Ishibashi, H. Ishihara, H. Kodama, D. Ida, S. Sugimoto, M. Sasaki, J. Soda, T. Shiromizu, M. Shibata, K. Maeda, K. Hosomiti,K. Nakao, *81-participants,*

http://www.yukawa.kyoto-u.ac.jp/contents/seminar/archive/2009/yitp-w-09-20/

YITP-W-09-21
2009 International School on Numerical Relativity and Gravitation, Dec 7 - Dec 11, 2009. G.W.Kang, R.Q.Liu, M. Shibata, H.J.Yo, *61-participants,*
http://apctp.org/conferences/2009/NRG2009/#tab04

YITP-W-09-22
Novel States of Matter Induced by Frustration, Jan 7 - Jan 9, 2010. H. Kageyama, T. Morinari, H. Kawamura, K. Totsuka, T. Tohyama, *101-participants,* Bussei Kenkyuu 95-1
http://www.frustration.jp/modules/bulletin/index.php?page=article&storyid=103

3.3 Regional Schools supported by YITP

▷ 2009.4.1—2010.3.31

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-09-01
The 37th Hokuriku-shinetsu Particle Physics Theory Group Meeting, May 22 - May 25, 2009, National Myoko Youth Outdoor Learning Center.
Kazuhiro Tobe, Tohru Iijima
Niigata Univ., Toyama Univ., Kanazawa Univ.

YITP-S-09-02
Chubu Summer School 2009, Aug 29 - Aug 31, 2009, Yamanakako Seminar House.
Yasuhiro Okada
Tokai Univ., Shinshu Univ., Shizuoka Univ.

YITP-S-09-03
14th Niigata-Yamagata School, Nov 6 - Nov 8, 2009, Iide Children's Center.
Teruhiro Kawano
Niigata Univ., Yamagata Univ.

YITP-S-09-04
22th Workshop in Hokkaido Nuclear Theory Group, Feb 13 - Feb 16, 2009, Hokkaido Univeresity.
Hiroshi Toki, Emiko Hiyama
Hokkaido Univ., Kitami Inst.Tech., Hokusei Gakuen Univ.

YITP-S-09-05
The 32th Shikoku-Seminar, Dec 19 - Dec 20, 2009, Kochi University.
Atsushi Hosaka
Tokushima Univ., Kochi Univ., Ehime Univ.

YITP-S-09-06
Shinshu Winter School, Mar 11 - Mar 14, 2010, Shiga Heights Villa, Ochanomizu University.
Takahiro Tanaka, Koji Harada
Kanazawa Univ., Shinshu Univ., Toyama Univ., Niigata Univ., Kinjo College