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YITP Annual Report

**Yukawa Institute For
Theoretical Physics
Kyoto University**

2006

Foreword

We present here an annual report of the scientific activities of Yukawa Institute for Theoretical Physics during the academic year 2006. We hope that the readers of this report will be able to see the scope of the research activities covered by the Institute as well as specific research accomplishments in individual fields.

From the year 2006 we started our new project of "Yukawa International Program of Quark-Hadron Sciences (YIPQS)" funded by Japan Minsitry of Educaton, Culture and Sports. In this project we select a few research topics in each year and host long-term workshops extending over periods of a few months. We invite leading experts from the world in each topic and aim at fruitful collaboration among the workshop participants. In the year 2006, workshops in the area of the interface between string theory and cosmology, condensed matter theory and nano technologies and also quark hadron physics have been held. We hope that we can report some of the new developments initiated by these workshops in the next year.

Director
Tohru Eguchi

Contents

Chapter 1

People

1.1 Regular Staff and Guest Professors (2006 April – 2007 March)

Regular Staff

Taichiro Kugo
Professor (E)

Masao Ninomiya
Professor (E)

Ken-ichi Shizuya
Professor (E)

Hideo Kodama
Professor (A) [– 2007.03.31]

Teiji Kunihiro
Professor (N)

Shin Mineshige
Professor (A)

Hirokazu Tsunetsugu
Professor (C) [– 2006.08.31]

Misao Sasaki
Professor (A)

Takao Ohta
Professor (C) [– 2006.06.30]

Hisao Hayakawa
Professor (C) [2006.07.01 –]

Takami Tohyama
Professor (C) [2006.10.01 –]

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)

Keisuke Totsuka
Associate Professor (C)

Shigehiro Nagataki
Associate Professor (A)

Yoshiko Kanada-Enyo
Associate Professor (N)

Ken-iti Izawa
Associate Professor (E) [2006.03.01 –]

Takao Morinari
Research Associate (C)

Daisuke Jido
Research Associate (E)

Seiji Terashima
Research Associate (E) [2006.08.01 –]

Rika Endo
Research Associate (Project Manager) [– 2007.03.31]

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. Berndt Mueller
(Duke University)
2006.5.1 — 2006.7.31
Various Phases and Dynamics of Hadron-Quark Matter

Prof. Jorge Vinals
(McGill University)
2006.7.1 — 2006.7.31
Dynamics of microphase separated structures

Prof. Pieter Hut
(Princeton University)
2006.10.1 — 2007.1.15
Dense Stellar Systems and Black Holes

Prof. Volodymyr Miranskyy
(University of Western Ontario)
2006.12.1 — 2007.3.31
Phase structure in dense Quark Matter

1.2 Research Fellows and Graduate Students (2006 April – 2007 March)

Research Fellows

JSPS Research Fellows (domestic)

Toru Takahashi
JSPS fellow (N) [2004.4.1 – 2007.3.31]

Shinsuke Kawai
JSPS fellow (E) [2004.4.1 – 2007.3.31]

Hiroyuki Abe
JSPS fellow (E) [2006.4.1 – 2009.3.31]

Tetsuo Hyodo
JSPS fellow (N) [2006.4.1 –]

Hideaki Iida
JSPS fellow (N) [2006.4.1 – 2007.3.31]

Kazuharu Bamba
JSPS fellow (A) [2006.4.1 – 2007.3.31]

JSPS Research Fellows (from abroad)

Antonino Flachi
JSPS fellow (A) [2004.8.3 – 2006.8.2]

Cristina Zambon
JSPS fellow (E) [2004.10.4 – 2006.10.3]

Alan Cornell
JSPS fellow (A) [2004.11.22 – 2006.9.30]

Cecilia Albertsson
JSPS fellow (E) [2005.10.1 –]

Fabio Scardigli
JSPS fellow (A) [2006.10.2 –]

Viktor Gabor Czinner
JSPS fellow (A) [2006.11.21 –]

Friedel T. J. Epple
JSPS short term fellow (A) [2006.3.1 – 2006.5.31]

Akhil R. Shhah
JSPS short term fellow (E) [2006.6.20 – 2006.8.22]

JSPS Invitation Fellows (from abroad)

Francesco Calogero
JSPS inv. fellow, short term (E) [2006.3.9 – 2006.4.21]

Istvan Ra'cz
JSPS inv. fellow, long term (A) [2006.10.5 –]

Dirk H. Rischke
JSPS inv. fellow, short term (C) [2006.11.26 – 2006.12.9]

21COE Research Fellows

Hiroaki Abuki
COE21 fellow (N) [2004.4.1 – 2006.11.30]

Antonino Flachi
COE21 fellow (A) [2006.10.1 –]

Tetsuji Kimura
COE21 fellow (E) [2006.10.1 –]

YITP Research Fellows

Naotoshi Okamura
YITP fellow (E) [2005.5.1 – 2007.3.31]

Masaaki Takashina
YITP fellow (N) [2006.4.1 –]

Tatsuya Yamasaki
YITP fellow (A) [2006.4.1 – 2006.10.31]

Kunihito Uzawa
YITP fellow (A) [2004.4.1 – 2007.3.31]

Mitsuhiro Arikawa
YITP fellow (C) [2005.4.11 – 2007.3.31]

Toru Goto
YITP fellow (E) [2006.4.1 – 2007.3.31]

Kimitake Hayasaki
KU part-time lecturer (A) [2006.4.1 – 2007.3.31]

Chiyori Urabe
KU part-time lecturer (C) [2006.4.1 – 2007.3.31]

Antonino Flachi
KU part-time lecturer (A) [2006.8.3 – 2006.9.30]

Shin Sasaki
KU part-time lecturer (E) [2006.11.1 – 2007.3.31]

SRF Research Fellows

Masato Minamitsuji
Research Assistant (A) [2006.4.1 – 2006.12.31]

Yoshinobu Habara
Research Assistant (A) [2005.4.1 – 2007.12.31]

Graduate Students

Junichi Aoi
(A) [2006.4.1 –]

Tatsuya Kubota
(E) [2006.4.1 –]

Masashi Kyoutani
(A) [2006.4.1 –]

Takahiro Mimori
(C) [2006.7.1 –]

Masaki Murata
(E) [2006.4.1 –]

Noriaki Ogawa
(E) [2006.4.1 –]

Hiroomi Tanaka
(N) [2006.4.1 –]

Daisuke Yamauchi
(A) [2006.4.1 –]

Hiroyuki Yoshidsumi
(C) [2006.4.1 –]

Youhei Ota
(E) [2003.4.1 –]

Roji Kawabata
(A) [2005.4.1 –]

Sugure Tanzawa
(A) [2005.4.1 –]

Kohta Murase
(A) [2005.4.1 –]

Hiroaki Ueda
(C) [2005.4.1 –]

Takayoshi Miki
(C) [2005.4.1 –]

Mituhisa Ohta
(E) [2005.4.1 –]

Kiki Vierdayanti
(A) [2005.4.1 –]

Yoshiharu Tanaka
(A) [2004.4.1 –]

Ken Nagata
(A) [2004.4.1 –]

Kazuya Mitsutani
(N) [2004.4.1 –]

Yuya Sasai
(E) [2004.4.1 –]

Michihisa Takeuchi
(E) [2004.4.1 –]

Yasutaka Taniguchi
(N) [2006.4.1 –]

Takahiro Nishino
(C) [2006.7.1 –]

Tatsuya Tokunaga
(E) [2003.4.1 –]

Norita Kawanaka
(A) [2003.4.1 –]

Tetsuya Mitsudo
(C) [2006.7.1 –]

Tomohisa Takimi
(E) [2002.4.1 – 2007.3.31]

Shunsuke Negishi
(E) [2003.5.1 – 2007.3.31]

Atsushi Kawarada
(C) [2006.7.1 –]

Ph.D Awarded

Tomohisa Takimi
A non-perturbative study of Supersymmetric Lattice Gauge Theories (E)
(advisor: Tetsuya Onogi)

Shunsuke Negishi
Precision study of $B^*B\pi$ coupling for the static heavy-light meson (E)
(advisor: Tetsuya Onogi)

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Chapter 2

Research Activities

2.1 Research Summary

Astrophysics and Cosmology Group

The goal of this research group is to acquire a comprehensive understanding of the whole evolution of our universe from its birth to the present as well as its rich structures and diverse activities at present, on the basis of fundamental laws of nature and observations. Due to this basic nature, researches in this group are always cross-disciplinary and cover a quite wide range of subjects from mathematical studies of spacetimes to phenomenological modeling of astronomical objects. Further, major topics are strongly influenced by new developments in investigations of fundamental laws as well as in observations.

The research topics covered by the cosmology subgroup span over numerous fields in theoretical physics, ranging from what is properly known as 'Cosmology', to cross-disciplinary subjects as astroparticle physics, string theory, quantum gravity, classical general relativity, quantum field theory in flat and curved space, and more formal mathematical aspects. The group developed collaborations with other major Institutes (in particular the connections with the University of Paris and the recently established Center for Astroparticle Physics and Cosmology (APC) have been strengthened through various visits and the organization of one international workshop).

Inflation and Cosmological Perturbation Theory

The recent years have seen a boost of experimental activities aiming to get a *picture* of the universe through its temperature anisotropies: WMAP recently released accurate data in perfect agreement with the previous measurements of COBE, and and next generation experiments (PLANCK and WMAP) will look for further details of the CMB, hopefully confirming the already solid inflationary scenario. Despite of this great progress, inflation is not yet in the form of a theory and there is a lot of physics to understand and many technical and formal issues to clarify.

The objective of some of the members of the group was to investigate some of these yet unclear aspects of inflation with particular attention to the possibility that the next generation experiments may reveal differences, as non-gaussian distribution of primordial curvature perturbations, from the original inflationary scenarios.

This motivated the study of multi-component scalar field theories that can predict a large non-gaussianity. M. Sasaki and his collaborators developed new methods to evaluate the primordial spectrum of curvature perturbations for multi-field theories. In addition to this fundamental work, specific examples, explicitly realizing non-gaussianity, were contructed in the so called curvaton model, where the inflaton is accompanied by a weakly coupled light scalar that is assumed to be subdominant during inflation. Exactly solvable models were also investigated. Further formal studies have been carried out by Y. Tanaka who has developed a method, based on the gradient expansion, to take into account the effects of non-linearity in the computations of cosmological perturbations. Other specific examples were studied by V. Czinner, who considered general-relativistic rotational perturbations in standard cosmology and compared the results with recent observational data of the dipole component of the CMB.

Cosmological Magnetic Fields

Another important problem of modern cosmology is to understand the origin of the large scale magnetic fields of 10^{-6} Gauss, which are observed at distances of order 1kpc to 1Mpc. K. Bamba and M. Sasaki have investigated the possibility that inflation may be the 'trigger' for such magnetic fields. The general idea was to consider a coupling between the electromagnetic field with a non-trivial time-varying function of some background field. Within this set-up, it is reasonable to think that, from small initial seeds, the observed large scale magnetic fields can be generated. It was found that the electromagnetic field has to be coupled to a function which is extremely small at the beginning and increase rapidly during inflation. Moreover, K. Bamba has considered the property of the spectrum of large-scale magnetic fields generated due to the breaking of the conformal invariance of the electromagnetic field through some mechanism in inflationary cosmology.

Baryogenesis

One of the most challenging, yet unexplained, problems in cosmology is to find an explanation for the observed net excess of baryons over anti-baryons. Many years ago, it was shown that for this to occur a number of criteria have to be met: baryon number violation, C and CP violation, and departure from thermal equilibrium. However these conditions are realized only to an insufficient extent in the standard model. K. Bamba has investigated the possibility that Hypercharge Electromagnetic fields, that can be incorporated in minimal extensions of the standard model, could play a significant role in some baryogenesis models. The intriguing outcome of this is that the right baryon asymmetry can indeed be generated only if magnetic fields with sufficient strength are generated at the horizon scale, suggesting an interesting link between the baryogenesys problem to that of cosmological magnetic fields.

Quantum Effects in Brane Models

The past decade has seen an explosion of interest of the scientific community in what is now termed as 'brane world scenario'. This is a model where our observable universe is a membrane immersed in a higher dimensional bulk space. In this context, one of the most significant issues is the so called 'moduli stabilization problem', namely the size of the extra dimensions, corresponding to some scalar degree of freedom, is not fixed by anything in the theory. One natural possibility, investigated by M. Minamitsuji, is that such scalar degree of freedom is stabilized by quantum effects (Casimir stabilization). He investigated codimension-2 brane models and showed that the volume modulus can indeed be stabilized in such a way. Interestingly, quantum effects, that contribute to the brane vacuum energy, seem to alleviate the cosmological constant problem, in such models.

Dynamics of Black Holes and Branes

The main objective of A. Flachi is to investigate the dynamics of extended topological structures under the influence of the gravitational field of a black hole. The interest in this problem has been triggered, from the point of view of the early universe cosmology, by the possible relevance for understanding the interaction between topological defects and primordial black holes. On the other hand, low scale gravity theories and the possibility of producing small black holes at the LHC or in cosmic rays provides more pressing interest in the problem. The main result of the work of A. Flachi is that the system of a brane and a black hole is basically an unstable one. The analysis of the dynamics has been carried out in the quasi adiabatic case, in a semi-analytical way, including the effect of a brane tension.

Cosmological domain wall problem

Another important problem in cosmology is the domain wall problem. In simple words, the basic observed features of the universe seem not to allow the presence of heavy extended objects, which are predicted by most cosmological theories. One possible solution to this problem has been outlined recently: the collision of a domain wall with a primordial black hole may cause the perforation with subsequent expansion of the hole and destruction of the domain wall. From a more formal point of view this process provides an interesting example of topology change. A. Flachi has explored this type of phenomena extensively giving a complete characterization of the process of hole formation, and showing that the cosmological domain wall problem cannot be solved in the above way, disproving previous claims.

Dynamical Solutions and Inflation in Supergravity

H. Kodama and K. Uzawa have been facing the challenging problem of constructing a consistent cosmological model based on string theory. String theory can be consistently formulated in higher dimensional spacetimes and, in order to obtain a consistent four dimensional universe at low energy, one typically appeals to compactification. However, one of the most serious problems of compactification is that the sizes (moduli) of the extra dimensions are not fixed. In this direction, new progress has been made recently by S. Kachru and collaborators. They proposed a model in which all moduli are stabilized. However, they argue, on the basis of 4D effective theory, that the scale of the CY space can be stabilized by nonperturbative quantum effects. One of the main objectives of the work of H. Kodama and K. Uzawa was to give full consistency to the previous picture by analyzing the stability of these moduli degrees of freedom in the full higher dimensional theory. The main achievement is a new (dynamical) solution is 10D IIB SUGRA. The main result is that such solution is dynamically unstable in the moduli sector representing the scale of the CY space, although it takes long time for the instability (associated with complete supersymmetry breaking) to sets in. They have also obtained a 4D effective theory from the dynamical solutions (both in IIB SUGRA and in the 11D Horava-Witten model), showing that the set-up allows a much larger class of theories than previously thought.

Quantum Mechanics and Gravity

Quantum mechanics and gravity, when combined together, seem to suggest the existence of a minimum length scale, which, in turn, implies modifications to the Heisenberg Uncertainty Principle. The work of F. Scardigli has mainly dealt with understanding and generalizing the above picture to higher dimensional set-ups like those arising in string theory. Interestingly, those generalizations imply a significant relation between the holographic principle and the equivalence principle, in the sense that if one aims to reconcile holography with a higher dimensional picture, a violation of the equivalence principle at short distances seems to be necessary. Alternatively, holography may dictate the right (four) number of dimensions. F. Scardigli is also working on the front of foundations of Quantum Mechanics, in the framework proposed by 't Hooft according to which quantum behaviour can be reproduced by adding dissipation to an underlying classical system. Specifically, he is studying how to explicitly insert the interaction in the 't Hooft models, the ambitious goal of this project being to reproduce typical quantum features like 'entanglement' between systems and 'linear superposition', starting from underlying classical systems.

Black Hole and Neutron Star Astrophysics

On the basis of the two-dimensional radiation-hydrodynamic (2D RHD) simulations of super-critical black-hole accretion flow which they made in 2005, K. Ohsuga and S. Mineshige investigate why super-critical accretion is feasible from the basic physical ground. They found two important mechanisms underlying supercritical disk accretion flow. One is the radiation anisotropy arising from the anisotropic density distributions. Another is the photon trapping, by which the radial component of the radiative flux in the rest frame becomes negative in the innermost region. Both tend to weaken the radiation pressure force, which makes super-critical accretion possible.

It still remains an open question if the Ultraluminous X-ray Sources (ULXs) really contain intermediate-mass black holes (IMBHs). To settle down this issue, K. Vierdayanti and S. Mineshige, together with K. Ebisawa investigate the XMM-Newton EPIC spectra of six ULXs, that are claimed as strong candidates of IMBHs. They first tried the conventional fitting, but found that the blackbody component, which was used to derive black-hole mass, is a minor spectral component, leading to the conclusion that the results derived solely from the minor component are questionable. Next, they tried to fit the same data by another model, confirming that super-critical accretion is really occurring in those sources. The estimated black hole masses are smaller than 20 times solar mass, meaning that the central engines of these ULXs are super-critical accretion flows to stellar-mass black holes, and not to IMBHs.

There has been a long discussion regarding how to identify the presence of a massive black hole from the information of stellar density distribution in a star cluster. S. Mineshige, together with visitors to YITP, D. C. Heggie, P. Hut, and J. Makino, and with H. Baumgardt, investigate a theoretical framework which establishes how the core radius of a star cluster varies with the mass of an assumed central black hole. They find that the ratio of the core radius to the half-mass radius of the cluster is proportional to $(M_{\rm bh}/M)^{3/4}$ where $M_{\rm bh}$ and M are the the black hole mass and the cluster mass, respectively, when the system is well relaxed. Their conclusion strengthens the view that clusters with large core radii are the most promising candidates in which to find a massive black hole.

There is growing evidence for the coevolution of supermassive black holes and their host galaxies. These strongly suggest the formation of a supermassive binary black hole at the common center of galaxies as a result of merger events. There is, however, little direct evidence for a supermassive binary black hole on the parsec/subparsec scale because of observable limits. K. Hayasaki, S. Mineshige, together with H. Sudou newly proposed the theoretical scenario to detect the light curves emitted from the supermassive binary black hole systems which are composed of the two black holes and a rotating gas surrounding them, i.e. a circumbinary disk. They found the mass can periodically inflow onto the central binary from two points at the inner edge of the circumbinary disk. This shows that the light curves from supermassive binary black hole systems vary with the binary orbital motion. They also found that the two accretion disks should be formed around each of black holes by the circularization of the infalling gas.

Gamma-Ray Bursts and X-Ray Flashes

It is believed that most Gamma-Ray Bursts (GRBs) are coming from highly relativistic jets driven by massive stars. X-Ray Flashes (XRFs) are similar phenomena to GRBs, although typical photon energy is lower than GRBs. Thus it is believed that X-Ray Flashes are coming from mildly relativistic jets. However, it is not well known how such highly/mildly relativistic jets are driven from massive stars. A. Mizuta, T. Yamasaki, S. Nagataki, and S. Mineshige performed 2D simulations to investigate the dynamics of an outflow propagating in a progenitor. They showed that the jet structure totally depends on the initially injected bulk Lorentz factor of the jet, Γ_0. When Γ_0 is high, high-pressure progenitor gas heated by the bow shock collimates the outflow to form a narrow, relativistic jet. When Γ_0 is low, on the contrary, the outflow expands soon after the injection, since the bow shock is weak and thus the pressure of the progenitor gas is not high enough to confine the flow. This result suggests that a smooth transition from GRBs to XRFs can be explained by the same model but with different Γ_0 values.

It is known that some GRBs are accompanied by hypernovae whose explosion energy is of the order of 10^{52} ergs, which is 10 times larger than that of a normal core-collapse supernova. The explosion energy of a hypernova is so large that it cannot be explained by the standard scenario of a normal core-collapse supernova. Thus hypernovae should be driven by an entirely different central engine from normal core-collapse supernovae, although the engine is not well understood. Hypernovae are also so luminous, which implies that a large amount of ^{56}Ni is synthesized in hypernovae. However, it is an open question where ^{56}Ni is synthesized in hypernovae. S. Nagataki, A. Mizuta, and K. Sato performed 2D simulations of hypernovae to investigate the origin of ^{56}Ni. They showed that ^{56}Ni is not produced in GRB jets sufficiently when the duration of the explosion is as long as 10 sec. Even though a considerable amount of ^{56}Ni is synthesized as long as all the explosion energy is deposited initially, the opening angles of the jets become too wide to realize GRBs. From these results, it is concluded that the origin of ^{56}Ni in hypernovae associated with GRBs should not be the explosive nucleosynthesis in GRB jets.

Recent observations of bright optical and X-ray flares by the Swift satellite suggest these are produced by the late activities of the central engine of GRBs. K. Murase and S. Nagataki studied the neutrino emission from far-ultraviolet and X-ray flares in the context of the late internal shock model. They showed that the efficiency of pion production in the highest energy is comparable to or higher than the unity, and the contribution from such neutrino flashes to a diffuse very high energy neutrino background can be larger than that of prompt bursts if the total baryonic energy input into flares is comparable to the radiated energy of prompt bursts. These signals may be detected by IceCube and are very important because they offer possibilities to probe the nature of the flares.

Condensed Matter and Statistical Physics Group

Condensed Matter Physics

The subjects of condensed matter physics are the states of matter that emerge at low-temperatures as a consequence of non-trivial many-body effects. Interplay among low-energy degrees of freedom such as charge, spin and (electron) orbital, when combined with a few simple fundamental principles (e.g. Fermi statistics, electromagnetic interactions among electrons), yields a variety of phenomena ranging from magnetism to superconductivity. The area of current research in our group covers low-energy dynamics of internal degrees of freedom in various phases of strongly correlated electron systems, frustrated magnets, low-dimensional quantum spin systems, and high-temperature superconductivity.

Electron-hole asymmetry in cuprate high-temperature superconductors: The long-range hoppings termed t' and t" induces electron-hole asymmetry in the electronic states and low-energy excitations of cuprate superconductors. This is one of hot topics in the field of high-temperature superconductivity. Tohyama examined the single-particle spectral function by using the t-t'-t"-J model and the Lanczos-type numerically exact diagonalization technique. Remarkable differences are found between hole- and electron- dopings. Around the boundary of the first Brillouin zone, an arc behavior of the Fermi surface appears in hole-doped system, while a Fermi-surface pocket emerges in electron- doped system. By using the exactly calculated Green's functions of the t-t'-t"-J model, the dynamical spin response function and the optical conductivity are constructed. In the hole-doped system, the spin response shows a sandglass-like behavior consistent with neutron scattering experiments. For the electron-doped system, the spin response and optical conductivity deviate from those obtained from the Kubo formula. This is due to the presence of strong antiferromagnetic correlations induced by t' and t".

A unifying approach to unconventional orders in frustrated spin systems: In recent years, several unconventional phases have been found and discussed in low-dimensional quantum spin systems. In particular, large-scale numerical simulations found that novel states of matter might be stabilized by including multi-spin interactions, which are in principle allowed by the Fermi statistics and Coulomb interactions among electrons. Unfortunately, we do not have a qualitative but fully-quantum understanding of the underlying mechanism. On the basis of previous analysis for (quasi) 1-diemensional system (spin 'ladder'), Totsuka constructed an effective Hamiltonian describing the competition among several quantum orders. It describes a system of interacting spin-1 (hard-core) bosons. As is well-known known from the physics of superfluid He^3, breaking of gauge U(1) and spin SO(3) leads to a variety of phases. The point is that different ordering patterns of this boson system can describe various competing phases (Neel antiferromagnet, p-type nematic etc.) This approach has much in common with the well-known SO(5) theory of high-temperature superconductivity. The parameters contained in the model have been determined by a non-perturbative method called 'Contractor Renormalization Method (CORE)'. By applying a simple variational analysis to the effective Hamiltonian obtained in this way, Totsuka, Capponi and Lecheminant have succeeded in describing the competition between Neel antiferromagnetism and a more exotic p-type nematic order in the square-lattice Heisenberg antiferromagnet with ring-exchange interaction.

BLBQ model on a zigzag lattice: Recent discovery of a Ni-based (spin-1) compound on an isotropic triangular lattice has renewed an interest in spin-1 systems with the so-called bilinear-biquadratic (BLBQ) interactions and possible spin-nematic phases. As a first step toward the understanding of the phase structure of the spin-1 BLBQ model on a triangular lattice, Totsuka, Corboz, Läuchli and Tsunetsugu investigated a BLBQ model on a zigzag lattice i.e. a one-dimensional reduction of a triangular lattice. By using various numerical methods (DMRG and exact diagonalization) together with field theories, we mapped out the phase diagram and showed that a novel trimerized phase appeears.

Magnon moeclues in magnetization processes: A new two-dimensional compound (CuBr)$LaNb_2O_7$ is intriguing since (i) it has a non-magnetic ground state with a finite spin gap and (ii) its magnetization process does not seem to be described by the standard theory based on Bose-Einstein condensation of (gapped) triplet magnons. To clarify this unusual magnetization process, Totsuka and Ueda proposed a new scenario that 'magnon molecules' (quintet bound states of triplet magnons) are responsible for the magnetization process. According to their scenario, transverse magnetization vanishes even after the Bose-Einstein condensation occurs unlike in such standard spin-gap systems as $TlCuCl_3$ and the Han Purple.

Chiral spin texture scenario for the cuprate high-temperature superconductors: Although it has passed twenty years since the discovery of high-temperature superconductivity in the copper-oxides, there is no consensus on the mechanism of high-temperature superconductivity. Contrary to conventional systems, such as metals and semiconductors, there are strong correlations between electrons in high-temperature superconductors. In fact, the parent material, which is expected to be a metal from the band theory, is the Mott insulator due to the strong short-range Coulomb repulsion. Presumably due to this strong correlation effect, various interesting phenomena have been observed. In particular, the pseudogap phenomenon is peculiar to high-temperature superconductors, and its origin is still in controversial. A fundamental question about the high-temperature superconductors is the description of carriers introduced in the Mott insulator. Morinari proposed a picture in which a spin texture characterized by chirality is induced by the carriers. It was shown that the excitation spectrum of such a spin texture, that is, half-skyrmion, is in good agreement with the quasiparticle excitation spectrum observed in angle-resolved photoemission spectroscopy in the parent compounds. The analysis was extended to finite carrier density. It was shown that partially truncated Fermi surface should appear because of the coherence factors in the presence of half-skyrmion hopping.

Hawking radiation in cold atoms: Creating sonic horizon in expanding Bose-Einstein condensate: The Hawking radiation is a phenomenon associated with quantum effects in curved space-time. However, it is extremely hard to verify this quantum effect experimentally. Because the characteristic temperature of the radiation is on the order of several tens of nanokelvins at most, which is much lower than the cosmic microwave background radiation temperature. So detecting thermal radiation from a real black hole is almost impossible. For the purpose of verifying this phenomenon, one can use artificial black holes. In 1981, Unruh showed that excitations in a supersonic flow corresponds to ascalar field equation on a curved spacetime. Morinari and Kurita proposed that cold atom systems can be used to realize quantum fluid system to simulate Hawking radiation. Numerically solving the Gross-Pitaevskii equation, it is shown that sonic horizon should appear by making Bose-Einstein condensate of cold atoms expand. The expansion is triggered by just changing the interaction between atoms which is controlled by the Feshbach resonance. The characteristic temperature associated with the particle creation is a few nanokelvin which is comparable to the lowest temperature obtained in the experiments.

The dynamical spin structure factor in the small momentum region of 1D electron systems : Spin-charge separation is a key subject in one-dimensional interacting electron systems. Conformal field theory has succeeded in the description of spin-charge separation in the low-energy physics of the Tomonaga-Luttinger liquid. Beyond the conformal field theory limit, exactly solvable models provide us with opportunities to obtain analytical knowledge on thermodynamics and dynamics, and it is intriguing how the spin-charge separation appears in these properties. Among exactly solvable models, the supersymmetric t-J model with $1/r^2$ interaction reveals the spin-charge separation in the simplest manner. Arikawa and Saiga derived analytically the dynamical spin structure factor in the small momentum region for the model. Strong spin-charge separation is found in the spin dynamics. The structure factor with a given spin polarization does not depend on electron density in the small momentum region. In the thermodynamic limit, only two spinons and one antispinon (magnon) contribute to the structure factor. These results are derived via solution of the SU(2,1) Sutherland model in the strong coupling limit.

Non-equilibrium Physics

Open systems far from thermodynamic equilibrium provide a wide variety of self-organizing cooperative processes. The aim is to explain and predict their dynamics, and extract skeletons of mechanisms.

Rheology of granular materials: Saitoh and Hayakawa examined the validity of constitutive equations of sheared granular fluids predicted from inelastic Enskog equation. They compared the results of the discrete element method (DEM) with the results of the simulation of hydrodynamic equations to verify the validity of the granular constitutive equations. They also demonstrated that the analtytic calcuation in the steady state reproduces the results of DEM, Their research has suggested that the correlation effects in sheared granular fluids are not importent even in dense flows.

Effect of impurity sites in ASEP: Asymmetric simple exclusion process (ASEP) is one of the simplest model in nonequilibrium physics. Mitsudo and Hayakawa introduced some impurity sites in ASEP where each impurity site allows detachment and attachment, and examined the properties of the impurities. The result has indicated the existence of attractive interaction between the impurity and the kink. The result is consistenly recovered from the simulation.

Elastic theory of blockcopolymers: Yamada and Ohta derived the elastic free energy of gyroid and diamond structures in a weak-segregation regime of microphase separation in block copolymer melts. They found that there is a simple relation among the elastic constants in the weak-segregation limit.

New structure in blockcoplymers: It is well known that lamellar structure, hexagonal structure of cylinder domains, gyroid and body-centred cubic structure of spherical domains all exist as equilibrium structures in AB-type diblock copolymers. Yamada, Nonomura and Ohta demonstrated that, in addition to the above four phases, there is another equilibrium phase, the so-called Fddd structure which is an interconnected but uniaxial structure. They confirmed this conclusion by two different methods. One is the mode-expansion including a substantial number of modes. The other is direct simulations of the time-evolution equation in three dimensions.

Dynamical approach to microphase separation in ABCA-type blockcopolymers: Kaga and Ohta studied microphase separation of ABCA-type tetrablock copolymers mainly in the weak segregation limit by means of a coarse grained approach. To clarify the origin of the unique order known as the non-centrosymmetric (NCS) lamellar structure (with the sequence ...ABCAABCA...) recently observed in an experiment, they derived the free-energy functional and the set of kinetic equations for ABCA tetrablock copolymers. By solving this numerically in one dimension, they explored how the NCS lamellar structure is selected.

Nonlinear Dissipative Waves under External Forcing: Tokuda and Ohta studied dynamics of traveling waves under spatio-temporal external forcing in non-equilibrium open systems. By using the 1D model system where phase separation and chemical reactions take place simultaneously they studied entrainment and modulation of traveling waves under space-time dependent external forcing are. In particular, they focused their attention on the case that the spatial period of the external forcing is different from the intrinsic period of the traveling waves, and proposed a conjecture about the mode selection of the nonlinear waves.

The Emergence of New Diseases Associated with Environmental Pollution: Despite the rapidly increasing knowledge of different disciplines in science and technology, we are unable, as yet, to understand a whole picture about the emergence of new diseases. Murase proposed a new hypothesis that there are hormonal bioeffects of electromagnetic fields, just like man-made chemicals have endocrine disrupting bioeffects. It is plausible to say that there are potential hazards of modern environmental electromagnetic pollution from a point of view of precaution principles.

Nuclear Theory Group

The main focus of the Nuclear Theory Group is on the subatomic physics governed by the strong interactions, which gives rich phenomena. The subjects are the structure and the dynamics of nuclei and hadrons, and properties of hadron-quark many-body systems in finite temperatures and densities.

The research activities of the group in the academic year of 2006 are summarized below.

Nuclear Structure and Reaction

The goal of nuclear structure physics is to construct the unified microscopic comprehension of properties of nuclear many-body systems. Recently, the nuclear physics enters a new phase due to the development of RI beam technology, which makes it possible to study the unstable nuclei in detail. In the region of unstable nuclei, various exotic phenomena have been discovered. The aim is to understand these phenomena and to provide theoretical predictions in systematic investigations of stable and unstable nuclei while focusing on the clustering aspect of the nuclear system.

Molecular state is one of the exotic structure in light neutron-rich nuclei. Kanada-En'yo and Taniguchi studied the excited states of ^{13}B with the method of antisymmetrized molecular dynamics (AMD), and theoretically predicted deformed bands with molecular orbital structure.

There were remarkable activities also in the research of excited states of light stable nuclei. Kanada-En'yo studied the excited states of ^{11}C, ^{11}B and ^{12}C with the AMD method, and found developed three-cluster states. It is interesting that dilute states of weakly interacting clusters were predicted to be appear in ^{11}C and ^{11}B as well as ^{12}C.

As described above, it is known that clustering plays a significant role in light-weight nuclei. In contrast, in heavier nuclei, the clustering effects are not clear. Taniguchi and Kanada-En'yo studied the structure of ^{40}Ca using AMD focusing on the cluster aspects. They obtained a normal-deformed band and a superdeformed band, and found that those bands had α-^{36}Ar cluster and ^{12}C-^{28}Si cluster components, respectively. The results suggest that cluster correlation will be important even in medium- and heavy-weight nuclei.

From the results of theoretical investigation, it is known that the second 0^+ state in ^{12}C has a well-developed 3 α cluster structure, and has the large nuclear radius compared with the ground state. Therefore, if the large nuclear radius of this excited state is experimentally confirmed, it will be a strong evidence of the α cluster state. Takashina and his collaborator studied the α inelastic scattering on ^{12}C exciting the second 0^+ state with the microscopic coupled-channel (MCC) method, and investigated how the spatial extension of the excited state is reflected in the details of the differential cross section angular distribution. They found that the oscillation pattern in the angular distribution is hardly changed even when the density distribution of the excited state is artificially shrunk or extended, although the absolute value changes.

Hadron structure and dynamics

Lattice QCD studies of the axial charge of $N(1535)$: Chiral symmetry is an approximate global symmetry in QCD, which is a fundamental theory of the strong interactions, and the symmetry and its spontaneous breaking is one of the key ingredients in the low-energy hadron physics. For instance, all the hadrons can be classified by some representations of $SU(N_f)_L \times SU(N_f)_R$. Once the representations are fixed, they give strong constraints to effective lagrangians for low-energy hadron dynamics and possible terms are unambiguously determined up to overall constants. The linear representation with scalar mesons as chiral partners of Nambu-Goldstone bosons would be important around the chiral restoration point. As for the realization of chiral representations in the baryon sector in the linear representation, there are naively two ways; one is the naive assignment and the other is the mirror assignment introduced by DeTar and Kunihiro. In the mirror assignment, the nucleon and its parity partner belong to the same chiral multiplet and there can exist chirally-invariant mass terms of nucleons. Such possible mass terms give rise to important differences between the naive and mirror cases especially in the chiral phase transition. In order to clarify which is the natural assignment in our world, it is advantageous to investigate the axial charge of $N(1535)$, since it is sensitive to the underlying chiral structure of baryons. Takahashi and Kunihiro performed the first unquenched lattice QCD study of $g_A^{N^*N^*}$ as well as g_A^{NN}.

Transition form factors of the $N(1535)$ as a dynamically generated resonance: Jido and his collaborators have evaluated the $A_{1/2}$ and $S_{1/2}$ helicity amplitudes as a function of Q^2 for the electromagnetic $N(1535) \to \gamma^* N$ transition. The calculation has been done within a coupled channel chiral unitary approach where the $N(1535)$ resonance is dynamically generated from the interaction of mesons and baryons. They have found a fair agreement for the absolute values of the transition amplitudes, as well as for the Q^2 dependence of the amplitudes. The ratios obtained between the $S_{1/2}$ and $A_{1/2}$ for the neutron or proton states of the $N(1535)$ are in good agreement with experiment. The global results provide a strong support to the idea of this resonance as being dynamically generated, hence, largely built up from meson-baryon components.

Mesic nuclei and in-medium meson spectral functions: The in-medium spectral functions for the η and K mesons have been investigated to describe meson-nucleus bound systems (mesic nuclei). The η-nucleus systems are so interesting and unique that the $N(1535)$ nucleon resonance plays an important role and the in-medium modification on the $N(1535)$ is expected to be observed in the formation spectra of the eta mesic nuclei.

Jido and his collaborators discussed the relation of the meson bound states in nuclei and the spectral functions of the mesons in infinite nuclear matter. It has been shown that possible level crossing of the eta and $N(1535)$-h modes associated by partial restoration of chiral symmetry in nuclear medium can be seen in structures of the bound states and the experimental formation spectra of the eta mesic nuclei. It is also discussed whether the few-body systems of nucleons and a kaon form bound states.

Exotic hadrons in s-wave chiral dynamics: The observed hadronic states can be classified by their flavor quantum numbers. Empirically, there is a regularity in the quantum numbers of the observed hadrons: the states with the valence quark contents of $\bar{q}q$ or qqq were observed, while no state was established with larger number of valence quarks (4, 5, 6,... quarks). The latter states, called exotic hadrons, were intensively studied recently after the report on the Θ^+ by LEPS collaboration. In spite of the large amount of theoretical work, it is not clear why the exotic hadrons are difficult (or impossible) to observe.

Hyodo, Jido and their collaborator have studied the exotic states in the scattering of the NG boson and a target hadron. They construct the scattering amplitude which satisfies the chiral low energy theorem and unitarity condition. It is found that the interaction in the exotic channels are in most cases repulsive, and possible attractive interaction is uniquely given as $C_{\text{exotic}} = 1$. It is shown that the strength of the attractive interaction is not sufficient to generate a bound state for the physically known masses of the target hadrons. Given the success of the description of the hadron resonances in chiral dynamics for the nonexotic sectors, the present result may partly explain the difficulty to observe exotic hadrons in nature.

Scalar meson spectrum: The scalar mesons (σ and κ resonances) have attracted much interest in recent years and more and more physicists believe that they truly exist as a light and broad resonance. There are two main objections to accept such resonances. One is that being light and broad makes their contributions to the phase shift hard to be distinguishable from background contributions. The other is that the scalar mesons are often out of control in various phenomenological studies. For instance, it seems difficult to describe them in the naive constituent quark models.

Zhou and his collaborator have developed a model independent scheme based on the analyticity and unitarity of S-matrix and dispersive technique. It is concluded that a resonance may have very different behavior from widely-used Breit-Wigner representation, especially when the resonance is very broad and has interference with other resonances. Using chiral perturbation theory to estimate the left-hand cut contributions (from t-channel exchange effects), and analyzing the data of πK scattering phase shift with the new approach, their work predicted the existence of the kappa resonance in πK scatterings and they confirmed the existence of $K_0(1950)$ resonance as a byproduct.

Zhou and collaborators also investigated the nature of the lightest scalars based on ENJL model, and argued that the σ, κ, $a_0(980)$ and $f_0(980)$ may be understood as chiral partners of Nambu-Goldstone bosons in the linear realization of chiral symmetry. They have found good mass relation among σ, κ and $a_0(980)$, but there remain some difficulties in understanding the role of $f_0(980)$ in this picture.

Using lattice QCD simulation in the quenched approximation, Kunihiro and his collaborators (SCALAR collaboration) studied the κ meson, which is the scalar counter part of the kaon and assigned to a ${}^3\mathrm{P}_0$ state in the quark model. The obtained mass was much higher than the recent experimental value, i.e., 800 MeV and thus they confirmed that the κ may have unconventional structure.

Investigation of colored scalar particles: The origin of mass generation from strong interaction for light fermions is considered to be described by chiral symmetry breaking. Then, how about the mass generation in the system without chiral symmetry breaking? To investigate the mass generation in such a system, Iida, Suganuma and Takahashi studied the system of colored scalar particles (scalar quarks) in lattice QCD. The mass generation is investigated through the color singlet states which are composed by scalar quarks (scalar-quark hadrons), as well as by scalar quarks and quarks (chimera hadrons). They found large dynamical mass generation of the scalar quark, about 1.5GeV at the lattice cutoff $a^{-1} \simeq 1$GeV. Therefore, in the system of colored scalar particles, there occurs large dynamical mass generation.

QCD phase structure

Quasi-particle picture of quarks at finite temperature: Recently, properties of the quark-gluon plasma (QGP) phase near the critical temperature (T_c) acquire much interest. The experimental results by RHIC (Relativistic Heavy-Ion Collider) at Brookhaven National Laboratory (BNL) suggest that the created matter is a strongly coupled system. Motivated by the observation that there may exist hadronic excitations even in the QGP phase, Kitazawa, Kunihiro and Nemoto investigated how the properties of quarks, especially within the quasi-particle picture, are affected by the coupling with bosonic excitations at finite temperature (T), employing Yukawa models with a massive scalar (pseudoscalar) and vector (axial-vector) boson of mass m. The quark spectral function and the quasi-dispersion relations are calculated at one-loop order. They found that there appears a three-peak structure in the quark spectral function with a collective nature when T is comparable with m, irrespective of the type of boson considered. Such a multi-peak structure had been first found in a chiral model yielding scalar composite bosons with a decay width. Kitazawa, Kunihiro and Nemoto elucidated the mechanism through which the new quark collective excitations are realized in terms of the Landau damping of a quark (an antiquark) induced by scattering with the thermally excited boson, which gives rise to mixing and hence a level repulsion between a quark (antiquark) and an antiquark-hole (quark-hole) in the thermally excited antiquark (quark) distribution. Their results suggest that the quarks in the QGP phase can be described within an interesting quasi-particle picture with a multi-peak spectral function. Because the models employed are rather generic, their findings may represent a universal phenomenon for fermions coupled to a massive bosonic excitation with a vanishing or small width. In addition, they gave a clear and unified description of their results and the quark plasmino excitation obtained in the hard-thermal loop approximation by revealing a new aspect of the plasmino excitation.

How about the massive quark case? Mitsutani, Kunihiro and their collaborators studied the properties of massless and massive quarks coupled with a scalar and pseudoscalar boson at finite temperature in Yukawa models at the one-loop order. The behavior of the spectral function and the pole structure of the propagator were analyzed as functions of temperature and the quark mass. It is shown that the three-peak structure of the spectral function found in a previous work for massless quarks is formed at temperatures comparable to the boson mass even for the finite quark mass, but gradually ceases to exist as the quark mass becomes larger. They identify the three poles of the quark propagator corresponding to the collective excitations of the quark in the complex energy plane. It is shown that the three trajectories made by the poles along with a variation of temperature undergo a structural rearrangement at a critical quark mass when the quark mass increases. This suggests that the physics content of the collective quark excitations is changed in a drastic way at this point. The results are nicely accounted for with the notion of the level mixing induced by a resonant scattering of the massive boson with quarks and holes of thermally excited anti-quarks.

Relativistic hydrodynamic equation: The success of the perfect hydrodynamics for the description of the data obtained by the RHIC at BNL has prompted a growing interest in the Relativistic HydroDynamics (RHD) for a *dissipative* system. Indeed a lot of works have been done which attempt to show how small can be the transport coefficients of the strongly-interacting systems composed of hadrons or quarks and gluons. One should notice, however, that the theory of the RHD for a dissipative system may not be well established, although there are enormous amount of fundamental studies since Eckart's pioneering work. Tsumura, Kunihiro and Ohnishi derived generic covariant hydrodynamical equations for a viscous fluid as a reduction of dynamics from relativistic Boltzmann equation in a mechanical way with no heuristic arguments on the basis of the so called renormalization-group (RG) method. This was made possible by introducing the macroscopic frame vector a^{μ} which defines the macroscopic Lorenz frame in which the slow dynamics is described. The generic equation of Tsumura et al can produce the relativistic dissipative hydrodynamic equation in any frame with a choice of the a^{μ}; the resulting equation in the energy frame coincides with that of Landau and Lifshitz while that in the particle frame is similar to but different from the Eckart equation. An interesting point is that their equation in the particle frame does not satisfy the constraints on the dissipative part of the energy-momentum tensor (PT) $u_{\mu}u_{\nu}\delta T^{\mu\nu}$ postulated by Eckart but satisfies the following one; (PT') $\delta T^{\mu}_{\mu} = 0$ together with (PN) $\delta N^{\mu} = 0$ for the dissipative part of the particle current; here u_{μ} denotes the flow velocity. It should be noticed that the new constraints (PT') are nothing but a matching condition postulated by Marle and Stewart (MS) in the course of the derivation of the RHD from the Boltzmann equation with the use of the Grad's moment theory. Tsumura, Kunihiro and Ohnishi proved that the simultaneous constraints of (PT) and (PN) can not be compatible with the underlying Boltzmann equation if the hydrodynamic equation describes the slow and long-wave length limit of the solutions of the Boltzmann equation. Actually, this is a good news because the solutions of the Eckart equation around the thermal equilibrium is unstable while the Landau theory is stable.

Color superconductivity and possible Bose-Einstein condensation in dense quark matter: In extremely high density matter, one gluon exchange dominates the interaction between quarks due to the asymptotic freedom. The interaction makes diquark-Cooper pairs in color triplet channel, and such a phase is called color superconduconductivity phase. As the density becomes lower, the interaction becomes strong, and Bose-Einstein condensation (BEC) of the diquark may emerge as the ground state of the quark matter.

Abuki and his collaborator showed that a relativistic fermion system in the BCS state undergoes a smooth transition to the relativistic BEC (RBEC) when the attractive force between fermions is increased far beyond the BCS/BEC transition point. Abuki has extended the analysis to the dynamic equation for fluctuating pair fields, and has found that the two-step crossover from the BCS to RBEC can also be seen clearly in the change of dynamic properties of pair fluctuations.

Hadrons in quark-gluon plasma: The properties of hadrons in quark gluon plasma (QGP) is one of the most important knowledge to understand QCD at high temperatures. In the RHIC at BNL, experimental research for the hadrons in QGP is performed energetically. In recent data from nuclear collisions at RHIC, it is shown that the emission of p-wave baryons are suppressed in Au+Au collisions. Müller and Kanada-En'yo showed that the suppression of the $\Lambda(1520)/\Lambda$ ratio can be naturally understood in the constituent quark recombination model.

Particle Physics Group

The research area of the particle physics group is wide and diverse. Particle physics is a branch of physics studying the origin of matter and spacetime as well as their interactions. The goal is to find a single principle that governs the whole of nature; such a unifying theory is often dubbed the "Theory of Everything". *String theory* is a leading candidate of such a grandiose theory and has been studied by many of 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. Driven by new concepts such as gauge/gravity duality, field theory has made remarkable progress in recent years. At low energy scales physical interactions observed in experiments are described accurately by the Standard Model (SM) of $SU(3)\times SU(2)\times U(1)$. However, this is not a complete theory as it contains too many tunable parameters, and it suffers from the hierarchy problem. *Phenomenology* of particle physics beyond the SM is actively investigated by the members, who work in close contact with experimental groups. *Lattice QCD* is a powerful method to analyze nonperturbative aspects of QCD, which is essential for constructing phenomenological models beyond the SM, and is also important to study new phenomena that may arise in finite temperature and/or finite density QCD.

String theory

Kugo talked on an *off-shell formulation of matter-Yang-Mills system coupled to supergravity* in five dimensions in a YITP workshop. He gave an invariant action for general system of vector multiplets and hypermultiplets coupled to supergravity (SUGRA). All auxiliary fields are kept uneliminated so that the SUSY transformation rules remain unchanged even when the action is changed.

Twistor string theory gives a new correspondence between perturbative $\mathcal{N}=4$ super Yang-Mills (SYM) and topological string on supertwistor space. Cachazo, Svrcek and Witten gave a new method to compute gluon amplitudes at tree and one-loop levels of perturbative $\mathcal{N}=4$ SYM. *Kunitomo* extended this to $\mathcal{N}=1$ SQCD including quarks while keeping SUSY manifest. He gave all the one-loop maximally helicity violating (MHV) amplitudes classified into three types that are the amplitudes with zero, one and two quark anti-quark pair(s) with an arbitrary number of gluons as the external lines.

Kunitomo also studied, with Mizoguchi (KEK), lower-dimensional superstrings in the *double-spinor formalism* introduced by Aisaka and Kazama. These superstrings can be consistently quantized and shown to be equivalent to the lower-dimensional pure-spinor superstrings proposed by Grassi and Wyllard. The unexpected physical spectrum of the pure-spinor superstrings may be regarded as a manifestation of noncriticality. They also discussed how to couple these superstrings to the compactified degrees of freedom described by $\mathcal{N}=2$ SCFT.

Recently Seiberg, Intriligator and Shih found SUSY-breaking meta-stable vacua in SQCD, which provide simple models of the phenomenological SUSY breaking sector. Solitons are very important in the light of cosmology and of experimental search of cosmic string. *Terashima*, with Eto and Hashimoto (Tokyo), examined the possible existence of such a *soliton in the meta-stable vacua*. They showed there is no nontrivial soliton. When $U(1)_B$ symmetry is gauged or the gauge group is $SO(N)$ instead of $SU(N)$, they found non-BPS vortex strings whose existence and properties are predicted from D-brane configurations in string theory.

Supertube is a SUSY bound state of D-branes and strings, and has played an important role in black hole physics in string theory. *Terashima* showed the equivalence between the supertubes in the D2-brane picture and the D0-brane picture in the boundary state formalism which is valid for all order in α'. This is an application of the method using the infinitely many D0-branes and $\overline{\text{D0}}$-branes, and has been used to show other equivalences between two different D-brane systems, including the D-brane realization of the ADHM construction of instanton.

Kawai investigated boundary dynamics of orbifolds involving T-duality twists, that appeared in contexts of *non-geometric string compactifications* called monodro-folds or T-folds in recent literature. He used techniques of boundary CFT for analysing such models from microscopic worldsheet perspective, and formulated bulk and fractional brane boundary states on these string backgrounds. These branes have various distinctive features that are absent in standard D-branes. He explicitly constructed boundary states in some simple cases and discussed the properties.

Albertsson studied canonical transformations of conformal worldsheet boundary conditions under *Poisson-Lie T-duality*, a generalisation of traditional T-duality. She showed that they can be written as a direct extension of the traditional T-duality map, and that under certain assumptions conformal D-branes are always Poisson-Lie T-dual to conformal D-branes. She also analysed, with Hlavatý and Šnobl (Prague), boundary conditions in the context of Poisson-Lie T-plurality, a generalisation of Poisson-Lie T-duality admitting more freedom in the choice of dual target spaces.

Kimura investigated *Atiyah-Singer index theorems* on geometry with torsion H under the condition $\mathrm{d}H=0$. Such a situation appears in string theory compactification with non-trivial background fields. Using an identification between the Clifford algebra and the canonical quantization condition in quantum mechanics, he explicitly reformulated Dirac index on manifolds with torsion, which would provide a fundamental information to effective theories derived from string theory.

Tokunaga, with Fuji (Sapporo), exactly derived the *dimer partition functions* from topological string on toric Calabi-Yau manifolds. They computed all-order amplitudes with a D-brane using the topological vertex method. They regularized the amplitudes for N, and did analytic continuation for the coupling, and took large N limit which gave the dimer partition functions. For any tree toric geometries, Tokunaga checked that this way works; "tree" means that there are no loops in the toric diagrams; "geometric engineering" means that the dimers can be determined by the mirror curves. Also, "Chern-Simons gravity" is related to the analytic continuation (and black hole OSV conjectures).

Field Theory

R. Sasaki obtained a wide class of *exact classical solutions of nonlinear sigma model on super-Grassmannian manifolds*. In the context of AdS/CFT, understanding superstring propagating on certain AdS backgrounds is quite important. In the Green-Schwarz formalism, the problem is reduced to nonlinear sigma model on certain supermanifolds, some of which have remarkable properties, e.g. the conformal symmetries remain unbroken by quantum corrections.

R. Sasaki and Odake (Matsumoto) obtained *exact Heisenberg operator solutions* for many one-dimensional quantum mechanical systems. The exact Heisenberg operator solution is known only for the free theory, which is a collection of an infinite number of harmonic oscillators.

Based on the well-known relation between Fokker-Planck (FP) equations and Schrödinger equations of quantum mechanics, *R. Sasaki* and Ho (Taipei) proposed *new types of deformed FP equations*, which are associated with the Schrödinger equations of the "discrete" quantum mechanics. The FP equation is one of the most important tools to deal with fluctuation phenomena in various kinds of systems.

Topological excitations that saturate the BPS bound play an important role in various contexts in physics. In certain supersymmetric theories topological charges acquire a new type of quantum anomalies, that govern the spectra of BPS-saturated excitations. *Shizuya* developed, by exploiting dilatation and supersymmetry, a unified way to study the *quantum effects on BPS excitations*.

There has recently been active interest, both experimentally and theoretically, in a "relativistic" condensed-matter system, called graphene, which is a monolayer of carbon atoms. Graphene is a gapless semiconductor, in which low-energy electronic transport is governed by massless Dirac fermions. *Shizuya* studied the *electromagnetic response of graphene in a magnetic field*, with emphasis on the quantum features of graphene. He pointed out that (1) The graphene vacuum is a dielectric medium. (2) The Coulomb interaction is efficiently screened on the scale of the magnetic length, leading to a prominent reduction of the exciton spectra.

Miransky studied the *phase transition and the quantum Hall effect in graphene*. The physics underlying the recently observed removal of sublattice and spin degeneracies in graphene in a strong magnetic field is suggested to describe a phase transition connected with the generation of excitonic and spin gaps. The strong-coupling regime is described by using a phenomenological model with enhanced Zeeman splitting (spin gap) and excitonic gaps. The experimental form of the Hall conductivity σ_{xy} with the additional $\nu = 0, \pm 1$ plateaus is reproduced.

Sasai and Sasakura studied *a scalar field theory on a nonassociative spacetime*. They showed UV/IR free property and verified the one-loop unitarity (the Cutkosky rule). This is in sharp contrast with the noncommutative field theory with these pathological behaviors. They also achieved the construction of quantum field theory with quantum group symmetries. This can be done in the braided quantum field theory.

Sasakura studied *tensor models as a model of quantum gravity*. In contrast to the (old) matrix model, which provides a powerful analytical method to two-dimensional quantum gravity, the tensor model lacks the analytical means of calculation. The tensor model was shown numerically to have several kinds of commutative nonassociative spaces as its classical solutions. These spaces are flat tori and spheres of some dimensions. Then he showed that the tensor model is regarded as a theory of dynamical spaces with dynamical dimensions and cosmological constants, and can provide an interesting candidate of quantum gravity. He also numerically studied small fluctuations around the classical solutions of the tensor models, where he found that the low-frequency fluctuation spectra around the Gaussian-type classical solutions in it have the same structures as the metric fluctuations of the general relativity, and that the tensor models contain the general relativity as effective field theory around the classical solutions.

S. Sasaki studied the *deformed SYM theories in the presence of R-R backgrounds*. A deformation of SUSY gauge theories with some SUGRA backgrounds can be sometimes interpreted as the geometric deformation of spacetime. It is known that the deformed $\mathcal{N} = 1$ four-dimensional SYM on D3-brane with self-dual R-R 5-form flux can be interpreted as the one constructed by star product formulation on the $\mathcal{N} = 1$ non(anti)commutative superspace. He and collaborators calculated open string disk amplitudes with insertion of a R-R vertex operator, then showed that the self-dual R-R 5-form flux actually induces $\mathcal{N} = 2$ non-singletly deformed non(anti)commutative harmonic superspace and $\mathcal{N} = 4$ non(anti)commutative superspace on D-brane worldvolume. This indicates that such a 5-form flux induces non(anti)commutativity of superspace coordinate not only for $\mathcal{N} = 1$ superspace but also for $\mathcal{N} = 2, 4$ superspaces.

Phenomenology

Searching new physics by flavor violating processes is quite effective because there is no flavor changing neutral current and the lepton flavor violation in the SM, if neutrinos were massless. *Goto* and his collaborators identified processes with sizable deviations from the SM and studied correlations among the deviations by which they can distinguish underlying models, such as SUSY models.

Neutrino experiments determine the magnitude of the mass-squared differences, the sign of the smaller one, the functional value of two of the three mixing angles, exact value of one of them, and the upper bound of the third mixing angle. *Okamura*, Hagiwara and Senda (KEK) gave a detailed explanation *why the mass hierarchy and CP phase can be measured by T2KK* (Tokaimura to Kamioka & Korea), and showed that the octant degeneracy can be solved by T2KK. He also derived a simple parametrization of matter effects on neutrino oscillation, and showed that the neutral current universality violation can be measured with very long base-line experiment.

The $\tilde{q}_L\tilde{q}_L$ production is one of the main SUSY production processes in the minimal SUSY SM (MSSM), which occurs due to the *chirality flip caused by the Majorana gluino mass*. This process is a source of same sign two lepton events, and gluino production also contributes to this channel. *Takeuchi* and his collaborator developed a method to identify gluino and squark production separately in this channel, based on cuts on the kinematical configuration of jets. They applied this to the MSSM, a model with an extended gluino sector, and the littlest Higgs model with T-parity. Then they found a distinctive difference among these models when considering the numbers of such events selected by the cuts.

Supersymmetry can control the form of a scalar potential, which is roughly suitable to obtain a *flat inflaton potential for slow-roll inflation*. However, in SUGRA, the scalar potential is not entirely independent of the kinetic function of the scalar field, which makes parameter tuning for a flat inflaton potential rather nontrivial in certain cases. *Izawa* investigated how to tune the coupling parameters of chiral multiplets to realize chaotic and new inflations in SUGRA and its relation to eternal inflation. In the chaotic case, the observationally favored quadratic potential turns out to result from the parameter tuning to achieve eternal R-invariant chaotic inflation.

SUGRA/String in higher dimensions and their compactified versions are good candidates for physics around the Planck scale beyond the SM. Moreover, a low energy SUSY theory is a leading candidate for a TeV scale physics. *Abe* and his collaborators studied *phenomenological aspects of the four-dimensional (4D) effective SUGRA*. They derived a condition for integrating out heavy moduli, proposed a way of achieving an almost vanishing vacuum energy utilizing a dynamical SUSY breaking, and found a region of soft SUSY breaking terms preferred by the successful electroweak breaking. They also proposed a systematic way of deriving a 4D effective theory of the five-dimensional SUGRA, and found a new SUSY breaking structure.

It is expected that at sufficiently high baryon density, cold quark matter should be in a color superconducting state. On the other hand, it was suggested long ago that quark matter might exist inside the central region of compact stars. This is one of the main reasons why the *dynamics of the color superconductivity* has been intensively studied. *Miransky* and his collaborators studied the dynamics in phases with vector condensates of gluons (gluonic phases) in dense two-flavor quark matter. These phases yield an example of dynamics in which the Higgs mechanism is provided by condensates of gauge (or gauge plus scalar) fields. Using the Ginzburg-Landau approach, they established the existence of a gluonic phase with both the rotational symmetry and the electromagnetic $U(1)$ being spontaneously broken. They also studied a $SU(2)$ gauge theory with a classical complex modulus and showed that the modulus condensation in turn generates homogeneous but anisotropic non-Abelian field strength condensates.

Lattice QCD: An interesting problem of lattice simulation is QCD near the chiral limit. In contrast to conventional actions, the "Neuberger's Overlap Fermion" is promising due to the exact chiral symmetry on the lattice, but it suffers the numerical cost problem. To improve and develop this, *Onogi* and his collaborators studied a new approach to introducing a *negative heavy Wilson fermion as a UV regulator*. They carried out the first large scale two flavor QCD simulation with dynamical overlap fermion as a collaboration of JLQCD. The goal is to confirm the validity of their approach by studying whether one can reproduce the essential features of the chiral dynamics from first principle calculation. They successfully reproduced the low eigenmodes distribution of the Dirac operator predicted from Chiral Random Matrix Model (ChRMM) by carrying out QCD simulations for 3 MeV quark mass with the lattice size of 1.6 fm. By fitting the lattice data, the chiral condensate in two flavor QCD is determined as $\Sigma^{\overline{MS}}(2\text{GeV}) = (251 \pm 7 \pm 11\text{MeV})^3$, where the first and second errors are statistical and systematic. And they solved numerical cost problem.

It is known that the *lattice Heavy Quark Effective Theory* (HQET) is one of the best method to describe the b-quark on the lattice with controlled systematic errors. *Negishi*, *Onogi* and their collaborator computed the $B^*B\pi\hat{g}_\infty$ for static heavy-light meson. To reduce well-known statistical errors they exploited all-to-all propagators. They showed that extracting 100 eigenmodes for low-mode averaging, the signal for the 2-point and 3-point functions for heavy-light meson indeed improves significantly. This suggests that the all-to-all propagators will be an efficient method for high precision computation of the $B^*B\pi$ coupling especially in unquenched QCD where the number of configurations is limited. This will be a crucial input for determining the $B \to \pi l \nu$ form factors which is necessary to extract the CKM matrix element $|V_{ub}|$.

2.2 Research Highlights

Phenomenological aspects of flux compactifications

Hiroyuki Abe (YITP)

Superstring/M-theory is a candidate for a unified description of elementally particles and their interactions including gravity. In such theory, the soft supersymmetry (SUSY) breaking parameters in the four-dimensional (4D) effective theory as well as the 4D Planck scale M_{Pl}, gauge couplings and Yukawa couplings are determined by vacuum expectation values (VEV) of modulus superfields which determine the size and the shape of the Calabi-Yau (CY) space. Therefore, the moduli stabilization and its effect on SUSY breaking is quite relevant to the particle phenomenology and cosmology. It was shown by Kachru *et al.* [1] that an almost vanishing vacuum energy required by the observations can be realized in string theory with all the typical closed string moduli stabilized, which is called KKLT scenario. The soft SUSY breaking parameters in such scenario were derived [2] which lead to an interesting pattern of low energy super-particle spectrum [3].

Here we generalize the KKLT scenario by introducing moduli mixings in the gauge couplings [4] which result from, e.g., an open string flux (a magnetic flux of D-brane), and a dynamical SUSY breaking sector [5] instead of the anti $D3$-brane ($\overline{D3}$) assumed in the KKLT scenario. The 4D effective supergravity is given by the Kähler potential and superpotential

$$\begin{aligned} K &= -n_T \ln(T+\bar{T}) - n_S \ln(S+\bar{S}), \\ W &= Ae^{-af_a} - Be^{-bf_b}, \end{aligned} \qquad (1)$$

where $f_{a,b} = m_{a,b}S + w_{a,b}T$. Here S and T are the dilaton and Kähler (size) modulus respectively, and $m_{a,b}$, $w_{a,b}$ are respectively the magnetic flux and winding number of the D-brane, where the gaugino condensation occurs. The existence of 3-form flux stabilize the complex structure (shape) moduli $\langle U \rangle \sim 1$ around $M_{Pl} \equiv 1$ and generates a significantly warped region in the CY space.

If the same 3-form flux induces a SUSY mass like $W \sim SU$, the dilaton is also stabilized $\langle S \rangle \sim 1$ at the same scale [6]. In this case we replace S in Eq. (1) by its VEV, $\langle S \rangle$. Then the effective superpotential becomes

$$W = A'e^{-aw_aT} - B'e^{-bw_bT},$$

which is in the same form as the racetrack model with single modulus, but the coefficients are exponentially suppressed $A' = Ae^{-am_a\langle S \rangle}$, $B' = Be^{-bm_b\langle S \rangle}$ where $a = 8\pi^2/N_a$ and $b = 8\pi^2/N_b$ for $SU(N_{a,b})$ gaugino condensation. The minimum of the scalar potential induced by (1) corresponds to a SUSY AdS_4 local minimum with negative vacuum energy, and $a\langle \mathrm{Re}\,T \rangle = aT_{SUSY} \sim \ln(M_{Pl}/m_{3/2})$, where $m_{3/2} \approx 10^{-14} M_{Pl}$ is the gravitino mass. To be phenomenologically viable, we uplift the vacuum energy by introducing $\overline{D3}$ at the top of the warped region in the CY space [1]. Then the SUSY is broken due to the slight shift $\delta T = (T_{SUSY} - \langle T \rangle) \ll T_{SUSY}$ caused by an additional potential energy of $\overline{D3}$.

In this case, the ratio between the VEV of auxiliary component $F^C/C \sim m_{3/2}$ in the chiral compensator C, and of F^T in T is given by ($w_a = 0$ for simplicity)

$$\alpha \;=\; \frac{F^C/C}{\ln(M_{Pl}/m_{3/2})}\,\frac{T+\bar{T}}{F^T} \;\simeq\; \frac{1}{1+m_b\langle S \rangle/w_b T_{SUSY}}.$$

This corresponds to the ratio between the so-called anomaly mediation and the modulus mediation for the visible sector SUSY breaking. We find that α varies in a wide range of $\mathcal{O}(1)$ with various magnetic flux $m_{a,b}$ [4], compared to $\alpha \approx 1$ without the magnetic flux [2]. In the visible sector on a D7 brane, gaugino masses are unified at the mirage scale $M_{\mathrm{mir}} = (m_{3/2}/M_{Pl})^{\alpha/2} M_{Pl}$, although there is no physical threshold at this scale [3]. Note that a successful electroweak breaking prefers $\alpha \approx 2$ [7]. A similar SUSY breaking structure is obtained even if we replace the above $\overline{D3}$ by a dynamical SUSY breaking sector [5]. This indicates that the modulus-anomaly mixing in the soft SUSY breaking terms is a generic feature of uplifting the AdS_4 SUSY vacuum.

On the other hand, if the 3-form flux does not contain the SUSY mass term $W \sim SU$, the dilaton remains as a light modulus as well as T in Eq. (1). A careful analysis of (1) shows that a SUSY AdS_4 stationary point of the scalar potential corresponds to a saddle point, and we have a SUSY breaking AdS_4 local minimum close to the SUSY point in this case [8]. By uplifting this local minimum, we can obtain Minkowski minimum but with modulus-dominated SUSY breaking $\alpha \ll 1$. This is because SUSY is broken before uplifting.

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On the Poisson-Lie T-plurality of boundary conditions

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The importance of T-duality in string theory cannot be overstated. It establishes an equivalence between a priori different theories, providing, e.g., weak-coupling descriptions of strongly coupled physics, thus allowing access to nonperturbative information. Ultimately it leads to insights about the underlying theory unifying the different types of string theories.

In this context *D-branes* are a particularly useful tool, as nonperturbative objects with relatively simple behaviour under T-duality. They are by definition dynamical objects to which the endpoints of open strings are confined, hence their properties are determined by the boundary conditions of the worldsheet theory of the string. T-duality may be realised as a transformation acting on the fields in this theory, and in particular its effect on the boundary conditions determines how D-branes transform.

The prerequisite for such a realisation, however, is that the target space on which the string propagates have an isometry group (i.e., a group action on the target under which the target space metric is invariant) which leaves the worldsheet action – a two-dimensional nonlinear sigma model – invariant. The dual theory is then found by gauging the isometry (promoting the global symmetry to a local one) to obtain a first-order "parent action" and integrating out gauge fields.

The requirement that the background be isometric is a severe restriction, making it difficult to prove T-duality for models where no isometry exists. Moreover, for non-Abelian isometry groups, this procedure is not symmetric in the sense that repeated application does not necessarily recover the original theory. Klimčík and Ševera [1] proposed a generalisation of T-duality to what is called Poisson-Lie T-duality. It allows duality on target spaces without isometries, and traditional Abelian and non-Abelian T-duality arise as special cases in this framework. Instead of the isometry condition, the background satisfies the slightly more relaxed *Poisson-Lie condition*. This condition is necessary for the existence of well-defined worldsheets in the two dual target spaces, when they are both Poisson-Lie group manifolds (i.e., Lie groups with Poisson structures compatible with the group action) whose Lie algebras $\mathscr{G}$ and $\widetilde{\mathscr{G}}$ constitute a *Drinfel'd double* $\mathscr{D}$. That is, they are maximally isotropic Lie subalgebras in a Lie bialgebra $\mathscr{D}$, satisfying $\widetilde{\mathscr{G}} = \mathscr{G}^*$. The Poisson-Lie condition translates into a flat-curvature condition which allows the worldsheet to be horizontally lifted into the group whose Lie algebra is $\mathscr{D}$, and hence to project down to a well-defined dual worldsheet on the dual manifold. In this manner one obtains the dual theory without using isometries.

A further generalisation of T-duality was introduced by von Unge [2] and dubbed Poisson-Lie T-*plurality*. The mutually dual target spaces in this case do not necessarily belong to the same Lie algebra decomposition of $\mathscr{D}$, thus the set of allowed dual target spaces is enlarged.

The gauging procedure in traditional T-duality produces canonical transformations acting on the worldsheet fields. Such transformations exist also for Poisson-Lie T-duality [3] as well as T-plurality [4], and may be used to derive the boundary conditions dual to the conformal sigma model [5, 6]. In particular, we derived the duality map for the gluing matrix which defines the relation between left- and right-moving fields on the worldsheet boundary. This matrix locally defines the properties of the D-brane; its eigenvalues determine the dimensionality of the brane, and its form the embedding of the brane in target space.

We analysed the duality map for consistency, as far as possible in general terms, and then by studying a number of explicit examples, including traditional Abelian and non-Abelian T-duality, with both two- and three-dimensional target spaces. We found that the dual model is always conformally invariant if the original model is, but that in some cases other crucial boundary conditions are not satisfied. Thus the duality transformation does not in general map arbitrary D-branes in the original model to well-defined D-branes on the dual manifold. To satisfy all boundary conditions on both sides of the duality, the choice of gluing matrix, i.e., the choice of embedding of the D-brane, is restricted, which limits the number of dualisable models.

There are thus a number of unclear points that remain to be understood, including the nature and precise form of the required restrictions on D-brane embeddings. Nevertheless we have made a notable step towards a consistent formulation of non-Abelian as well as non-isometric T-duality for open strings.

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Collisions of black holes and domain walls

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Domain walls occur in any gauge theory in which a discrete symmetry, not part of the gauge symmetry, is spontaneously broken. Despite of the fact that it is difficult to imagine that domain walls, regardless of what the fundamental theory may be, have not been created in the early universe, their presence has, in most cosmological models, disastrous consequences. This is, essentially, due to the fact that domain walls carry too much energy and destroy the prediction of standard Big bang nucleosynthesys [1]. The question is how to avoid their domination over the energy density of the universe.

This problem has been explored extensively, and a range of possible solutions have been considered. Inflation is a popular way out, since it can dilute, over an expanding volume, the energy density of the walls. However, this mechanism may not work if the walls are created at energies below the inflationary scale typically of order 10^{16} GeV. Other remedies have been suggested, but none of them has a 'universal' character that cures the problem in a general and model independent way. A recent solution has been proposed in Ref. [2]. The idea is that domain walls, colliding with primordial black holes, may be perforated. The holes can, then, expand and destroy the wall. Although, at first glance, the mechanism may seem attractive, when considering specific realizations, one can easily argue that it may only work in cosmologically safe situations. In order to study this problem, we considered models, as a working example, the invisible axion model described by the lagrangian

$$
\begin{aligned}
L &= -\partial_\mu \Phi^\dagger \partial^\mu \Phi - \frac{\lambda}{4}\left(\Phi\Phi^\dagger - \eta^2\right)^2 \\
&+ 2\mu^2\Phi^2(\cos N\theta - 1)\,,
\end{aligned}
$$

where hybrid domain wall-string systems occur, and the process of perforation is, in principle, possible. The perforation of the wall is a topologically allowed process only in the $N = 1$ case. In the $N > 1$ case (N essentially tells us how many 'domain wall branches' are attached to the string), the production of a hole is topologically impossible. In the case of $N = 1$, there is a string of vacua, and the interpolating field configuration goes around the bottom of the potential. In this case, the metastability of the walls makes them harmless for cosmology, since the walls rapidly break up as result of multiple self-intersections and decay into elementary particles and gravitational waves. The previous considerations make the mechanism proposed in [2] less appealing. It is, however, reasonable to ask whether the collisions with primordial black holes may enhance the destruction of the wall.

To understand what is going on, we can simulate the collision of a domain wall with a black hole in the above axion model. The details can be found in [3]. First of all, one can notice that for fixed μ, there are two critical values of λ: λ_1 and λ_2. λ_1 gives the lower bound on the existence of a domain wall solution, λ_2 indicates that for larger values, the domain wall is topologically stable, in the sense that the black hole cannot perforate the domain wall. The explanation for this second critical value comes from the fact that the string forms with a certain length. When the string length, δ_s, equals the proper distance between the horizon and the string core, Δ, the black hole 'accretes' the hole leaving a stable domain wall; on the other hand, in the limit $\delta_s < \Delta$ a static configuration of a domain wall with a floating string exists, and this marks the critical value λ_2. In the intermediate region, the domain wall can instead be perforated and we observe the existence of a critical collisional velocity, v_{crit}, above which the brane the domain wall is also stable against collision with a black hole. This fact is illustrated in the phase diagram in which we plot the critical velocity vs the ratio λ/μ^2 (see Fig. 2.1). Now we can estimate the potential relevance for the cosmological domain wall problem. First of all, one can notice that the collision with a black hole can be an efficient way of getting rid of the walls in the region of parameters where μ is of order $10^{-1}\eta$, *i.e.* one order of magnitude, or less, smaller than η. In other words the mechanism turns out to be efficient only if the domain walls form immediately after the strings. This has been observed in the simulations. In the 'invisible' axion model η is of order of $10^9 - 10^{12}$ GeV, while the mass scale of the domain wall is of order 1 GeV. These values suggest that the mechanism has no chance to work. In fact, one can argue that collisions with black holes do not help to erase the walls more generically, because the walls are already 'holey' when they form.

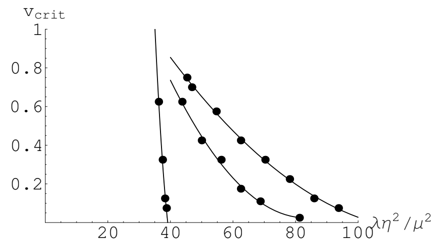

Figure 2.1: This figure illustrate the dependence of the critical velocity, above which a hole does not form, on the ratio $\lambda\eta^2/\mu^2$.

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Deformed Super Yang-Mills Theories in R-R backgrounds

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Deformations of supersymmetric gauge theories in the presence of specific supergravity backgrounds are interesting subject and have been intensively investigated in recent years.

Especially, we are interested in Ramond-Ramond (R-R) backgrounds in type II superstring theory. The deformation of field theory caused by a R-R background sometimes gives a geometric interpretation. A similar analysis is the deformed super Yang-Mills (SYM) theory in the presence of constant NS-NS Kalb-Ramond field. The effective gauge theory on D-brane world-volume in the presence of constant NS-NS Kalb-Ramond field can be interpreted as the one defined on the noncommutative space-time geometry.

In some cases, the R-R backgrounds would give supersymmetric gauge theories a useful property to investigate a non-perturbative nature. For example, the C-deformation [1], which is caused by the R-R background with an appropriate α' scaling, provides the non-pertabative analysis of $\mathscr{N}=1$ SYM theory.

On the other hand, the deformation of gauge theories defined on D-brane world-volume in the presence of some specific R-R background can be interpreted as the deformation of the superspace geometries. For example, the self-dual graviphoton background which originates from the self-dual R-R 5-form field strength background in type IIB superstring theory induces the non(anti)commutative deformation of four-dimensional $\mathscr{N}=1$ superspace [2, 3]. This deformation is characterized by the non(anti)commutative relation between the fermionic coordinate of $\mathscr{N}=1$ superspace, $\{\theta^{\alpha},\theta^{\beta}\}=C^{\alpha\beta}\neq 0$ where the deformation parameter $C^{\alpha\beta}$ is a VEV of the background R-R field. The field theory action in this setup can be constructed by the star product formulation.

It is natural to consider the generalization of this idea to the extended superspaces, *i.e.* $\mathscr{N}=2$ harmonic superspace and, possibly, $\mathscr{N}=4$ superspace. Due to the presence of the internal indices, there are several kinds of deformations for the extended superspaces. For instance, the $\mathscr{N}=2$ harmonic superspace involves two specific non(anti)commutativities, which are called singlet and non-singlet deformations. The field theory analysis in these deformed $\mathscr{N}=2$ harmonic superspaces has been intensively studied. For example, see the review [4]. Note that the explicit form of the deformed action is obtained by star product formulation only for the abelian case in $\mathscr{N}=2$ singlet and non-singlet deformed harmonic superspaces [4].

It is interesting to study the string theory origin of these deformed harmonic superspaces. In [5], we investigated $\mathscr{N}=2$ $U(N)$ SYM theory on N D3-branes in the presence of self-dual R-R 5-form background in type IIB superstring theory compactified on $\mathbb{C}\times\mathbb{C}^2/\mathbb{Z}_2$. We calculated open string disk amplitudes with the insertion of a R-R vertex operator and derived the effective SYM theory defined on the D3-brane world-volume. Due to the specific α' scaling of the background, the SYM theory receives non-trivial correction terms and the theory is deformed. Taking abelian limit, the resulting action completely agrees with $\mathscr{N}=2$ gauge theory defined on $\mathscr{N}=2$ non-singletly deformed harmonic superspace $\{\theta^{\alpha i},\theta^{\beta j}\}=C^{(\alpha\beta)(ij)}$ $(i,j=1,2)$. In addition, the deformed non-abelian action is consistent with $\mathscr{N}=1$ non(anti)commutative superspace formulation of $\mathscr{N}=2$ SYM theory.

Although there are no manifestly supersymmetric formulations of $\mathscr{N}=4$ SYM theory, it is amusing to consider the non(anti)commutative deformation of $\mathscr{N}=4$ superspace which would be characterized by $\{\theta^{\alpha A},\theta^{\beta B}\}=C^{\alpha\beta AB}$ $(A,B=1,\cdots 4)$. We study the $\mathscr{N}=4$ deformed SYM in the presence of R-R 5-form background [6]. As in $\mathscr{N}=2$ case, we calculated open string disk amplitudes with insertion of a R-R vertex operator and derived the deformed effective action defined on D3-brane world volume in flat space-time. The result is consistent with $\mathscr{N}=1$ non(anti)commutative formulation of $\mathscr{N}=4$ super Yang-Mills theory and suggest that this theory is defined on $\mathscr{N}=4$ non(anti)commutative superspace.

Deformation by another rank of R-R background is also interesting issue. For example, the index structure of $\mathscr{N}=2$ singlet deformation and charge cancellation condition among open and the R-R closed string vertex operators suggest that the R-R 1-form field strength would provide this deformation.

These R-R backgrounds deformations of supersymmetric gauge theories and its geometric interpretation would provide the deep understanding of the gauge theory in the presence of supergravity backgrounds.

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Generalized uncertainty principles and foundations of Quantum mechanics

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Generalized uncertainty principles: In Ref. [1], I studied how the generalized uncertainty principles would appear in a Universe with (large) extra dimension(s), when only gravity propagates in the extra dimensions. Explicit expressions for such GUPs in 4+n dimensions have been obtained and their holographic properties investigated. Unexpected new results have emerged. Some versions of GUP do not appear to satisfy the holographic counting of degrees of freedom. Remarkably, a particular version of GUP (see [2]) obeys the holographic principle, at least in 4 dimensions. However, when extra spatial dimensions are admitted, the holographic counting is lost [1]. Somehow, holography seems to dictate the (correct?) number of space-time dimensions. The generalization of the GUP [2] to a Universe with extra dimensions depends of course on which braneworld model is adopted, and in a critical way, on the behaviour of the black hole solutions in the braneworld. We have explored also the reverse point of view, namely what kinds of metrics are able to produce GUPs satisfying the holographic counting in 4+n dimensions. Here, strong indications point towards a violation of the principle of equivalence at short distances, if one wants to hold holography and extra dimensions at the same time (a paper on this has been just accepted [3]). A different kind of generalization that is going to be investigated is the extension of the GUP in Ref.[4] to AdS-Schwarzschild metrics. Preliminary calculations show an interesting influence of the cosmological constant (non local effect) on the GUP analytical structure (local effect). At present, we are working to find a unique form of generalized uncertainty principle in 4+n dimensions. In fact, such form seems to contain some ambiguities, but indeed its unique determination is crucial to correctly compute, for example, reliable values for the lifetime of micro-black holes that are expected to be created at LHC sometime next year (see Ref.[5]). A sort of clash seems to rise between the stringy inspired GUP (which displays an error linear in the energy term) and the possibility to reveal micro black holes (at LHC) which have a gravitational radius sub-linear in the energy.

Foundations of Quantum Mechanics: In the framework proposed by 't Hooft [6], according to which quantum behaviour can be reproduced by adding dissipation to an underlying classical system, with some colleagues (M.Blasone, P.Jizba, G.Vitiello), I am studying how to explicitly insert the interaction in the 't Hooft models. A first attempt was to consider a classical scalar field on a Schwarzschild background, in which the quantization is "induced" by the dissipation of information into the black hole. Recently, starting from the paper [7], we studied a couple of classical Bateman oscillators which, after a dissipation constraint *a la* 't Hooft has been enforced, can generate genuine different interacting quantum systems. An ambitious goal of this project is to reproduce typical quantum features like "entanglement" between systems and "linear superposition", starting from underlying classical systems. At the moment we have obtained a quantum oscillator with a spin-orbit interaction. The mapping of this system into the Coulomb problem is also an aim of this project. The possibility of reproducing a genuine quantum system by using an underlying classical dissipative system evidently opens a whole array of interesting applications. A typical property of the 't Hooft approach is that, for a given classical system, there may exist many different "quantum shadows", depending on the choice of the dissipation constraint. On changing the constraint, also the resulting quantum system changes. It is also correct to say that this kind of research in foundations of quantum theory naturally interfaces with (and has plentiful consequences in) research about quantum information theory.

Planetary Systems: Starting again from the ideas in [6], I developed a quantum-like description of the planetary systems [8]. The description seems to work very well for the known planetary systems close to us (Solar system, Jupiter, Saturn and Uranus satellites systems). Moreover, it contains a very good prediction of the basic features of the rings of Saturn, Jupiter, Uranus. Some parts of the wave function language seem indeed to be able to describe also features of classical systems. In future studies I aim to develop the model, refining its predictive ability, especially as regard to the flatness of planetary systems, which seems to be encoded in some analytical properties of the wave function, and to look for confirmation also in extra solar planetary systems. In fact, only from a few years astronomers have found evidences of multiple planetary systems around a single star.

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Lattice Formulation of Topological Field Theory

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Supersymmetry is one of the main subjects in the particle physics. The supersymmetric gauge theories exhibits a variety of complex non-perturbative phenomena which have been vigorously investigated. We can learn much more from the numerical study using the lattice formulation, which is more universal method, since the method would enable us to calculate any observables.

In spite of the need for supersymmetric lattice model, the construction of the lattice formulation applicable to the numerical study has been difficult for a long year. Since the supersymmetry including the infinitesimal translation in its algebra is broken on the lattice which breaks the translational invariance, the ordinary lattice formulations suffer from the fine-tuning problem. Fine-tuning problem is the difficulty to recover the target continuum theory when the quantum effects are taken into account, and it makes the computation time too huge to perform the practical numerical calculation.

To solve the fine-tuning problem, several lattice gauge theories which preserve partial supersymmetry on the lattice are proposed [1, 2, 3, 4] recently. They utilize the topological twisting which is picking up a set of supersymmetry generators which does not include the infinitesimal translation in its algebra. In this way, partial supersymmetry can be preserved on the lattice.

It is very important to investigate whether the models really solve the fine-tuning problem or not. To do it, we should investigate whether they recover the target continuum theories or not. In the perturbative level, such investigations have done well. (For example [5]) But, on the other hand, there is not a sufficient study which takes the non-perturbative effects into consideration. Then we will non-perturbatively examine whether the models really solve the fine-tuning problem or not.

Note that the models can be regarded as the lattice regularization of the topological field theory (TFT). This is because preserved supercharges on the lattice are equivalent to the BRST charge in the TFT obtained by the topological twisting. The target continuum theories of these lattice models are extended supersymmetric gauge theories including the TFT as a special subsector. Therefore the topological field theory in the continuum theory must be recovered in the continuum limits if the lattice models really recover the target continuum theories.

The quantities in the TFT can be regarded as non-perturbative quantities since they can be exactly obtained by the semi-classical approximation Therefore, examining whether the TFT properties are recovered at the continuum limit or not would be a non-perturbative criteria whether the supersymmetric lattice model preserving the partial SUSY on the lattice really recover the target continuum limit or not. In the paper [6], using the non-perturbative criteria we tried to perform the non-perturbative investigation whether a supersymmetric lattice model really recover the target continuum limit or not. There, we investigated the BRST cohomology, which is the observable in the TFT, of the two dimensional $\mathscr{N} = (4,4)$ CKKU supersymmetric lattice model to examine whether the model really recovers the desired continuum limit or not. There, we estimate the situation by the comparison between the BRST cohomology on the two dimensional $\mathscr{N} = (4,4)$ CKKU lattice and the BRST cohomology in its target continuum theory. By this study, we have understood that the BRST cohomology in the target continuum theory cannot be realized from the BRST cohomology on the lattice. This implies that there is a possibility that the CKKU lattice model cannot realize the desired target continuum theory in the continuum limit.

Moreover, we consider the reason of the impossibility. The reason of the impossibility would be that the BRST cohomology is a topological quantity defined by the inner product of the homology cycle and its dual cohomology. Such a topological quantity is generally difficult to be realized on the lattice since the gauge symmetry on the lattice admits the singular gauge transformation which prevents us from defining the topological quantity on the lattice. ¿From this observation, we can guess that also other models like [3, 4] might be difficult to recover the desired target theories. But, from this, we could obtain the valuable strategy to develop the lattice formulation which can easily recover the desired target continuum theory, namely the formulation applicable to the numerical study. We propose that we should apply the Admissibility condition [7] etc, which enables to define the topological quantity like the chiral anomaly, to define the BRST cohomology on the lattice and to recover the desired target theory.

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2.3 Publications

2.3.1 YITP preprints (January∼December 2006)

06-01 Minako Honda, Naotoshi Okamura and Tatsu Takeuchi, *Matter Effect on Neutrino Oscillations from the violation of Universality in Neutrino Neutral Current Interactions* (March); hep-ph/0603268.

06-02 Hideo Kodama and Kunihito Uzawa, *Moduli Instability in Warped Compactification* (January); Proc. of JGRG 15, Tokyo, Japan, 28 Nov - 2 Dec 2005. (2006) 217-220. hep-th/0601100.

06-03 Yasunari Kurita and Ken-ichi Nakao, *Naked singularity resolution in cylindrical collapse* (January); Phys. Rev. **D73** (2006) 064022. gr-qc/0511044.

06-04 unused no.

06-05 Toru Kojo, Arata Hayashigaki and Daisuke Jido, *Pentaquark state in pole-dominated QCD sum rules* (February); Phys. Rev. **C74** (2006) 045206. hep-ph/0602004.

06-06 Noriyuki Kogo and Eiichiro Komatsu, *Angular Trispectrum of CMB Temperature Anisotropy from Primordial Non-Gaussianity with the Full Radiation Transfer Function* (February); Phys. Rev. **D73** (2006) 083007. astro-ph/0602099.

06-07 Shinsuke Kawai, Esko Keski-Vakkuri, Robert G. Leigh and Sean Nowling, *Fractional S-branes on a Spacetime Orbifold* (February); Phys. Rev. **D73** (2006) 106004. hep-th/0602083.

06-08 Shinsuke Kawai, Esko Keski-Vakkuri, Robert G. Leigh and Sean Nowling, *The Rolling Tachyon Boundary Conformal Field Theory on an Orbifold* (February); Phys. Rev. **D73** (2006) 106003. hep-th/0602081.

06-09 Antonino Flachi, Oriol Pujolas, Misao Sasaki and Takahiro Tanaka, *Critical escape velocity of black holes from branes* (April); Phys. Rev. **D74** (2006) 045013. hep-th/0604139.

06-10 Mitsuhiro Arikawa and Yasuhiro Saiga, *Exact spin dynamics of the* $1/r^2$ *supersymmetric t-J model in a magnetic field* (April); J. Phys. **A39** (2006) 10603-10621. cond-mat/0607444.

06-11 Yoshinobu Habara, Yukinori Nagatani, Holger B. Nielsen and Masao Ninomiya, *Dirac Sea and Hole Theory for Bosons – A new formulation of quantum field theories –* (March); hep-th/0603242.

06-12 Shigehiro Nagataki, Akira Mizuta and Katsuhiko Sato, *Explosive Nucleosynthesis in GRB Jets Accompanied by Hypernovae* (January); Astrophys. J. **647** (2006) 1255-1268. astro-ph/0601111.

06-13 K. Asano and S. Nagataki, *Very High Energy Neutrinos Originating from Kaons in Gamma-Ray Bursts* (March); Astrophys. J. **640** (2006) L9-L12. astro-ph/0603107.

06-14 Yuuiti Sendouda, Shigehiro Nagataki and Katsuhiko Sato, *Mass spectrum of primordial black holes from inflationary perturbation in the Randall-Sundrum braneworld: a limit on blue spectra* (March); JCAP **0606** (2006):003. astro-ph/0603509.

06-15 Kunihiko Terasaki, *Production of neutral and doubly charged partners of* $D_{s0}^{+}(2317)$ (April); Prog. Theor. Phys. **116** (2006) 435-440. hep-ph/0604207.

06-16 S. Rai Choudhury, A. S. Cornell, Naveen Gaur and Ashok Goyal, *Little Higgs model effects at* $\gamma\gamma$ *collider* (April); Phys. Rev. **D73** (2006) 115002. hep-ph/0604162.

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06-19 Shigenori Seki, Katsuyuki Sugiyama and Tatsuya Tokunaga, *Superconformal Symmetry in Linear Sigma Model on Supermanifolds* (May); Nucl. Phys. **B753** (2006) 295-312. hep-th/0605021.

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06-23 Satoru Odake and Ryu Sasaki, *Unified Theory of Annihilation-Creation Operators for Solvable ('Discrete') Quantum Mechanics* (May); J. Math. Phys. **47** (2006) 102102. quant-ph/0605215.

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06-27 Naoki Sasakura, *Tensor model and dynamical generation of commutative nonassociative fuzzy spaces* (June); Class. Quant. Grav. **23** (2006) 5397-5416. hep-th/0606066.

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06-32 Masato Minamitsuji, Wade Naylor and Misao Sasaki, *Volume stabilization in a warped flux compactification model* (June); JHEP **0612** (2006) 079. hep-th/0606238.

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06-42 Yasunori Fujii and Misao Sasaki, *Gravitational scalar field coupled directly to the Maxwell field and its effect to solar-system experiments* (August); Phys. Rev. **D75** (2007) 064028. astro-ph/0608508.

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06-54 Tetsuya Onogi, *Heavy flavor physics from lattice QCD* (October); PoS (LAT2006) 017. hep-lat/0610115.

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06-61 Kazuharu Bamba and Misao Sasaki, *Large-scale magnetic fields in the inflationary universe* (Novemver); JCAP **0702** (2007) 030. astro-ph/0611701.

06-62 Holger B. Nielsen and Masao Ninomiya, *Future Dependent Initial Conditions from Imaginary Part in Lagrangian* (December); Proc. to the 9th Workshop, Bled, September 16-26, 2006. (2006) 87-124. hep-ph/0612032.

06-63 Choon-Lin Ho and Ryu Sasaki, *Deformed Fokker-Planck Equations* (December); Prog. Theor. Phys. **118** (2007) 667-674. cond-mat/0612318.

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06-65 Katsushi Ito, Yoshishige Kobayashi and Shin Sasaki, *Deformation of N=4 Super Yang-Mills Theory in Graviphoton Background* (December); JHEP **0704** (2007) 011. hep-th/0612267.

06-66 Ignacio Zaballa, Anne M. Green, Karim A. Malik and Misao Sasaki, *Constraints on the primordial curvature perturbation from primordial black holes* (December); JCAP **0703** (2007) 010. astro-ph/0612379.

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06-68 S. Negishi, H. Matsufuru and T. Onogi, *Precision study of $B^*B\pi$ coupling for the static heavy-light meson* (December); Prog. Theor. Phys. **117** (2007) 275-303. hep-lat/0612029.

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06-70 Fumiko Okiharu, Hideo Suganuma, Toru T. Takahashi and Takumi Doi, *Multi-Quarks and Two-Baryon Interaction in Lattice QCD* (January); AIP Conf. Proc. **842** (2006) 231-233. Also in *Santa Fe 2005, Particles and nuclei* 231-233. hep-lat/0601005.

06-71 T. T. Takahashi, T. Doi and H. Suganuma, *Nuclear force in Lattice QCD* (January); AIP Conf. Proc. **842** (2006) 249-251. Also in *Santa Fe 2005, Particles and nuclei* 249-251. hep-lat/0601006.

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06-73 H. Iida, H. Suganuma and T. T. Takahashi, *Bound States of (Anti-)Scalar-Quarks in $SU(3)_c$ Lattice QCD* (December); hep-lat/0612019.

06-74 Tetsuo Hyodo, Daisuke Jido and Atsushi Hosaka, *Chiral dynamics and s-wave exotic hadrons* (December); hep-ph/0612333.

2.3.2 Publications and Talks by Regular Staff (April 2006 — March 2007)

Hisao Hayakawa

Journal Papers

1. Tetsuya Mitsudo and Hisao Hayakawa,
The effect of detachment and attachment to a kink motion in the asymmetric simple exclusion process .
J. Phys. A: Math. Gen. **39** (2006) 15073-15082.
2. Kuniyasu Saitoh and Hisao Hayakawa,
Rheology of a granular gas under a plane shear .
Phys. Rev. E **75**, 021302 (2007) 1-11.

Books and Proceedings

1. Hisao Hayakawa, in Science of Complex Systems "Fukuzatsu System Kagaku" edited by Hiroshi Namaizawa,
(The University of the Air Publ. 2007) (in Japanese) pp.137-177, 247-251.
2. Hisao Hayakawa, Nonequilibrium Statistical Mechanics "Hiheikou Toukei Rikigaku" (Bessatsu Suurikagaku, SGC54, Science Publ. 2007) (in Japanese) 8+159+2 pages.

Talks at international Conferences

1. Kinetic Approach to the Rheology of Granular Fluids.
Workshop "Dynamics and Statics of Nonequilbrium Complex Many-Body Systems", Invited, 24–26 October 2006, International Institute of Advanced Studies, Seika.

Invited Seminars (in Japan)

1. Anomalous impact and fluctuation theorem (in Japanese)
27, July, 2006, Dept. Physics, Nagoya Univ. (as a part of concentrated lecture course).
2. What is granular material? (in Japanese)
27-28, September, 2006, University of the Air.

Ken-Iti Izawa

Invited Seminars (Overseas)

1. Minimal Supergravity and Inflation with a Large Cutoff.
Center for Theoretical Physics, Seoul National University,
25 May 2006, Seoul, Korea.

Daisuke Jido

Journal Papers

1. Toru Kojo, Arata Hayashigaki, Daisuke Jido,
Pentaquark state in pole-dominated QCD sum rules,
Phys. Rev. **C74**, (2006) 045206 (8 pages), [hep-ph/0602004], YITP-06-05.
2. Tetsuo Hyodo, Daisuke Jido, Atsushi Hosaka,
Exotic hadrons in s-wave chiral dynamics,
Phys. Rev. Lett. **97**, (2006) 192002 (4 pages). [hep-ph/0609014], YITP-06-45.
3. Tetsuo Hyodo, Daisuke Jido, Atsushi Hosaka,
Study of exotic hadrons in s-wave scatterings induced by chiral interaction in the flavor symmetric limit,
Phys. Rev. **D 75** (2007) 034002 (16 pages), [hep-ph/0611004], YITP-06-58.

Talks at International Conferences

1. In-medium pions and partial resoration of chiral symmety,
Yukawa International Seminars (YKIS2006) on New Fronties in QCD – Exotic Hadrons and Hadronic matter –, November 20 - December 8, 2006, Invited, YITP, Kyoto University, Kyoto.

Invited Seminars (in Japan)

1. Baryon resonances in chiral dynamics with coupled channel approach (in Japanese),
27 February 2007, KEK.

Yoshiko Kanada-En'yo

Journal Papers

1. M. Takashina, Y. Kanada-En'yo and Y. Sakuragi,
   ^{16}C inelastic scattering studied with the microscopic coupled-channels method,
   Phys. Rev. **C71** (2005) 054602 (7 pages).
2. Y. Kanada-En'yo and M. Kimura,
   Dipole resonances in light neutron-rich nuclei studied with time-dependent calculations of antisymmetrized molecular dynamics,
   Phys. Rev. **C72** (2005) 064301 (13 pages).
3. Y. Kanada-En'yo and M. Kimura,
   Superdeformation and clustering in ^{40}Ca studied with antisymmetrized molecular dynamics,
   Phys. Rev. **C72** (2005) 064322 (17 pages).
4. Y. Kanada-En'yo, M. Kimura and H. Horiuchi,
   Cluster structure in stable and unstable nuclei,
   Eur. Phys. J. A **25** (2005) 305-310.

Invited Talks at international Conferences

1. Cluster aspect in C isotopes,
   Second Joint Meeting of the Nuclear Physics Divisions of the APS and JPS,
   September 18-22, 2005, Hawaii, U.S.A.

Hideo Kodama

Journal Papers

1. Hideo Kodama and Nobuyoshi Ohta,
   Time-dependent Supersymmetric Solutions in M Theory and Compactification-Decompactification Transition
   Prog. Theor. Phys. **116** (2006) 295–318, arXiv: hep-th/0605179, YITP-06-22.

Talks at international Conferences

1. Einstein's Dream,
   The 24th Meeting of the Indian Association of General Relativity and Gravity, Invited, 5–8 February 2007, Jamia Millia Islamia, Delhi, India.

Invited Seminars (Overseas)

1. Gauge-invariant Formulation for Spacetime Perturbations.
   Center of Theoretical Physics, Jamia Millia Islamia, 9–12, February, Delhi, India.

Invited Seminars (in Japan)

1. Perturbative Approach to Higher-Dimensional C-metric (in English),
   16 March 2007, Dept. of Physics, Kinki University.
2. Perturbative Approach to a Braneworld Black Hole (in Japanese),
   23 February 2007, Dept. of Physics, Kyoto University.
3. Dynamics of Compactification in HUNT (in Japanese),
   Workshop on Gravity and Quanta (The meeting to celebrate the 60th birthday of Prof. Akio Hosoya), 23–25 June 2006, Yumoto KKR Seifukan, Hakona.
4. Higher-Dimensional Cosmology (in Japanese),
   20–22 June 2006, Lectures at Dept. of Physics, Tokyo Insitute of Technology.

Taichi Kugo

Invited Seminars (in Japan)

1. A Manual for the Superconformal Tensor Calculus of 5D Supergravity (in Japanese),
   2 August 2006, talk at the YITP workshop "Developments in Particle Physics 2006", YITP, Kyoto University.
2. From Yukawa Theory to the Standard Model through Tomonaga's Renormalization Theory (in Japanese),
   11 November 2006, an extension lecture at Kyoto University Museum at the occasion of Centennial of Yukawa and Tomonaga's Births, Kyoto University.

Teiji Kunihiro

Journal Papers

1. Teiji Kunihiro and Kyosuke Tsumura,
   Application of the renormalization-group method to the reduction of transport equations,
   J. Phys. **A39** (2006), 8089–8104. arXiv:hep-th/0512108.
2. K. Tsumura, T. Kunihiro and K. Ohnishi,
   Derivation of covariant dissipative fluid dynamics in the renormalization-group method,

Phys. Lett. **B646** (2007), 134–140, hep-ph/0609056, YITP-06-46.

3. Masakiyo Kitazawa, Teiji Kunihiro and Yukio Nemoto,
Novel Collective Excitations and Quasi-particle Picture of Quarks Coupled with a Massive Boson at Finite Temperature,
Prog. Theor. Phys. **117** (2007) 103–138, hep-ph/0609164, YITP-07-02.

Books and Proceedings

1. T. Kunihiro, S. Muroya, A. Nakamura, C. Nonaka, M. Sekiguchi and H. Wada,
Mass spectroscopy of scalar and axial vector mesons in lattice QCD,
Prepared for Physics at LHC, Cracow, Poland, 3-8 Jul 2006,
Published in Acta Phys. Polon. **B38** (2007) 491-496.
2. Masakiyo Kitazawa, Teiji Kunihiro and Yukio Nemoto,
Quasiparticle picture of quarks near chiral transition at finite temperature.
The proceedings of International Conference on Strong and Electroweak Matter (SEWM 2006), Upton, New York, 10-13 May 2006.
Published in Nucl. Phys. **A785** (2007) 257-260, hep-ph/0608185.
3. Hiroaki Abuki and Teiji Kunihiro,
Thermal unpairing transitions affected by neutrality constraints and chiral dynamics,
AIP Conf.Proc.**842**, 110-112 (2006).
The proceedings of Particles and Nuclei International Conference (PANIC 05), Santa Fe, New Mexico, 24-28 Oct 2005. hep-ph/0601055.
4. Masakiyo Kitazawa, Teiji Kunihiro and Yukio Nemoto,
Quasiparticle picture of quarks near chiral phase transition.
The proceedings of 18th International Conference on Ultrarelativistic Nucleus-Nucleus Collisions: Quark Matter 2005 (QM 2005), Budapest, Hungary, 4-9 Aug 2005.
Published in Acta Phys. Hung. **A27** (2006) 343-346, hep-ph/0510381.

Talks at international Conferences

1. QCD Phase Diagram and Quasi-particle Picture in Chiral Effective Models.
APCTP Focus Program ‘Search for Exotic State of Dense Matter,’ Invited, June 19 -30, 2006, APCTP, Pohang, Korea.
2. Relativistic Dissipative Fluid dynamics Consitent with Boltzmann Equation — a dynamical-reduction theoretical approach —.
The 1st Asian Triangle Heavy Ion Conference (ATHIC 2006), June 29 - July 1, 2006, Yonsei University, Seoul, Korea.
3. Low-mass Scalar Mesons and Related Topics.
YKIS2006 ’Frontiers in QCD; exotic hadrons and hadronic matter,’ Invited, Nov. 20 — Dec. 8, 2006, Kyoto.
4. Soft Modes of QCD Phase Transitions and Lepton-pair Production.
HNP2007, Busan,
Invited Feb. 22 — 24, 2007.

Invited Seminars (in Japan)

1. QCD Phase Transitions; chiral transition and color superconductivity (in Japanese).
invited series of lectures at summer school of Lab. of elementary particle physics, 1 - 3, September, 2006, Kanazawa Spring, Ishikawa prefectutre.
2. Manybody theory of hadron/quark systems based on effective chiral models (in Japanese).
invited series of lectures given at Nagoya University, October 16 - 18, 2006, Nagoya University.
3. From nuclear physics to quark/hadron manybody physics; separation of scales and effective theries—soft modes and slow dynamics (in Japanese).
invited talk at Nuclear physics meetig celebrating the retirement of Professor Hisashi Horiuchi, Kyodai Kaikan, 29 April, 2006.
4. Relativistic dissipative fluid dynamics consistent with Boltzmann equation — a dynamical-reduction theoretical approach —(in Japanese).
invited talk at YITP workshop ’Thermodynamics Field Theory and Its Applications,’ 23 – 25 August, 2006, at YITP.

Hiroshi Kunitomo

Journal Papers

1. Hiroshi Kunitomo,
One-loop amplitudes in supersymmetric QCD from MHV vertices.
Prog. Theor. Phys. **116** (2006) 363–403, arXiv:hep-th/0604210, YITP-06-20.
2. Hiroshi Kunitomo and Shun'ya Mizoguchi,
Lower-deimensional superstrings in the double-spinor formalism.
Prog. Theor. Phys. **117** (2007) 765–793, arXiv:hep-th/0612183, YITP-06-67.

Invited Seminars (in Japan)

1. One-Loop amplitudes in supersymmetric QCD from MHV vertices (in Japanese).
23 May 2006, Dept. Physics, Osaka City University.
2. Lower-dimensional superstrings in the double-spinor formalism (in Japanese).
15 September 2006, YITP Workshop "String theory and quantum field theory" Kyoto University.
3. Lower-dimensional superstrings in the double-spinor formalism (in Japanese).
09 November 2006, Institute of Physics, University of Tokyo.
4. Lower-dimensional superstrings in the double-spinor formalism (in Japanese).
27 December 2006, Workshop "String Theory 2006" Rikkyo University.
5. Lower-dimensional superstrings in the double-spinor formalism (in Japanese).
31 January 2007, Department of Physics, Kyoto University.
6. Lower-dimensional superstrings in the double-spinor formalism (in Japanese).
16 Febrary 2007, Okayama Institute for Quantm Physics.

Shin Mineshige

Journal Papers

1. D. Heinzeller, S. Mineshige, and K. Ohsuga,
Spectral energy distribution of super-Eddington flows.
Mon. Not. Roy. Astron. Soc. **372** (2006) 1208-1216, arXiv:astro-ph/0608263.
2. A. Mizuta, T. Yamasaki, S. Nagataki, and S. Mineshige,
Collimated Jet or Expanding Outflow: Possible Origins of Gamma-Ray Bursts and X-Ray Flashes,
Astrophys. J. **651** (2006) 960-978, arXiv:astro-ph/0607544.
3. K. Vierdayanti, S. Mineshige, K. Ebisawa, and T. Kawaguchi,
Do Ultraluminous X-Ray Sources Really Contain Intermediate-Mass Black Holes?
Pub. Astron. Soc. Japan **58** (2006) 915-923.
4. M. Trenti, E. Ardi, S. Mineshige, and P. Hut,
Star clusters with primordial binaries - III. Dynamical interaction between binaries and an intermediate-mass black hole,
Mon. Not. Roy. Astron. Soc. **374** (2007) 857-866, arXiv:astro-ph/0610342.

Books and Proceedings

1. W. Stantyo, P. W. Premadi, P. Mahasena, T. Hidayat, and S. Mineshige,
Proc. of The 9th Asian-Pacific Regional IAU Meeting
Institut Teknologi Bandung Press (2006) 378 pages.

Talks at international Conferences

1. Super-critical accretion flow?
Symposium "The Central Engine of Active Galactic Nuclei", Invited, 16–21 October 2006, Xi'an, China.
2. Conference summary
Workshop "East-Asian Numerical Astrophysics Meeting", Invited, 1–3 November 2006, Dae-jeon, Korea.
3. Super-critical accretion flow?
Workshop "Accretion and Outflow in AGN and Stellar Black Holes", Invited, 27 November – 8 December, 2006, TIARA, Taiwan.

Invited Seminars (Overseas)

1. Super-critical Accretion Flow and Bright X-ray Sources.
Institute for Theoretical Astrophysics, University of Heidelberg,
May 17, 2006, Heidelberg, Germany.
2. Simpler Cellular Automaton Model for Black Hole Variability.
University of Kiel,
March 12, 2007, Kiel, Germany.
3. Simpler Cellular Automaton Model for Black Hole Variability.

Institute for Theoretical Astrophysics, University of Heidelberg,
March 15, 2007, Heidelberg, Germany.

Invited Seminars (in Japan)

1. Do ULXs Really Contain IMBHs? (in Japanese),
July 10, 2006, talk at University of Tsukuba.
2. How Are Black Holes Observed?
August 4, 2006, talk at the Annual Meeting of Society of Astronomical Education and Popularization of Japan.
3. Super-critical accretion flow (in Japanese),
September 30, 2006, talk at Kanazawa University.

Takao Morinari

Journal Papers

1. Yasunari Kurita and Takao Morinari,
Horizon formation in isotropically expanding Bose-Einstein condensates,
Phys. Rev. A **76** (2007) 053603.

Books and Proceedings

1. Takao Morinari,
Chiral spin texture scenario for high-temperature superconductivity,
Physica C **460** (2007) 1000-1001.

Shigehiro Nagataki

Journal Papers

1. Shigehiro Nagataki, Akira Mizuta, and Katsuhiko Sato,
Explosive Nucleosynthesis in GRB Jets Accompanied by Hypernovae.
Astrophys. J. **647** (2006) 1255-1268, arXiv:astro-ph/0601111, YITP-06-12.
2. Yuuiti Sendouda, Shigehiro Nagataki, and Katsuhiko Sato,
Mass spectrum of primordial black holes from inflationary perturbation in the Randall Sundrum braneworld: a limit on blue spectra.
Journal. Cosmology and Astroparticle Physics **06** (2006) 003. arXiv:astro-ph/0603509, UTAP-552, RESCEU-1/06, YITP-06-14.
3. Kohta Murase and Shigehiro Nagataki,
High Energy Neutrino Flashes from Far-Ultraviolet and X-Ray Flares in Gamma-Ray Bursts.
Phys. Rev. Lett. **97** (2006) 051101, arXiv:astro-ph/0604437. YITP-06-37.
4. Kohta Murase, Kunihito Ioka, Shigehiro Nagataki, and Takashi Nakamura
High-Energy Neutrinos and Cosmic Rays from Low-Luminosity Gamma-Ray Bursts?
Astrophys. J. **651** (2006) L5-L8, arXiv:astro-ph/0607104. YITP-06-38.
5. Akira Mizuta, Tetsuya Yamasaki, Shigehiro Nagataki, and Shin Mineshige,
Collimated Jet or Expanding Outflow: Possible Origins of Gamma-Ray Bursts and X-Ray Flashes.
Astrophys. J. **651** (2006) 960-978, arXiv:astro-ph/0607544. YITP-06-39.

Books and Proceedings

1. Shigehiro Nagataki, Akira Mizuta, Katsuhiko Sato,
Explosive Nucleosynthesis Inside/Outside of the Jet Launched by a Collapsar.
AIP Conference Proceedings 847, Melville, New York, (2006) p.445.
2. Shigehiro Nagataki,
2D Numerical Simulation of a Collapsar.
AIP Conference Proceedings 856, Melville, New York, (2006) p.153.
3. Shigehiro Nagataki,
Explosion Mechanism of Core-Collapse Supernovae and Collapsars.
Proceedings of Energy Budget in the High Energy Universe, World Scientific, (2007) p.146-151.
4. Kohta Murase and Shigehiro Nagataki,
High Energy Neutrino Emission from Gamma-Ray Bursts
Proceedings of Energy Budget in the High Energy Universe, World Scientific, (2007) p.311.
5. Shigehiro Nagataki,
Explosion Mechanism of Core-Collapse Supernovae and Collapsars.
Proceedings of High Energy Density Laboratory Astrophysics, Springer, (2007) p203-206.
6. Akira Mizuta, Tetsuya Yamasaki, Shigehiro Nagataki, and Shin Mineshige,

Outflow Propagation in Collapsars: Collimated Jets and Expanding Outflows.
Proceedings of High Energy Density Laboratory Astrophysics, Springer, (2007) p23-27.

Talks at international Conferences

1. Numerical simulations of collapsars with neutrino heating and magnetic field.
International Conference 'Swift and GRBs: Unveiling the Relativistic Universe', 5-9 June 2006, Venice, Italy.
2. High Energy Neutrino Emission and Neutrino Background from Internal Shocks of GRBs.
International Conference 'SUSY06', 12-17 June 2006, Irvine, USA.
3. Toward Understanding the Central Engine of Long GRBs.
International Conference 'Supernova 1987A: 20 Years After Supernovae and Gamma-ray Bursters', Invited, 19-23 Aspen, Colorado, USA.

Invited Seminars (in Japan)

1. Toward Understanding of Long GRBs.
Workshop 'Supernova Confrerence 2007', 3 Feburyary 2006, Dept. of Phys., Univ. of Tokyo.
2. Toward Understanding the Central Engine of Long GRBs (in Japanese).
Workshop 'Black Hole Astronomy in Suzaku-era', 14 Feburyary 2006, Yukawa Institute for Theoretical Physics, Kyoto Univ.
3. GRB and AGN Central Engines and Particle Acceleration.
International Symposium on "Astronomy and Astrophysics of the Extreme Universe", 22 March 2007, RIKEN.
4. Gravitational Collapse of Massive Stars and High-Energy Phenomena (in Japanese).
Annual Meeting of The Physical Society of Japan, 27 March 2007, Tokyo Metoropolitan, Univ.

Takao Ohta

Journal Papers

1. K. Yamada and T. Ohta,
Elastic theory of microphase separated interconnected structures,
Europhysics Letters **73** (2006) 614-620.
2. M. Kaga and T. Ohta,
Dynamical Approach to Microphase Separation in ABCA-Type Tetra-Block Copolymers,
J. Phys. Soc. Jpn. **75** (2006) 043002 (4).
3. H. Tokuda and T. Ohta,
Entrainment and modulation of nonlinear dissipative waves under external forcing,
J. Phys. Soc. Jpn. **75** (2006) 064005.
4. M. Ataka and T. Ohta,
Anomalous Synchronization in integrate-and-fire oscillators with global coupling.
Prog. Theor. Phys. (Suppl.) **161** (2006) 156-160.
5. H. Tokuda and T. Ohta,
Entrainment and modulation of traveling waves under external forcing,
Prog. Theor. Phys. (Suppl.) **161** (2006) 368-371.
6. K. Yamada , M. Nonomura, and T. Ohta,
Fddd structure in AB-type diblock copolymers,
J. Phys.: Condens. Matter **18** (2006) L421-L427.

Talks at international Conferences

1. Kinetics of morphological transitions in soft matter,
Workshop International conference on small angle scattering, Invited, 7-12 July 2006, Kyoto.

Tetsuya Onogi

Journal Papers

1. H. Fukaya et al.,
Two-flavor lattice QCD simulation in the epsilon-regime with exact chiral symmetry.
Phys. Rev. Lett. **98** (2007) 172001, arXiv:hep-lat/0702003, YITP-07-4.
2. S. Negishi, H. Matsufuru, and T. Onogi,
Precision study of $B^*B\pi$ coupling for the static heavy-light meson.
Prog. Theor. Phys. **117** (2007) 275-303, arXiv: hep-lat/0612029, YITP-06-68.
3. H. Fukaya et al.,
Lattice gauge action suppressing near-zero modes of H(W).

Phys. Rev. **D74** (2006) 094505, arXiv:hep-lat/067020, YITP-06-34.

Books and Proceedings

1. Heavy flavor physics from lattice QCD.
   PoS LST2006:017,2006. hep-lat/0610115.

Talks at international Conferences

1. Heavy flavor physics from lattice QCD.
   Plenary talk at 24th International Symposium on Lattice Field Theory (Lattice 2006).
   July 2006, Tucson, Arizona.
2. Future prospects from lattice QCD,
   Invited talk at the 4th International Workshop on the CKM Unitarity Triangle. 12-16 December,2006, Nagoya University, Japan.
3. Working Group 2 summary,
   Summary talk at the 4th International Workshop on the CKM Unitarity Triangle. 12-16 December 2006, Nagoya University, Japan.
4. Should we change the topology at all?
   Invited talk at the Workshop on Domain Wall Fermions at Ten Years 15-17 March 2007, Brookhaven National Laboratory, USA.

Invited Seminars (in Japan)

1. Progress in unquenched lattice QCD simulations (in Japanese),
   9 Feburary 2006, seminar at ICRR, Univ. of Tokyo,

Misao Sasaki

Journal Papers

1. Antonino Flachi, Oriol Pujolas, Misao Sasaki and Takahiro Tanaka,
   Critical escape velocity of black holes from branes,
   Phys. Rev. D **74** (2006) 045013, [arXiv:hep-th/0604139], YITP-06-09.
2. Shuichiro Yokoyama, Takahiro Tanaka, Misao Sasaki and Ewan D. Stewart,
   Wronskian Formulation of the Spectrum of Curvature Perturbations,
   JCAP **0606** (2006) 020, [arXiv:astro-ph/0605021].
3. Masato Minamitsuji, Wade Naylor and Misao Sasaki,
   Volume stabilization in a warped flux compactification model,
   JHEP **0612** (2006) 079, [arXiv:hep-th/0606238].
4. Misao Sasaki, Jussi Valiviita and David Wands,
   Non-gaussianity of the primordial perturbation in the curvaton model,
   Phys. Rev. D **74** (2006) 103003, [arXiv:astro-ph/0607627], YITP-06-33.
5. Yasunori Fujii and Misao Sasaki
   Gravitational scalar field coupled directly to the Maxwell field and its effect to solar-system experiments
   Phys. Rev. D **75** (2007) 064028, [arXiv:astro-ph/0608508], YITP-06-42.
6. Tomomi Akutsu *et al.* [TAMA Collaboration],
   Results of the search for inspiraling compact star binaries from TAMA300's observation in 2000-2004,
   Phys. Rev. D **74** (2006) 122002, [arXiv:gr-qc/0610064].
7. Christian T. Byrnes, Misao Sasaki and David Wands,
   The primordial trispectrum from inflation,
   Phys. Rev. D **74** (2006) 123519, [arXiv:astro-ph/0611075].
8. H. Nomura, Misao Sasaki and Kazuhiro Yamamoto,
   Classical and quantum radiation from a moving charge in expanding universe,
   JCAP **0611** (2006) 013, [arXiv:gr-qc/0611066].
9. Kazuharu Bamba and Misao Sasaki,
   Large-scale magnetic fields in the inflationary universe,
   JCAP **0702** (2007) 030, [arXiv:astro-ph/0611701], YITP-06-61.
10. Ignacio Zaballa, Anne M. Green, Karim A. Malik and Misao Sasaki,
    Constraints on the primordial curvature perturbation from primordial black holes,
    JCAP **0703** (2007) 010, [arXiv:astro-ph/0612379].
11. Yoshiharu Tanaka and Misao Sasaki,
    Gradient expansion approach to nonlinear superhorizon perturbations,
    Prog. Theor. Phys. **117** (2007) 633, [arXiv:gr-qc/0612191], YITP-06-69.
12. Misao Sasaki,

Nonlinear curvature perturbations in an exactly soluble model of multi-component slow-roll inflation,
Class. Quant. Grav. **24** (2007) 2433, [arXiv:astro-ph/0702182], YITP-07-05.

Books and Proceedings

1. Jussi Valiviita, Misao Sasaki and David Wands,
Non-Gaussianity and constraints for the variance of perturbations in the curvaton model,
arXiv:astro-ph/0610001, in the Proceedings of the 40th Rencontres de Moriond, "Contents and structures of the universe", 2006.

Talks at international Conferences

1. A new δN formalism for multi-component inflation.
Workshop on "Non Gaussianity from Inflation", Invited, 19–22 April 2006, Univ. Cambridge, UK.
2. Recent Developments in Inflationary Cosmology.
Summer Institute on "New Trends in Particle Physics and Cosmology", Invited, 19–23 June 2006, Univ. Sheffield, UK.
3. δN formalism for inflationary curvature perturbations.
Workshop on "Modern Cosmology: Inflation, CMB and LSS", Invited, 30 July – 18 August 2006, Benasque, Spain.
4. Future directions (discussion leader).
Workshop on "Brane-World Gravity: Progress and Problems", Invited, 18–29 September 2006, Portsmouth, UK.
5. ΔN Formalism for the Curvature Perturbation from Inflation.
DESY thoeory workshop on "The Dark Universe: Dark Matter, Dark Energy, String Cosmology", Invited, 26–29 September 2006, Hamburg, Germany.
6. Black Hole Perturbations (lectures).
Henri Poincare Trimester on "Gravitational Waves, Relativistic Astrophysics and Cosmology", Invited, 18 September – 15 December 2006, Paris, France.
7. Self-force Approach to EMRIs.
GR Trimester Workshop on "Gravitational Wave Data Analysis", Invited, 13–17 November 2006, Paris, France.
8. Black Hole Perturbation and Self-force Regularization (lectures).
Taiwan School and Workshop on "Cosmology and Gravitation", 13–16 January 2007, Tainan, Taiwan.

Invited Seminars (Overseas)

1. Theory of Cosmological Perturbations.
Sommerfeld Theory Colloquium, ASC, Ludwig Maximilians University
31 May 2006, Munich, Germany.

Ryu Sasaki

Journal Papers

1. Satoru Odake and Ryu Sasaki,
Exact solution in the Heisenberg picture and annihilation-creation operators,
Phys. Lett. **B641** (2006) 112–117, arXiv:quant-ph/0605221, YITP-06-24.
2. Satoru Odake and Ryu Sasaki,
Unified Theory of Annihilation-Creation Operators for Solvable ('Discrete') Quantum Mechanics,
J. Math. Phys. **47** (2006) 102102, 33pages, arXiv:quant-ph/0605215, YITP-06-23.
3. R. Sasaki, W-L. Yang and Y-Z. Zhang,
Exact classical solutions of nonlinear sigma models on supermanifolds,
Nucl. Phys. **772** (2007) 371–384. arXiv:hep-th/0612154, YITP-06-64.
4. C-L. Ho and R. Sasaki,
Deformed Fokker-Planck Equations,
Prog. Theor. Phys. **117** (2007) 667–674, arXiv:cond-mat/0612318, YITP-06-63.
5. C-L. Ho and R. Sasaki,
Deformed multi-variable Fokker-Planck equations,
J. M. Phys. **48** (2007) 073302 (9 pages), arXiv:cond-mat/0703291, YITP-07-10.

Talks at international Conferences

1. Exact solution in the Heisenberg picture and annihilation-creation operators.
Workshop "EXACTLY SOLVABLE SYSTEMS IN QUANTUM FIELD THEORY", Invited, 4–13 August 2006, Univ. York, England.

Invited Seminars (Overseas)

1. Exact solution in the Heisenberg picture and annihilation-creation operators,
   National University of Taiwan, National Center for Theoretical Science,
   4 July 2006, Taipei.
2. Exactly Solvable Quantum Mechanics.
   Department of Mathematics, University of Queensland
   5 September 2006, Brisbane, Australia.
3. Exact classical solutions of the nonlinear sigma models on supermanifolds,
   National University of Taiwan, National Center for Theoretical Science,
   22 December 2007, Taipei.

Invited Seminars (in Japan)

1. Classical and Quantum Integrability in Multi-particle Dynamics (in Japanese).
   10 May 2006, Dept. Mathematical Science, Univ. Tokyo.

Naoki Sasakura

Journal Papers

1. Naoki Sasakura,
   Tensor model and dynamical generation of commutative nonassociative fuzzy spaces,
   Class.Quant.Grav. **23** (2006) 5397-5416, arXiv:hep-th/0606066, YITP-06-27.
2. Yuya Sasai, Naoki Sasakura,
   One-loop unitarity of scalar field theories on Poincare invariant commutative nonassociative spacetimes,
   JHEP **0609** (2006) 046, arXiv:hep-th/0604194, YITP-06-17.

Books and Proceedings

1. Naoki Sasakura,
   An Invariant approach to dynamical fuzzy spaces with a three-index variable: Euclidean models.
   15pages, in the proceedings of 4th International Symposium on Quantum Theory and Symmetries (QTS-4), Varna, Bulgaria, 15-21 Aug 2005.
   hep-th/0511154, YITP-05-70.

Invited Seminars (in Japan)

1. Rank-three tensor models and gravity on fuzzy spaces,
   1 November 2007, Dept. of Phys., Kyoto Univ.

Ken-ichi Shizuya

Journal Papers

1. K. Shizuya
   Effect of quantum fluctuations on topological excitations and central charge in supersymmetric theories
   Phys. Rev. D **74** (2006) 025013 1-10, arXiv:hep-th/0606172, YITP-06-28.

Takami Tohyama

Books and Proceedings

1. Takami Tohyama,
   Electron-hole asymmetry in high-T_c cuprates from theoretical viewpoints.
   Iranian J. Phys. Res. **6** (2006) 149–158.

Talks at international Conferences

1. Theory of Resonant Inelastic X-Ray Scattering in Cuprates.
   Joint conference of the Asian Crystallographic Association and the Crystallographic Society of Japan (AsCA'06/CrSJ), Invited, 20–23 November 2006, Tsukuba, Japan.
2. Momentum-Dependent Charge Dynamics in High-Tc Cuprates.
   International Conference on Stripes (STRIPES2006), Invited, 20–23 December 2006, Roma, Italy.
3. Spin and Charge Dynamics in High-Tc Cuprates.
   Sixth International Conference on New Theories, Discoveries and Applications of Superconductor and Related Materials (New^{3}SC-6), Invited, 9–11 January 2007, Sydney, Australia.

Invited Seminars (in Japan)

1. Electron-hole asymmetry in high-T_c cuprates: An approach from Mott insulator (in Japanese).
   5 December 2006, Dept. Physics, Hokkaido Univ.
2. Electron-hole asymmetry in high-T_c cuprates: An approach from Mott insulator (in Japanese).
   16 January 2007, Mater. Struct. Lab., Tokyo Inst. of Tech.

Keisuke Totsuka

Journal Papers

1. P. Lecheminant and K. Totsuka,
Competing orders and hidden duality symmetries in two-leg spin ladder systems,
Phys. Rev. **B74** (2006) 224426, arXiv:cond-mat/0606691, YITP-06-51.
2. P. Lecheminant and K. Totsuka,
SU(N) Self-Dual Sine-Gordon Model and Competing Orders,
J. Stat. Mech. **0612** (2006) L001, arXiv:cond-mat/0610254, YITP-06-52.
3. K. Totsuka, P. Lecheminant and S. Capponi,
A Unifying Approach to Unconventional Orders in Frustrated Spin Systems
J. Mag. Mat. Mater. **310** (2007) 1355.

2.3.3 Publications and Talks by Research Fellows and Graduate Students (April 2006– March 2007)

Hiroyuki Abe

Journal Papers

1. H. Abe, T. Higaki and T. Kobayashi,
   Remark on integrating out heavy moduli in flux compactification,
   Phys. Rev. **D74** (2006) 045012, 8 pages, arXiv:hep-th/0606095, YITP-06-26.
2. H. Abe and Y. Sakamura,
   Roles of Z_2-odd N = 1 multiplets in off-shell dimensional reduction of 5D supergravity,
   Phys. Rev. **D75** (2007) 025018, 17 pages, arXiv:hep-th/0610234, YITP-06-53.
3. H. Abe, T. Higaki, T. Kobayashi and Y. Omura,
   Moduli stabilization, F-term uplifting and soft supersymmetry breaking terms,
   Phys. Rev. **D75** (2007) 025019, 7 pages, arXiv:hep-th/0611024, YITP-06-59.
4. H. Abe and Y. Sakamura,
   Supersymmetry breaking in a warped slice with Majorana-type masses,
   JHEP **0703** (2007) 106, 22 pages, arXiv:hep-th/0702097, YITP-07-06.
5. H. Abe, T. Kobayashi and Y. Omura,
   Relaxed fine-tuning in models with non-universal gaugino masses,
   Phys. Rev. **D76** (2007) 015002, 8 pages, arXiv:hep-ph/0703044, YITP-07-12.

Books and Proceedings

1. H. Abe,
   Patterns of supersymmetry breaking in moduli-mixing racetrack model,
   American Institute of Physics, Conference Proceedings 903, SUSY06: the 14th International Conference on Supersymmetry and the Unification of Fundamental Interactions, page 517–520.
2. H. Abe,
   Supersymmetry breaking in moduli-mixing racetrack model,
   Soryushiron-Kenkyu **114** (2007) D104; E138–E141; F37.

Talks at international Conferences

1. Patterns of supersymmetry breaking in moduli-mixing racetrack model,
   The 14th International Conference on Supersymmetry and the Unification of Fundamental Interactions (SUSY 2006),
   12–17 June 2006, Irvine, California, USA.
2. Supersymmetry breaking in moduli-mixing racetrack model,
   International Workshop on Supersymmetry, Electroweak Symmetry Breaking and Particle Cosmology (Summer Institute 2006),
   23–30 August 2006, Asia Pacific Center for Theoretical Physics, Pohang, Korea.

Cecilia Albertsson

Journal Papers

1. Cecilia Albertsson and Ronald A. Reid-Edwards,
   Worldsheet boundary conditions in Poisson-Lie T-duality
   JHEP **03** (2007) 004–022, arXiv:hep-th/0606024, YITP-06-25.

Talks at international Conferences

1. Worldsheet boundary conditions in Poisson-Lie T-duality
   Workshop "INTERNATIONAL WORKSHOP ON NON-COMMUTATIVITY IN STRINGS, GRAVITY AND FIELD THEORY"
   16–18 November, 2006, Tokyo Metropolitan University, Tokyo, Japan.

Invited Seminars (Overseas)

1. Worldsheet boundary conditions and Poisson-Lie T-duality,
   Physics Department, Milano University,
   14 June, 2006, Milan, Italy.
2. Worldsheet boundary conditions and Poisson-Lie T-duality,
   Department of Physics, Czech Technical University,
   17 October, 2006, Prague, Czech Republic.

3. Worldsheet boundary conditions and Poisson-Lie T-duality,
Department of Theoretical Physics, Uppsala University
22 December, 2006, Uppsala, Sweden.

Mitsuhiro Arikawa

Journal Papers

1. Mitsuhiro Arikawa and Yasuhiro Saiga,
Exact spin dynamics of the $1/r^2$ supersymmetric t-J model in a magnetic field.
J. Phys. A: Math. Gen. **39** (2006) 10603-10621.
2. Mitsuhiro Arikawa, Michael Karbach, Gerhard Müller, Klaus Wiele,
Spinon excitations in the XX chain: spectra, transition rates, observability.
J. Phys. A: Math. Gen. **39** (2006) 10623-10640.
3. Hirokazu Tsunetsugu and Mitsuhiro Arikawa,
Spin Nematic Phase in S=1 Triangular Antiferromagnets. J. Phys. Soc. Jpn **75** (2006) 083701 (4 pages).

Books and Proceedings

1. Hirokazu Tsunetsugu and Mitsuhiro Arikawa,
The spin nematic state in triangular antiferromagnets. J. Phys.: Condens. Matter **19** (2007) 145248 (6 pages).
2. Mitsuhiro Arikawa and Hirokazu Tsunetsugu,
The spin nematic state in triangular antiferromagnets. Journal of Magnetism and Magnetic Materials **310** (2007) 1308-1310.

Kazuharu Bamba

Journal Papers

1. Kazuharu Bamba,
Baryon asymmetry from hypermagnetic helicity in dilaton hypercharge electromagnetism.
Phys. Rev. D **74** (2006) 123504, arXiv:hep-ph/0611152, YITP-06-47.
2. Kazuharu Bamba and Misao Sasaki,
Large-scale magnetic fields in the inflationary universe.
J. Cosmol. Astropart. Phys. **0702** (2007) 030, arXiv:astro-ph/0611701, YITP-06-61.
3. Kazuharu Bamba,
Property of the spectrum of large-scale magnetic fields from inflation.
Phys. Rev. D **75** (2007) 083516, arXiv:astro-ph/0703647, YITP-07-13.

Viktor G. Czinner

Invited Seminars (in Japan)

1. Linear perturbations of a dust filled universe with cosmological constant,
30. January, 2007, YITP, Kyoto University.

Antonino Flachi

Journal Papers

1. A. Flachi, O. Pujolàs, M. Sasaki, T. Tanaka,
Critical escape velocity of black holes from branes,
Physical Review **D74** (2006) 045013, arXiv:hep-th/0604139.
2. A. Flachi, T. Tanaka,
Branes and black holes in collision,
Physical Review **D76** (2007) 025007, arXiv:hep-th/0703019.

Books and Proceedings

1. A. Flachi,
Black holes, Branes and Extra Dimensions,
CDUP News Letters **18** (2007) 6.
2. A. Flachi, T. Tanaka,
Black holes - Domain walls collisions as a solution to the cosmological domain wall problem,
published in the proceedings of the Internation Workshop on the 'Fundamental problems and applications of quantum field theory,' Soryushiron Kenkyu **113** (2006) A-23.

Talks at international Conferences

1. Branes - black holes dynamics,
Brane World gravity - Progress and Problems Institute of Cosmology and Gravitation, University of Portsmouth, September 2006.
2. On the cosmological domain wall problem,
Workshop on 'Topological Aspects of Quantum Field Theory', Kyoto University, December 2006.

3. Branes and black holes in collision, Workshop on ‘Recent Developments in Branes and Cosmology’, APC University of Paris, March 2007.

Invited Seminars (Overseas)

1. Branes-black holes collisions and the cosmological domain wall problem, INFN, University of Calabria (Cosenza, Italy), March 2007.

Invited Seminars (in Japan)

1. Small black holes, branes and extra dimensions, COE annual meeting, Physics Department, Kyoto University, November 2006.
2. On the cosmological domain wall problem, Annual Cosmology Workshop, Department of Physics, Kyoto University, March 2007.

Tetsuo Hyodo

Journal Papers

1. Tetsuo Hyodo, Daisuke Jido, Atsushi Hosaka, Exotic Hadrons in *s*-Wave Chiral Dynamics. Phys. Rev. Lett. **97** (2006) 192002, arXiv:hep-ph/0609014, YITP-06-45.
2. Tetsuo Hyodo, Daisuke Jido, Atsushi Hosaka, Study of exotic hadrons in *s*-wave scatterings induced by chiral interaction in the flavor symmetric limit. Phys. Rev. D **75** (2007) 034002, arXiv:hep-ph/0611004, YITP-06-58.

Invited Seminars (in Japan)

1. Exotic hadrons in *s*-wave chiral dynamics. 9 Feb 2007, Tokyo Institute of Technology.

Hideaki Iida

Journal Papers

1. Hideaki Iida, Takumi Doi, Noriyoshi Ishii, Hideo Suganuma and Kyosuke Tsumura, Charmonium properties in deconfinement phase in anisotropic lattice QCD, Phys. Rev. D**74** (2006) 074502, arXiv:hep-lat/0602008, YITP-06-24.

Talks at international Conferences

1. Bound states of (anti-)scalar-quarks in SU(3)(c) lattice QCD. Workshop “17th International Spin Physics Symposium (SPIN06)”, 2–7 October 2006, Kyoto Univ.
2. Charmonium prospects from anisotropic lattice study. Workshop “International workshop on Heavy Quarkonium 2006”, 27–30 June 2006, Brookhaven National Laboratory, New York.

Shinsuke Kawai

Talks at international Conferences

1. Cosmological string backgrounds and S-branes. International Workshop, ‘APCTP Focus Program on Liouville, Integrability and Branes (3),’ Invited lectures, 5 June 2006, APCTP, Postech, Korea.
2. The worldsheet theory of T-folds and Mirrorfolds in superstring compactifications. ‘Finnish-Japanese Workshop on Particle Cosmology,’ Invited talk, 8-9 March 2007, University of Helsinki, Finland.

Invited Seminars (Overseas)

1. Brane decay from the origin of time. National Center for Theoretical Sciences, National Taiwan University, 5 January 2007, Taipei, Taiwan.

Invited Seminars (in Japan)

1. Boundary deformation and S-branes on an orbifold (in Japanese). 26 July 2006, Dept. Physics, Kyoto Univ.

Masato Minamitsuji

Journal Papers

1. M. Minamitsuji, W. Naylor and M. Sasaki, “Volume stabilization in a warped flux compactification model,” JHEP **0612** (2006) 079, arXiv:hep-th/0606238.

2. T. Kobayashi and M. Minamitsuji,
"Scalar cosmological perturbations in the Gauss-Bonnet braneworld,"
JCAP **0612** (2006) 008, arXiv:hep-th/0610265.
3. E. Elizalde, M. Minamitsuji and W. Naylor,
"Casimir effect in rugby-ball type flux compactifications,"
Phys. Rev. D **75** (2007) 064032, arXiv:hep-th/0702098.

Books and Proceedings

1. M. Minamitsuji, W. Naylor, M. Sasaki,
Volume stabilization in a warped flux compactification model,
The proceedings of the 16th Workshop on General Relativity and Gravitation, pp.271, 2006.

Talks at international Conferences

1. Volume stabilization in a warped codimension two braneworld,
" Brane-WORLD GRAVITY PROGRESS AND PROBLEMS " ,
Portsmouth, UK, September 2006.

Invited Seminars (in Japan)

1. Quantum volume stabilization in a warped codimension two brane model,
Seminor at Tokyo Institute for Technology, Tokyo, Japan, December 2006.

Yuya Sasai

Journal Papers

1. Yuya Sasai, Naoki Sasakura,
One-loop unitarity of scalar field theories on Poincare invariant commutative nonassociative spacetimes.
JHEP **0609** (2006) 046, arXiv:hep-th/0604194, YITP-06-17.

Shin Sasaki

Journal Papers

1. Katsushi Ito, Yoshishige Kobayashi and Shin Sasaki,
Deformation of N = 4 Super Yang-Mills Theory in Graviphoton Background.
JHEP **04** (2007) 011, arXiv:hep-th/0612267, TIT/HEP-564, YITP-06-65.

Books and Proceedings

1. Shin Sasaki,
"Deformed super Yang-Mills theory in R-R Background".
Proceedings of Fundamental Problems and Applications of Quantum Field Theory (2007) A45. (YITP-W-06-16).

Talks at international Conferences

1. Deformation of $\mathcal{N} = 4$ SYM theory in Graviphoton (R-R) background,
International workshop - NON-COMMUTATIVITY in STRINGS, GRAVITY and FIELD THEORY, Tokyo Metropolitan University, Tokyo, Japan, November 16-18 2006.

Fabio Scardigli

Journal Papers

1. Fabio Scardigli
A quantum like description of the planetary systems.
Found. of Phys. **37** (2007) 1278–1295, arXiv:gr-qc/0507046.

Books and Proceedings

1. Fabio Scardigli
A quantum like description of the planetary systems.
Proceedings of the Third International Workshop DICE 2006,
Journal of Physics: Conference Series 67 (2007) 012038.

Invited Seminars (Overseas)

1. A quantum like description of the planetary systems.
Institute for Theoretical Physics, University of Utrecht,
22 February 2007, Utrecht, Netherland.
2. The equivalence principle, the uncertainty principle, and some fundamental questions.
Joint Seminar KIPAC(Slac)-HEPL(Stanford), Stanford University,
23 May 2007, Stanford, Palo Alto, California, USA.

Invited Seminars (in Japan)

1. Quantum-like description of planetary systems.
   Cosmology seminar, 5 December 2006, Department of Physics, Kyoto University.

Tomohisa Takimi

Journal Papers

1. Hidenori Fukaya, Masashi Hayakawa, Issaku Kanamori, Hiroshi Suzuki and Tomohisa Takimi,
   Note on Massless Bosonic States in Two-Dimensional Field Theories.
   Prog. Theor. Phys. **116** (2006) 1117-1129, arXiv:hep-lat/0609049, YITP-06-44.
2. Kazutoshi Ohta, Tomohisa Takimi,
   Lattice Formulation of a Two-Dimensional Topological Field Theory
   Prog. Theor. Phys. **117** (2007) 317-345, arXiv:hep-lat/0611011, YITP-06-56.

Books and Proceedings

1. Tomohisa Takimi
   Lattice Formulation of Two-Dimensional Topological Field Theory (in Japanese).
   Soryushiron Kenkyu, **114** (6) (2007).

Invited Seminars (in Japan)

1. Lattice Formulation of Two-Dimensional Topological Field Theory (in Japanese).
   13 February 2007, KEK.

Yoshiharu Tanaka

Journal Papers

1. Yoshiharu Tanaka and Misao Sasaki,
   Gradient expansion approach to nonlinear superhorizon perturbations.
   Prog. Theor. Phys. **117**, 633 (2007) arXiv:gr-qc/0612191,YITP-06-69.

Books and Proceedings

1. Yoshiharu Tanaka, and Misao Sasaki,
   Non-linear cosmological perturbations on large scales,
   ”The 16th Workshop on General Relativity and Gravitation”, No.16, Niigata, Japan, (November 2006).

Talks at international Conferences

1. Non-linear cosmological perturbations on large scales.
   “The 16th Workshop on General Relativity and Gravitation,” 27th November – 1st December 2006, Univ. Niigata, Japan.
2. Gradient expansion approach to nonlinear superhorizon perturbations.
   ”Finnish-Japanese Workshop on Particle Cosmology,” 8–9 March 2007, Univ. Helsinki, Finland.

Chiyri Urabe

Books and Proceedings

1. Chiyori Urabe
   Dynamics of Fluctuation of the Top Location and Avalanches in the Formation Process of a Sandpile (in Japanese).
   Bussei Kenkyu, (2006) Vol.88, No.2 (20070520) pp. 151-154.

Invited Seminars (in Japan)

1. Formation Process of a Sandpile and Change of its Surface State (in Japanese).
   7 Feb 2007, International Graduate School of Arts and Sciences, Yokohama City Univ.
2. Dynamics of Fluctuation of the Top Location (in Japanese).
   28 Apr 2006, Graduate School of Engineering, Nagoya Institute of Technology.

2.4 Seminars, Colloquia and Lectures

▷ 2006.4.1 — 2007.3.31

- 4.6 S. D. Odintsov (IEEC & ICREA, Barcelona, Spain): *Modified gravity as gravitational alternative for dark energy*
- 4.12 Dmitri Diakonov (INP/Nordita): *Instantons, monopoles and the confinement-deconfinement transition*
- 4.14 Francesco Calogero (Physics Department, University of Rome I, "La Sapienza"): *Isochronous systems are not rare*
- 4.17 Alan D. Martin (Durham Univ.): *Exclusive Higgs signals at the LHC*
- 4.24 Izawa K.-I. (YITP): *YITP Colloquium: United theories of elementary particles confronting experiments in heaven and earth*
- 4.25 Thomas Quella (King's College London): *Generalized permutation branes*
- 4.28 Satoshi Fujimoto (Department of Physics, Kyoto University): *Low energy properties of two-dimensional quantum triangular antiferromagnets: Non-perturbative renormalization group approach*
- 4.28 Frits Wiegel (Emeritus professor, Institute for Theoretical Physics, University of Amsterdam): *Wolfgang Pauli and Carl Jung*
- 5.11, 12, 19, 25, 29, 6.5, 8, 19, 7.3 B. Mueller (Duke University): *Lecture Series: Introduction to Quark-Gluon Plasma*
- 5.12 Brajesh C. Choudhary (Fermilab): *Neutrino Oscillations with NOvA and INO*
- 5.12 Bulent Yilmaz (Physics Department of Ankara University): *Quantum Effects on Stochastic Fusion, Dynamics of Heavy Ions*
- 5.17 Berndt Muller (Duke University and YITP): *YITP Colloquium: What makes the quark-gluon plasma a "perfect" fluid?*
- 5.19 Hiroyuki Abe (YITP): *Moduli stabilization and SUSY breaking in moduli-mixing racetrack model*
- 5.24 M. Takashina (YITP): *Nuclear size of excited state and inelastic angular distribution*
- 5.26 Cecilia Albertsson (YITP): *Worldsheet boundary conditions and Poisson-Lie T-duality*
- 5.30 Mikhail Shaposhnikov (Ecole Polytechnique Federale de Lausanne): *Neutrinos, Dark Matter and Baryon Asymmetry of the Universe*
- 6.5 G. Petrakovskii (Siberian Branch of Russian Academy of Sciences): *Magnetism of Two-Dimensional Spin Systems*
- 6.5 Takashi Hamazaki (): *Solving the evolutions of cosmological perturbations in the universe dominated by multiple resonant scalar fields*
- 6.8 Toshifumi Futamase (Tohoku University): *Does backreaction of nonlinear inhomogeneities accelerate the universe?*
- 6.9 Ken-Ichiro Imura (RIKEN): *Full counting statistics for molecular spintronics — an analytically solvable model in the incoherent tunneling regime*
- 6.13 Robert Brandenberger (McGill University): *Cosmological Perturbations from String Gas Cosmology*
- 6.21 T. Hyodo (YITP): *S-wave resonances in meson-baryon scattering induced by Weinberg- Tomozawa interaction*
- 6.26 Douglas Heggie (University of Edinburgh): *Tides and Star Clusters*
- 6.27 Akihiro Ishibashi (University of Chicago): *A higher dimensional stationary rotating black hole must be axisymmetric*
- 6.29 Junko Yamagata (Nara Woman's University): *In-Flight* K^-, p) Reactions for the Formation of Kaonic Atoms and Kaonic Nuclei in Green function method
- 7.6 Yoshiyuki Nakagawa (Research Center for Nuclear Physics, Osaka University): *Confinement mechanism in Coulomb gauge QCD*
- 7.6 J. Vinals (McGill University): *Grain boundary motion and orientation selection in lamellar phases*
- 7.13 Masatsugu Isse (Osaka Univ.): *Hadronic transport approach and*

hadronization in heavy-ion collisions

7.13 Akio Nakahara (Nihon University, College of Science and Technology): *Memory in paste and its application to control crack pattern*

7.14 Tetsuji KIMURA (KIAS): *Comments on Heterotic Flux Compactifications*

7.21 Tatsuru Kikuchi (KEK): *D-term Contributions to the Mixed Modulus-Anomaly Mediated Supersymmetry Breaking*

7.27 M. Lakshmanan (Bharathidasan University): *A new approach to integrability of nonlinear dynamical systems: Some unexpected features*

7.28 Satoru Kaneko (Ochanomizu Univ.): *Phenomenology of supersymmetric TeV scale seesaw model*

9.4 Masakiyo Kitazawa (RIKEN/BNL): *Chiral transition and mesonic excitations for quarks with thermal mass*

9.8 Motoi Endo (ICRR, DESY): *Gravitino Production from Moduli Decay and Its Cosmological Implications*

9.12 Fuminobu Takahashi (ICRR, DESY): *Gravitinos as a probe into inflation and SUSY breaking sectors*

9.15 Alexei B. Zamolodchikov, (Montpellier U.): *Metastability in 2D Liouville gravity*

9.26 Shung-ichi Ando (Sungkyunkwan University, Korea): *Renormalization group analysis of nuclear current operators*

10.12 Wataru Horiuchi (Niigata University): *Structure of 16C and 22C in a three-body model*

10.13 Akitsugu Miwa (Uni. Tokyo): *Holography of Wilson-Loop Expectation Values with Local Operator insertions*

10.19 Hisao Hayakawa (YITP): *YITP Colloquium: Statistical Mechanics of Dissipative Particles*

10.20 Tomio Petrosky (Center for Complex Quantum Systems, The University of Texas at Austin and Institute of Industrial Science, University of Tokyo): *A Problem of Infrared Divergence in Kubo formula in terms of Complex Spectral Representation of the Liouville Operator*

10.20 Yu Nakayama (Univ. of Tokyo): *The Nothing at the beginning of the universe made precise*

10.20 Sei Suzuki (Tokyo Institute of Technology): *Quantum annealing using transverse interactions and mean-field approximations*

10.23 Kunimasa Miyazaki (Kochi University of Technology): *Nonlinear Susceptibility of Glasses and Growing Length Scale*

10.25 Ting-Kuo Lee (Institute of Physics, Academia Sinica, Taipei, Taiwan): *Recent progress toward understanding of high temperature superconductivity by studying t-J type models*

10.26 Piet Hut (Institute for Advanced Study, Princeton and YITP): *The Future of N-body Simulations*

10.27 Giulio Bonelli (SISSA/YITP): *On Topological Membrane*

11.2 M. Zahid Hasan (Physics Department, Princeton University): *Correlated Electrons in NaxCoO2 : An ARPES Viewpoint*

11.2 Nan Lin Wang (Institute of Physics, Chinese Academy of Sciences): *Optical properties of NaxCoO2 single crystals*

11.6 I.B. Khriplovich (Budker Institute of Nuclear Physics, Novosibirsk, Russia): *Quantized Black Holes, Their Spectrum and Radiation*

11.8 Kouichi Hirotani (TIARA): *Pulsars: an excellent system for testing particle acceleration theories*

11.10 Urlichs Konrad (Erlangen Univ.): *Thermodynamics of simple four-fermion interaction theories*

11.13 Janez Bonca (J. Stefan Institute and Department of Physics, University of Ljubljana, Slovenia): *Correlation Effects in Conductance through Quantum Dots and Molecules*

11.15 Jun Goryo (Aoyama Gakuin University): *Adiabatic process and Chern number*

11.30 Robert L. Jaffe (Massachusetts Institute of Technology, US): *Ordinary and Extraordinary Hadrons*

12.4 Hayato Shiba (Univ. of Tokyo): *Anomalous heat transport in three-dimensional nonlinear lattice systems*

12.8 Hoang Ngoc Long (Academy of Science and Technology, Hanoi): *Phenomenology and neutrino masses in the economical 3-3-1 model*

12.14 Bruce Normand (): *High-dimensional* *fractionalisation and spinon deconfinement in pyrochlore antiferromagnets*

12.18 Akihiro Tanaka (National Institute for Materials Science): *Extending Haldane gap physics to higher dimensional spin systems:field theory approach*

12.19 Einan Gardi (Cambridge U.): *Dressed Gluon Exponentiation and Inclusive B decays*

12.19 David Langlois (APC, Paris & Paris, Inst. Astrophys.): *Non-linear perturbations in relativistic cosmology*

12.20 Yoshitsugu Ohno (University of Illinois): *"Town meeting" for Second Introduction to Statistical Mechanics (Part 1)*

12.21 Yoshitsugu Ohno (University of Illinois): *"Town meeting" for Second Introduction to Statistical Mechanics (Part 2)*

12.21 Piet Hut (Institute for Advanced Study, Princeton and YITP): *YITP Colloquium: Star Clusters: A Laboratory for Stellar Astrophysics*

12.22 Satoshi Tanaka (Osaka Prefecture Univ.): *Kinetic Theory of One-dimensional Polaron System: Emergence of hydrodynamics from a viewpoint of the complex spectral representation of Liouville operator*

12.25 Yuji Tachikawa (Institute for Advanced Study, Princeton): *Black Hole Entropy in the presence of Chern-Simons Terms*

12.26 Yoichiro Nambu (University of Chicago): *The Legacies of Yukawa and Tomonaga*

1.9 Ookouchi Yutaka (CalTech): *Meta-stable SUSY breaking vacua in Supersymmetric gauge theories*

1.11 Zhou Zhiyong (YITP, Southeast University): *On the lightest scalar nonet*

1.19 Masaaki Sakagami (Graduate School of Human and Enviromental Studies, Kyoto University): *A New Approach to the Out-of Equilibrium Dynamics in Self-gravitating N-body Systems*

1.19 Goro Ishiki (Osaka University): *Relations between theories with SU(2|4) symmetry and the Gauge/Gravity correspondence*

1.22 Seiji Terashima (YITP): *YITP Colloquium: Geometry of D-branes*

1.24 Frank Wilczek (MIT): *QCD Meets BCS*

1.29 Shinji Mukohyama (School of Science, the University of Tokyo): *Higgs Phase of Gravity*

1.30 Piero Ullio (SISSA): *Dark matter from late decays and the small-scale structure problems*

1.30 Viktor Czinner (YITP): *Linear perturbations of a dust filled universe with cosmological constant*

2.8 Amnon Aharony (Tel Aviv University, Ben Gurion University): *Mesoscopic physics, quantum dots and the Aharonov-Bohm interferometer*

2.8 Ora Entin-Wohlman (Tel Aviv University): *AC spin-Hall effect in insulators*

2.9 Hari Dass (HCAS, Hayama / IMS, Chennai): *Nature of QCD Strings*

2.13 Michio Otsuki (The University of Tokyo, Komaba Graduate School of Arts and Sciences): *Microscopic Theory for Non-linear Rheology of Glassy Materials*

2.15 Takami Tohyama (YITP): *YITP Colloquium: Physics of Doped-Mott Insulators*

2.16 Kentarou Mawatari (KIAS): *Spin Analysis of Supersymmetric Particles*

2.20 Dirk Manske (Max-Planck Institute for Solid State Physics, Stuttgart, Germany): *Elementary excitations in the high-Tc cuprates: kink, resonance peak, and anisotropy*

2.20 Istvan Racz (YITP, KFKI Research Institute for Particle and Nuclear Physics): *"Rumpled hairy" black holes*

2.20 David Blaschke (University of Wroclaw): *EoS for dense matter and modern compact star observations*

2.22 Kouhei Hasegawa (University of Alberta): *Coulomb force correction to the decay $b \to c\,\bar{c}\,s$ in the threshold*

2.23 Michihisa Takeuchi (KEK): *The study of $sq_L sq_L$ production at LHC in the $l^{\pm}l^{\pm}$ channel and sensitivity to other models*

2.26 Jonathan Shock (KITPC): *Hadrons from holography*

2.27 Dumitru Astefanesei (Harish-Chandra Research Institute): *Entropy of attractor horizons*

2.27 Kiwoon Choi (KAIST): *Moduli stabilization with QCD axion and the pattern of soft terms*

2.28 Yoichi Ikeda (Osaka University): *Study of the strange dibaryon using $\bar{K}NN \to \pi\Sigma N$*

coupled channel equation

3.6 Nanrong Zhao (Nagoya Institute of Technology, Sichuan Univ.): *Review on Relativistic Extended Thermodynamics of Gases*

3.8 Andrzej A. Zdziarski (N. Copernicus Astronomical Center): *4U 1820-303: a physical laboratory in the sky*

3.13 Yuichiro Kiyo (Univ. Karlsruhe): *Soft gluon corrections to nonrelativistic QCD bound states : Effective Field Theory and Renormalization*

3.14 Kazumitsu Sakai (The University of Tokyo Komaba, Graduate School of Arts and Sciences): *Anomalous Transport Properties for One-Dimensional Quantum Systems*

3.19 Hossein Malekzadeh (Frankfurt International Graduate School for Science): *Three-flavor color superconductivity*

3.22 Rohta Takahashi (Tokyo University): *Hypercritical accretion flow and neutrino shadow in gamma-ray burst*

3.23 Shin Sasaki (YITP): *Extended non(anti)-commutative superspaces from R-R background*

3.27 Takeshi Fukuyama (Ritsumeikan Univ.): *Solving problems of 4D minimal SO(10) model in a warped extra dimension*

2.5 Visitors (2006)

Atom-type Visitors

Keisuke Nakajima
(Utsunomiya University)
2006.7.24 – 2006.8.23
Condensed Matter

Wataru Horiuchi
(Niigata University)
2006.10.10 – 2006.11.9
Nuclear Physics

Kouichi Toda
(Toyama Prefectural University)
2007.2.15 – 2007.2.24 2007.3.8 – 2007.3.28
High Energy

YITP Visitor Program

Mikhail Shaposhnikov
(EPFL, Switzerland)
2006.5.25–2006.5.31

Shung-ichi Ando
(Sungkyunkwan U.)
2006.9.23–2006.9.27

Ting-Kuo Lee
(Academia Sinica, Taipei)
2006.10.24–2006.10.26

Janez Bonca
(U. of Ljubljana)
2006.11.12–2006.11.14

Einan Gardi
(Cambridge University)
2006.12.16–2006.12.20

Bruce Normand
2006.12.13–2006.12.15

Yutaka Ookouchi
(CalTech)
2007.1.9–2007.1.11

Piero Ullio
(SISSA)
2007.1.28–2007.2.4

Hari Dass
(IMS, Chennai)
2007.2.4–2007.2.10

Dumitru Astefanesei
(Harish-Chandra Research Institute)
2007.2.21–2007.2.28

Kiwoon Choi
(KAIST)
2007.2.23–2007.2.28

Andrzej A. Zdziarski
(N. Copernicus Astronomical Center)
2007.3.5–2007.3.10

21 COE Visitors

Shinsuke Shimojo
(California Institute of Technology)
2006.6.1–2006.6.3

Chul-Moon Yoo
(Osaka City University)
2006.6.1–2006.6.30

Robert H. Brandenberger
(McGill University)
2006.6.11–2006.6.23

Junichiro Makino
(NAOJ)
2006.6.26–2006.6.27

Ken Ebisawa
(ISAS/JAXA)
2006.7.13–2006.7.14

Masakiyo Kitazawa
(Brookhaven National Lab)
2006.8.29–2006.9.04

Tadakatsu Sakai
(Ibaraki University)
2006.9.4–2006.9.11

Shigeki Sugimoto
(Nagoya University)
2006.9.4–2006.9.16

Giulio Bonelli
(SISSA)
2006.10.21–2006.11.4

J. Richard Bond
(Canadian Inst. for Theoretical Astrophysics)
2006.11.21–2006.11.25

Valery A. Rubakov
(INR of the Russian Academy of Sciences)
2006.12.1–2006.12.9

Motoyuki Saijo
(Univ. of Southampton)
2006.12.4–2006.12.7

Paul Kienle
(Stefan Meyer Institute)
2006.12.14–2006.12.16

Toshimitsu Yamazaki
(University of Tokyo)
2006.12.14–2006.12.16

Motoyuki Saijo
(Univ. of Southampton)
2006.12.18–2006.12.28

Yasuhiro Sekino
(Okayama Institute for Quantum Physics)
2007.1.8–2007.1.11

Norichika Sago
(University of Southampton)
2007.1.8–2007.1.19

Jonathan Shock
(Chinese Academy of Sciences)
2007.1.22–2007.2.20

Tsuyoshi Hondou
(Tohoku University)
2007.2.5–2007.2.7

Kouichi Hirotani
(TIARA)
2007.2.10–2007.2.28

Kazunori Takenaga
(Tohoku University)
2007.2.20–2007.2.23

Short Visitors

Nemanja Kaloper
(University of California, Davis)
2006.3.25–2006.4.1

Sergey Odintsov
(IEEC)
2006.3.27–2006.4.23

Ken-ichi Konishi
(Universita di Pisa)
2006.4.10–2006.4.15

Dmitri Diakonov
(INP/Nordita)
2006.4.12–2006.4.12

Alan D. Martin
(Durham Univ.)
2006.4.17–2006.4.17

Edward Corrigan
(University of York)
2006.4.17–2006.4.24

Frits Wiegel
(University of Amsterdam)
2006.4.22–2006.4.30

Thomas Quella
(King's College London)
2006.4.24–2006.4.28

R. B. Laughlin
(KAIST)
2006.5.7–2006.5.9

Brajesh Choudhary
(Fermilab)
2006.5.11–2006.5.13

Bulent Yilmaz
(Ankara University)
2006.5.12–2006.5.13

Helmut Brand
(Universität Bayreuth)
2006.6.5–2006.6.11

Shinobu Kitayama
(University of Michigan)
2006.6.14–2006.6.14

Toshitaka Hidaka
(Research Institute for Humanity and Nature)
2006.6.14–2006.6.14

Akihiro Ishibashi
(University of Chicago)
2006.6.25–2006.7.2

Jorge Vinals
(McGill University)
2006.7.1–2006.7.31

Tetsuji Kimura
(KIAS)
2006.7.14–2006.7.14

M. Lakshmanan
(Bharathidasan University)
2006.7.26–2006.7.28

Kazumi Maki
(Univ. Southern California)
2006.8.17–2006.8.25

P. Thalmeier
(Max-Planck Institute)
2006.8.17–2006.8.26

Edward Corrigan
(University of York)
2006.8.22–2006.9.7

S Rai Choudhury
(Jamia Millia University)
2006.8.26–2006.9.11

Alexei B. Zamolodchikov
(Montpellier U.)
2006.9.7–2006.9.20

Holger Baumgardt
(University of Bonn, (RIKEN))
2006.9.12–2006.9.16

Tomio Petrosky
(University of Texas)
2006.10.20–2006.10.21

Nan Lin Wang
(Chinese Academy of Sciences)
2006.11.1–2006.11.3

M. Zahid Hasan
(Princeton University)
2006.11.1–2006.11.3

Iosif Khriplovich
(Budker Institute of Nuclear Physics)
2006.11.6–2006.11.6

Koichi Hirotani
(TIARA)
2006.11.8–2006.11.8

Harald Grosse
(Univ. of Vienna)
2006.11.9–2006.11.22

Laurent Freidel
(Perimeter Institute)
2006.11.7–2006.11.24

Choon-Lin Ho
(Tamkang University)
2006.11.13–2006.11.18

Kensuke Yoshida
(Universita di Roma, La Sapienza)
2006.12.3–2006.12.14

Hoang Ngoc Long
(Academy of Science and Technology, Hanoi)
2006.12.8–2006.12.8

Dragan Popovic
(Institute of Physics, Belgrade)
2006.12.10–2006.12.16

David Langlois
(Universite Paris 7)
2006.12.11–2006.12.21

Yoshitsugu Ohno
(University of Illinois)
2006.12.20–2006.12.21

Yuji Tachikawa
(Institute for Advanced Study)
2006.12.25–2006.12.26

Jinn-Ouk Gong
(KIAS)
2007.1.28–2007.2.4

Amnon Aharony
(Ben Gurion University)
2007.2.7–2007.2.11

Wohlman Ora Entin
(Ben Gurion University)
2007.2.7–2007.2.11

Kentaro Mawatari
(KIAS)
2007.2.16–2007.2.17

David Blaschke
(University of Wroclaw)
2007.2.18–2007.2.21

Dirk Manske
(Max-Planck-Institute)
2007.2.20–2007.2.21

Yuichiro Kiyo
(Univ. Karlsruhe)
2007.3.11–2007.3.14

Hossein Malek Zadeh
(Frankfurt International Graduate School for Science)
2007.3.14–2007.3.25

Kang Sin Choi
(University of Bonn)
2007.3.15–2007.3.25

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.

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. Year 2006 is the Hundred Year Anniversary of Hideki Yukawa and Sin-itiro Tomonaga's birthday. A Centennial Symposium was held.

Here is a list of main international workshops and conferences held in 2006.

Yukawa International Seminar (YKIS)

YKIS2006: New Frontiers in QCD–Exotic Hadrons and Hadronic Matter

20 Nov. – 8 Dec. 2006, Chaired by Teiji Kunihiro, 191 participants (69 from overseas)
For details see http://www2.yukawa.kyoto-u.ac.jp/˜ykis06/
Proceedings: *Prog. Theor. Phys. Suppl.* No.168 (2007).
For details, see http://ptp.ipap.jp/journal/PTPS-168.html

Nishinomiya Yukawa Symposium

Noncommutative geometry and space-time in physics

11 – 15 Nov. 2006, Chaired by Naoki Sasakura, 85 participants (32 from overseas)
For details, see http://www2.yukawa.kyoto-u.ac.jp/˜nys2006/
Proceedings: *Prog. Theor. Phys. Suppl.* No.171 (2008).
For details, see http://ptp.ipap.jp/journal/PTPS-171.html

Yukawa-Tomonaga Centennial Symposium

Yukawa-Tomonaga Centennial Symposium — Progress in Modern Physics —

11–13 December, 2006, Chaired by Taichiro Kugo, 174 participants (23 from overseas)

A commemorative symposium to celebrate the births of Hideki Yukawa and Sin-itiro Tomonaga and to honor their great achievements. It was held, on this centennial occasion, to review the developments in modern physics pioneered by them, discuss the present status of various areas in physics, and provide a future perspective on fundamental physics in the 21st century.

For details, see http://www2.yukawa.kyoto-u.ac.jp/˜yt100sym/
Proceedings: *Prog. Theor. Phys. Suppl.* No.170 (2008).
For details, see http://ptp.ipap.jp/journal/PTPS-170.html

3.2 YITP Workshops and Public Lectures

YITP workshops are one of our 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.
YITP organizes several Public Lectures every year for general audience and non-specialists including high-school students.

▷ 2006.4.1 — 2007.3.31

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-06-01
4th Meeting on Society of Nano Science and Technology, May 19 - May 21, 2006. Makoto YAO, *417-participants,*
http://www.yukawa.kyoto-u.ac.jp/contents/seminar/archive/2006/yitp-w-06-01/ nano2006/index.html

YITP-W-06-02
Environmental Physics: Toward Developing The Interdisciplinary Frontiers, Jun. 12 - Jun. 16, 2006. Tsuyoshi Hondo, Satoru Ikeuchi, Shin Takagi, Yasuo Nakaoka, Kosaku Yamada, Kensuke Ikeda, Shigenori Tanaka, Masatoshi Murase, Kuniyoshi Ebina, *92-participants,* Bussei Kenkyuu 88-4
http://www.yukawa.kyoto-u.ac.jp/contents/seminar/archive/2006/yitp-w-06-02/epws06/index.html

YITP-W-06-03
XIII International Conference on Small-angle Scattering /Satellite meeting of SAS2006, Jul. 9 - Jul. 15, 2006. Seto, H., Kanaya, T., Onuki, A., Ohta, T., Yao, M., Kitahata, H., Kawabata, Y., Tasaki, S., *503-participants,*
http://www.yukawa.kyoto-u.ac.jp/contents/seminar/archive/2006/yitp-w-06-03/

YITP-W-06-04
Structures and Dynamics in Soft Matter - Beyond Self-Organization and Hierarchical Structures -, Jul. 14 - Jul. 16, 2006. M. Imai, T. Araki, T. Kawakatu, J. Fukuda, H. Seto, A. Toda, J. Yamamoto, T. Ohta, H. Morita, Y. Kimura, *165-participants,* Bussei Kenkyuu 87-1

YITP-W-06-05
Quantum Fluids and Solids (QFS2006), Aug. 1 - Aug. 6, 2006. Takao Mizusaki, Akira Matsubara, *255-participants,*
http://qfs.ltm.kyoto-u.ac.jp/qfs2006/cgi-bin/top.cgi?html=hom

YITP-W-06-06
Progress in Particle Physics 2006, Jul. 31 - Aug. 3, 2006. Ken-iti Izawa, Kenichi Ishikawa, Yusuke Taniguchi, Satoru Kaneko, Takeshi Nihei, Nobuhiro Maekawa, Youichi Yamada, Hiroaki Nakano, Koichi Yoshioka, Isamu Watanabe, Kenzou Ogure, Yoshichika Okada, *110-participants,* Soryuushiron Kenkyuu 114-4
http://www.yukawa.kyoto-u.ac.jp/contents/seminar/archive/2006/yitp-w-06-06/ppp06/index.html

YITP-W-06-07
Thermal Quantum Field Theories and Their Applications, Aug. 23 - Aug. 25, 2006. Hiroyuki Yabu, Masahiko Okumura, Tomohiro Inagaki, Hideki Matsumoto, Yoshiya Yamanaka, Shin Muroya, Akira Niegawa, Yasuhiko Tsue, Shinji Ejiri, Hirohumi Sawayanagi, Hisao Nakagawa, Masa-aki Sakagami, Motoi Tachibana, Masayuki Asakawa, *63-participants,* Soryuushiron Kenkyuu 114-3
http://www.yukawa.kyoto-u.ac.jp/contents/seminar/archive/2006/yitp-w-06-07/TQFT/html2006/TQFT2006.html

YITP-W-06-08
Summer School on Astronomy and Astrophysics 2006, Jul. 31 - Aug. 4, 2006. E. Mitsuda, *364-participants,*

YITP-W-06-09
The 51th Summer Seminar for young researchers of condensed-matter physics, Aug. 1 - Aug. 5, 2006. Masayoshi Shimomoto, *197-participants,* Bussei Kenkyuu 87-5

YITP-W-06-10
YONUPA Summer School 2006, Aug. 5 - Aug. 10, 2006. Mitsuru Kanada, Takashi Kuwabara, Kouhei Washiyama, Ayumi Yasuoka, Futoshi Minato, Hiroshi Yamada, Natsuki Asano, Kentaro Kojima, Atsushi Watanabe, Shun Asaji, Tomoaki Egami, Keijiro Takahashi, Yasutaka Taniguchi, Daisuke Kitagawa, Kazuki Sakamoto, Akina Kato, Takahiro Fujihara,Kazunori Tanaka, Norio Horigome, Hiroaki Kanzawa, Keisuke Kimura, Kazumi Tsuda, Shinsaku Nakayama, Takeshi Araki, Ken Matsushima, *281-participants,*
http://www.yukawa.kyoto-u.ac.jp/contents/seminar/archive/2006/yitp-w-06-10/

YITP-W-06-11
String Theory and Quantum Field Theory, Sep. 12 - Sep. 16, 2006. Hiroshi Kunitomo, Tomohiko Takahashi, Nobuyoshi Ohta, Yuji Sato, Koji Hashimoto, Mitsuhiro Kato, Masashi Hamanaka, Shigeki Sugimoto, Yosuke Imamura, Makoto Sakamoto, *114-participants,* Soryuushiron Kenkyuu 114-6
http://www2.yukawa.kyoto-u.ac.jp/˜qft/

YITP-W-06-12
The 17th International SPIN Physics Symposium, Oct. 2 - Oct. 7, 2006. K. Imai, *308-participants,*
http://www.yukawa.kyoto-u.ac.jp/contents/seminar/archive/2006/yitp-w-06-12/SPIN2006/index.html

YITP-W-06-13
The Extreme Universe Probed with Thermal and Non-Thermal Radiations - The First Suzaku Conference in the millenium of SN1006, Dec. 4 - Dec. 8, 2006. K. Koyama, *386-participants,*
http://www.yukawa.kyoto-u.ac.jp/contents/seminar/archive/2006/yitp-w-06-13/conference/suzaku2006/index.html

YITP-W-06-14
Yukawa-Tomonaga Centennial Symposium-Progress in Modern Physics -, Dec. 11 - Dec.13, 2006. Hiroyuki Hata, Ryusuke Ikeda, Taichiro Kugo, Misao Sasaki, Noboru Sasao, Yoshiko Kanda-Enyo, *174-participants,*
http://www2.yukawa.kyoto-u.ac.jp/˜yt100sym/

YITP-W-06-15
Present and Future for the Fundamental Physics : After 'Trends of Fundamental Physics' in 2005 and Yukawa-Tomonaga, Nov. 16 - Nov. 18, 2006. Tohru Eguchi, Ken-Ichi Aoki, Hisao Hayakawa, Mihoko Toya, Misao Sasaki, Yoshiki Kuramoto, Taichi Kugo, Rika Endo, Masako Bando, *81-participants,*
http://www2.yukawa.kyoto-u.ac.jp/˜endo/keifu2006/index.html

YITP-W-06-16
Fundamental Problems and Applications of Quantum Field Theory -Topological Aspects of Quantum Field Theory , Dec. 14 - Dec. 16, 2006. Kazuo Fujikawa, Muneto Nitta, Hiroyuki Yabu, Norisuke Sakai, Ryu Sasaki, Kei-ichi Kondo, Tadakatsu Sakai, Kenichi Shizuya, Shougo Tanimura,Jun Goryou, *135-participants,* Soryuushiron Kenkyuu 115-1 &115-2
http://www.yukawa.kyoto-u.ac.jp/contents/seminar/archive/2006/yitp-w-06-16/˜w3-matsu/jungoryo/qft7/index.html

YITP-W-06-17
YITP Meeting of Nuclear Cluster Physics, Dec. 18 - Dec. 23, 2006. Masaaki Takashina, Naoyuki Itagaki, Makoto Ito, Yoshiko Enyo, Masaaki Kimura, Chie Kurokawa, Satoru Sugimoto, Yasutaka Taniguchi, *38-participants,* Soryuushiron Kenkyuu 115-4

YITP-W-06-18
Present Status and Perspective in Granular Physics, Dec. 25 - Dec. 27, 2006. Atsuko Shimosaka, Hisao Hayakawa, Ryoichi Yamamoto, Takahiro Hatano, Sin-iti SIRONO, Hikaru Kawamura, Satoshi Yukawa, Toshihiko Umekage, Toshitsugu Tanaka, *67-participants,* Bussei Kenkyuu 88-2
http://www.yukawa.kyoto-u.ac.jp/contents/seminar/archive/2006/yitp-w-06-18/hatano/workshop.htm

YITP-W-06-19
New Frontiers in Gamma-Ray Bursts, Jan. 16 - Jan. 18, 2007. Toru Tamagawa, Tadayuki Takahashi, Toshio Murakami, Daisuke Yonetoku, Ryo Yamazaki, Tomonori Totani, Makoto Tashiro, Nobuyuki Kawai, Takashi Nakamura, Kunihito Ioka, *77-participants,* Soryuushiron Kenkyuu 115-1
http://www.yukawa.kyoto-u.ac.jp/contents/seminar/archive/2006/yitp-w-06-19/ ˜ioka/workshop/grb/grb_kiken.html

YITP-W-06-20
Black Hole Astronomy in the Suzaku Era, Feb. 13 - Feb. 15, 2007. K. Hayasaki, K. Sato, K. Makishima, J. Makino, H. Sudou, S. Nagataki, S. Mineshige, F. Takahara, *124-participants,* Soryuushiron Kenkyuu 115-3
http://www2.yukawa.kyoto-u.ac.jp/˜bh2007/index.htm

YITP-W-06-21
Effective Interaction Theories and Nuclear Physics, Fef. 5 - Feb. 7, 2007. Ryoji Okamoto, Yasuyuki Suzuki, Shinichiro Fujii, Kouichi Hagino, Michio Kohno, Yoshikazu Fujiwara, *33-participants,* Soryuushiron Kenkyuu 115-2

Public Lectures

In the academic year 2006, a series of public lectures were delivered as a part of the program commemorating the Centennial of Hideki Yukawa and Shin-ichiro Tomobaga's birthdays.

YITP-P-06-01
8 May 2006,
Title: A Different Universe
R. B. Laughlin. President of KAIST, Nobel Laureate Physics 1998

YITP-P-06-02
2 June 2006,
Title: Time, Consciousness, and Free Will in Psychophysics
Nobusuke Shimojo, CalTech

YITP-P-06-03, Part 1
14 June 2006 Morning,
Title: Subjective and Illusion
Tositaka Hidaka, Director, Research Institute for Humanity and Nature

YITP-P-06-03, Part 2
14 June 2006 Afternoon,
Title: Culture and Self: A Psychological Approach
Shinobu Kitayama, University of Michigan

3.3 Regional Schools supported by YITP

▷ 2006.4.1—2007.3.31

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-06-01
Hokuriku-Shin-etsu Particle Physics Theory Group Meeting, May 26 - May 28, 2006, Kokuritsu Myoko Shonen Shizen no Ie.
Koji Hashimoto (U. of Tokyo)
Kanaza Univ., Fukui Univ., Toyama Univ., Niigata Univ.

YITP-S-06-02
Niigata-Yamagata School, Nov. 10 - Nov. 12, 2006, Iinoh Shonen Shizen no Ie.
Kei-Ichi KONDO (Chiba University)
Niigata Univ., Yamagata Univ., Ohu Univ., Iwate Univ., Akita Keizaihoka Univ. and Joetsu Univ. of Education.

YITP-S-06-03
Chubu Summer School, Aug. 24 - Aug. 27, 2006, Yamanakako Seminar House (Tokai Univ.).
M. Fukuma (Kyoto University)
Shizuoka Univ., Shinshu Univ., Tokai Univ., Nagoya Univ.

YITP-S-06-04
The 29th Shikoku-Seminar, Dec. 26 - Dec. 27, 2006, University of Tokushima.
Junpei Shirai (Tohoku University)
Tokushima Univ., Takamatsu National College of Technology, Kochi Univ., Kochi Women's Univ.

YITP-S-06-05
Shinshu Winter School, Mar. 1 - Mar. 4, 2006, Shiga Heights Villa, (Ochanomizu University).
Ken-ichi Hikasa (Tohoku University)
Kanazawa Univ., Shinshu Univ., Niigata Univ., Kinjo Coll.