YITP Annual Report

Yukawa Institute For Theoretical Physics Kyoto University

2004

Foreword

We here present the annual report of the Yukawa Institute for Theoretical Physics (YITP) to make a report on our activities for the academic year 2004.

In the year 2004, all national universities became independent administrative corporations, and even the cooperative research institutes at the inter-university level formally turned to be defined only in the individual universities to which they belong. So our YITP also turned into just an institute inside Kyoto University Corporation. Despite such a change of the formal status, our YITP declares to continue to be an inter-university cooperative research institute open to all the physicists.

This is because our successful history of the system. YITP was founded in 1953, in commemoration of Prof. Yukawa's winning of the first Nobel Prize in Japan, as the first inter-university cooperative research institute, that is, a new type of national research center with its facilities open for use for research collaborations by the entire community of theoretical physicists in Japan. Moreover, YITP adopted a new system for its operation: although it formally belongs to Kyoto University, its basic policy has been discussed and decided by the representatives of physicists elected from all over the country together with institute's own academic staffs. One of the unique roles played by the institute was to provide a forum for physicists on various problems at the forefront of research in theoretical physics. Many physicists participated in the organization of topical workshops and international conferences at YITP and stayed at the institute for some periods to work in collaboration with others. With this spirit and system, YITP has been successfully playing important roles in creating various novel and interdisciplinary fields in fundamental physics. Thus the spirit of the inter-university cooperative research has really taken root in YITP and now constitutes its identity.

We are now trying to make the present research cooperation based at YITP mainly nationwide lifted to that of more international level. For instance, we have changed Yukawa International Seminar to hold every year from every two years. The YKIS 2004 "Physics of Strongly Correlated Electron Systems" was held as a staying-type workshop for three weeks. We are now applying for the fund to hold a few multi-month programs every year on timely and interdisciplinary themes in theoretical physics, selected from proposals from throughout the world. The application has not yet been approved, unfortunately, but we hope to realize this plan by the continual support from the world-wide community.

In the previous year 2003, we innovated our WWW homepage and started the publication of annual reports in English, in order to get people in the world more acquainted with the members and activities of our institute. Thus, this is the second English annual report of our institute. This report contains information concerning institute members including graduate students, visitors, research contents, publications, workshops, schools and conferences of the academic year 2004. We have also included some brief highlight reports by individual members on their recent research achievements. Thus, the contents of the annual report are limited to the research activities in this institute and the supporting activities of domestic as well as international collaborative researches, in general in 2004. Materials that are not specific to each year, such as the history, organization, services and facilities of our institute, can be found in the WWW homepage, http://www.yukawa.kyoto-u.ac.jp/, which includes the html version of this report as well. We hope this report will help physicists in the world know our institute much better and make it easier to access our research services.

Director
Taichiro Kugo

Contents

Chapter 1

People

1.1 Regular Staff and Guest Professors (2004 April – 2005 March)

Regular Staff

Taichiro Kugo
Professor (E)

Masao Ninomiya
Professor (E)

Kenichi Shizuya
Professor (E)

Hideo Kodama
Professor (A)

Teiji Kunihiro
Professor (N)

Shin Mineshige
Professor (A)

Hirokazu Tsunetsugu
Professor (C)

Misao Sasaki
Professor (A)

Takao Ohta
Professor (C)

Ryu Sasaki
Associate Professor (E)

Masatoshi Murase
Associate Professor (C)

Hiroshi Kunitomo
Associate Professor (E)

Mihoko Nojiri
Associate Professor (E)

Naoki Sasakura
Associate Professor (E)

Tetsuya Onogi
Associate Professor (E)

Keisuke Totsuka
Associate Professor (C)

Shigehiro Nagataki
Associate Professor (A)

Takao Morinari
Research Associate (C)

Shigeki Sugimoto
Research Associate (E)

Rika Endo
Research Associate (Project Manager) [2004.4.1 –]

Kouichi Hagino
Research Associate (N) [– 2004.4.30]

Yasuhisa Abe
Associate Professor (N) [– 2005.3.31]

Kunihiko Terasaki
Research Associate (E) [– 2005.3.31]

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. Serguey Todorov Petkov
(SISSA)
2004.2.1 — 2004.4.30
Phenomena Related to Neutrino Mass

Prof. Luc Christian Blanchet
(Institut d'Astrophysique de Paris)
2004.5.26 — 2004.8.25
Gravitational Wave Physics

Prof. Thomas Maurice Rice
(ETH, Zurich)
2004.10.8 — 2004.12.21
Theoretical Study of Novel Quantum Phases in Strongly Correlated Electron Systems

Prof. Bernardus Quirinus Petrus Josep de Wit
(ITP, Utrecht University)
2005.1.1 — 2005.3.31
$N = 2$ *Supersymmetric Effective Action and Black Hole*

1.2 Research Fellows and Students (2004 April – 2005 March)

Research Fellows

JSPS Research Fellows (domestic)

Sachiko Ogushi
JSPS fellow (E) [2002.4.1 – 2005.3.31]

Kazuki Hasebe
JSPS fellow (E) [2003.4.1 –]

Takashi Umeda
JSPS fellow (N) [2003.4.1 –]

Hiroshige Kajiura
JSPS fellow (E) [2003.4.1 –]

Toru Takahashi
JSPS fellow (N) [2004.4.1 –]

Shinsuke Kawai
JSPS fellow (E) [2004.4.1 –]

Akira Mizuta
JSPS fellow (A) [2004.4.1 – 2005.3.31]

Ayumu Sugita
JSPS fellow (N) [2003.4.1 – 2004.9.30]

Makoto Uemura
JSPS fellow (A) [2004.4.1 –]

JSPS Research Fellows (from abroad)

Wen-Li Yang
JSPS fellow (E) [2002.11.11 – 2004.5.10]

Sebastian Gurrieri
JSPS fellow (E) [2003.7.2 –]

Oriol Pujolas
JSPS fellow (A) [2003.10.15 –]

Marco Rossi
JSPS fellow (E) [2003.11.4 – 2004.10.3]

Marco Rossi
JSPS fellow (E) [2005.1.5 –]

Antonino Flachi
JSPS fellow (A) [2004.8.3 –]

Cristina Zambon
JSPS fellow (E) [2004.10.4 –]

Alan Cornell
JSPS fellow (A) [2004.11.22 –]

21COE Research Fellows

Noriyuki Nakai
COE21 fellow (C) [2003.10.1 –]

Toru Goto
COE21 fellow (E) [2003.10.1 –]

Hiroaki Abuki
COE21 fellow (N) [2004.4.1 –]

Naylor Wade
COE21 fellow (A) [2004.7.16 – 2005.3.31]

Yoshiyuki Morisawa
COE21 fellow (A) [2004.8.1 – 2005.3.31]

YITP Research Fellows

Naoto Yokoi
YITP fellow (E) [2004.4.1 – 2004.10.15]

Kunihito Uzawa
YITP fellow (A) [2004.4.1 –]

Hiroto Shoji
YITP fellow (C) [2004.10.16 – 2005.3.31]

Kazuaki Ohnishi
YITP fellow (N) [2004.12.1 – 2005.3.31]

Shoji Zeze
YITP fellow (E) [2004.12.16 – 2005.3.31]

Kyoto University Research Fellow

Yoshiyuki Morisawa
KU research fellow (A) [2004.4.1 – 2004.7.31]

Part-time Lecturers

Hiroto Shoji
KU part-time lecturer (C) [2004.5.1 – 2004.10.15]

Kazuaki Ohnishi
KU part-time lecturer (N) [2004.4.1 – 2004.11.30]

Naoko Ikezi
KU part-time lecturer (N) [2004.4.1 – 2004.10.31]

Eiji Nakano
KU part-time lecturer (N) [2004.10.16 – 2005.2.22]

Shigehiro Yasui
KU part-time lecturer (N) [2005.1.1 – 2005.3.31]

Tetsuya Shiromizu
KU part-time lecturer (A) [2005.2.1 – 2005.3.31]

Yosuke Imamura
KU part-time lecturer (E) [2005.2.1 – 2005.3.31]

SRF Research Fellows

Eliani Ardi
Research Assistant (A) [2003.4.1 –]

Yoshiaki Kato
Research Assistant (A) [2003.4.1 – 2005.3.31]

Matsuo Sato
Research Assistant (E) [2004.4.1 – 2004.8.31]

Shinpei Kobayashi
Research Assistant (E) [2004.4.1 – 2004.4.15]

Koichi Murakami
Research Assistant (E) [2004.10.1 – 2005.3.31]

Graduate Students

Yoshiharu Tanaka (A) [2004.4.1 –]

Ken Nagata (A) [2004.4.1 –]

Kazuya Mitsutani (N) [2004.4.1 –]

Michihisa Takeuchi (E) [2004.4.1 –]

Yuya Sasai (E) [2004.4.1 –]

Tatsuya Tokunaga (E) [2003.4.1 –]

Norita Kawanaka (A) [2003.4.1 –]

Youhei Ota (E) [2003.4.1 –]

Hiromitsu Kaneko (A) [2002.4.1 – 2005.3.31]

Hidekazu Tokuda (C) [2004.4.1 –]

Tomohisa Takimi (E) [2002.4.1 –]

Wataru Hikida (A) [2001.4.1 –]

Hidenori Fukaya (E) [2001.4.1 –]

Kazuyoshi Takahashi (E) [2001.4.1 –]

Takashi Hosokawa (A) [2002.4.1 – 2005.3.31]

Rohta Takahashi (A) [2002.4.1 – 2005.3.31]

Masakiyo Kitazawa (N) [2000.4.1 – 2005.3.31]

Kohtaro Yamada (C) [2004.4.1 –]
(from Hiroshima Univ.)

Masayuki Ataka (C) [2004.4.1 –]
(from Hiroshima Univ.)

Masafumi Kaga (C) [2004.4.1 –]
(from Hiroshima Univ.)

Masato Minamitsuji (A) [2003.4.1 –]
(from Osaka Univ.)

Noriyuki Kogo (A) [2004.4.1 –]
(from Osaka Univ.)

Kiki Vierdayanti (A) [2003.10.1 – 2005.3.31]
(Visiting student from Indonesia)

Ewa Czuchry (A) [2003.10.1 – 2005.3.31]
(Visiting student from Poland)

Axel Grzesik (C) [2003.10.6 – 2004.9.30]
(Visiting student from Germany)

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Chapter 2

Research Activities

2.1 Research Summary

Astrophysics and Cosmology Group

The final goal of this 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.

Now, we give the summary of major research activities and achievements by this group in 2004.

Black-hole Astrophysics

Magnetohydrodynamical Accretion Flows and Jet: We continued our three-dimensional (3D) magnetohydrodynamical (MHD) simulations of radiatively inefficient flow, finding that magnetic-tower jets can emerge under quite general conditions and that jet energy is nearly equally carried by Poyinting flux and kinetic energy flux. (Y. Kato, S. Mineshige) We also calculate Fe line emission line profiles based on a simple disk-corona model, which postulates that magnetic reconnection provides coronal heating, finding a good agreement with the theory and the X-ray observations. (N. Kawanaka, S. Mineshige)

Near- and Super-critical accretion flows and Outflows: We have studied the quasi-steady structure of supercritical accretion flows around a black hole is studied based on the two-dimensional radiation-hydrodynamical (2D-RHD) simulations. We find that the emission is highly anisotropic and moderately collimated so that the apparent luminosity can exceed the Eddington luminosity by a factor of a few in the face-on view. Further, the mass-accretion rate increases with increase of the absorption opacity (metalicity) of the accreting matter, implying that the black hole tends to grow up faster in the metal rich regions as in starburst galaxies or star-forming regions. (K. Ohsuga, S. Mineshige)

Microlensing and Black Hole Shadows: In order to determine the nature of baryonic dark matter, we have investigated light trajectories and light curves of astrometric microlensing phenomena caused by finite-size lenses. Also, We have investigated how contours of black hole shadows depend on physical parameters of black holes (e.g. mass, spin, electric charge, inclination angle). (R. Takahashi)

Relativistic Jet Propagation and Dynamics in Massive Progenitor of GRBs: We investigate the propagation of the outflow in the progenitor in the context of the collapsar model using two dimensional relativistic hydrodynamic simulations. We discuss which type of outflows can break out the progenitor keeping collimated structure for gamma-ray bursts. (A. Mizuta)

Intermediate Mass Black Hole (IMBH) Formation in the Dense Star Clusters: We develop the Nbody4 code which allow us to produce and follow the runaway stellar merging within star clusters. As a preliminary result, we found that a dense star cluster with a high central density potential indeed shows that in the inner core the massive stars undergo a runaway stellar merging and a very massive star form with mass exceeding 800 solar mass which finally collapse into a IMBH within 3 Myr. (A. Eliani, S. Mineshige)

Supernovae

Magneto-driven shock wave in core-collapse supernovae: We have performed a series of two-dimensional magnetohydrodynamic simulations of the rotational core collapse of a magnetized massive star with a realistic equation of state and effects of the neutrino cooling. It was shown that the toroidal magnetic fields are amplified by the differential rotation enough to generate a tightly collimated shock wave along the rotational axis, which may be the central engine of the gamma-ray bursts. (Takiwaki, T., Kotake, K., Nagataki, S., Sato, K.)

Anisotropic kinetic pressure in ideal MHD and application to entropy production in neutrino-driven wind in supernovae: We study the stress tensor of electron in strong magnetic fields which are greater than the critical value Bc =4.4 × 1013 G. We claim that such a strong magnetic field induces the anisotropic kinetic pressure term of electron in magnetohydrodynamic equations and can generate entropy in collisional quantum plasmas. This mechanism might successfully account for the production of the heavy nuclei with mass numbers A=80-250 through the r-process nucleosynthesis. (Kohri, K., Yamada, S., Nagataki, S.)

High-Energy Cosmic Rays

Statistical Significance of Small-Scale Anisotropy in Arrival Directions of Ultra-High-Energy Cosmic Rays: HiRes experiment indicated that there is no small-scale anisotropy in the arrival distribution of ultra-high-energy cosmic rays above E¿1019 eV, contrary to AGASA observation. We discussed the statistical significance of this discrepancy using Monte Calro method. We concluded that the indication by HiRes is not statistically significant at present. (Yoshiguchi, H., Nagataki, S., Sato, K.)

Sub-GeV galactic cosmic-ray antiprotons from primordial black holes in the Randall-Sundrum braneworld: We investigated cosmic-ray antiprotons emitted from the galactic primordial black holes (PBHs) in the Randall-Sundrum type-2 braneworld. We showed that the magnitude of antiproton flux from PBHs in the Randall-Sundrum braneworld is proportional to negative power of the anti-de Sitter radius, which means that a large extra dimension can relax upper limits on the abundance of the galactic PBHs. We also showed that we will detect signatures of the braneworld as a difference between the flux of the antiprotons predicted in 4D and 5D by future observations in sub-GeV region with a few percent precision. (Sendouda, Y., Kohri, K., Nagataki, S., Sato, K.)

Particle Cosmology

Affleck-Dine Baryogenesis and Heavy Element Production from Inhomogeneous Big Bang Nucleosynthesis: We studied influence of the formation of high density baryonic bubbles, which is predicted by the Affleck-Dine model of baryogenesis, on the big bang nucleosynthesis with a nuclear reaction network containing 242 nuclei elements. We found even iron elements can be generated in such a baryonic bubbles in the stage of big bang nucleosynthesis, which may be confirmed by future observations of metal poor stars. (Matsuura, S., Dolgov, A.D., Nagataki, S., Sato, K.)

Higher-Dimensional Cosmology

Role of Kaluza-Klein modes in the brane cosmology: We have investigated the role of Kaluza-Klein(KK) modes in the 2nd Randall-Sundrum (RSII) brane cosmology. In the model including the Gauss-Bonnet term into the 5-dimensional action, we have shown that on an inflating brane the linearized gravity is 4-dimensional also in high energy regime due to the KK modes. In the Einstein theory, we have also shown the backreaction of KK gravitons behave as negative energy cosmic dust. (Masato Minamitsuji and Misao Sasaki)

Quantum effects in the bulk inflation model: We studied the vacuum expectation value of the stress tensor for light scalar fields in the bulk inflaton model. We found that for a natural choice of the model's parameters, the backreaction from the quantum effects is not large. On the other hand, a simple extension of the Allen Follaci prescription to the BW with one brane does not provide a regular vacuum. Rather, it seems necessary to modify the vacua of the KK modes as well. (Oriol Pujolas)

Quantum effects in brane world models: We investigated the role of quantum effects in brane world to cosmology. The calculation gives a new derivation of the zeta function and of the effective potential for quantum fields in anti-de Sitter background bounded by a de Sitter section. Interestingly, many of the techniques developed can be applied to calculations in other areas. For example, we recently looked at how to generalise the partition function for a charged scalar field with a non-constant background. This will allow us to determine how a BEC is affected by the presence of any boundaries or other kinds of varying field configurations. This may be important in the context of cosmology (and Bubble Nucleation) for any case where a charged scalar field occurs. (Antonio Flachi, Wade Naylor and Misao Sasaki)

Moduli instability in the type IIB supergravity: We have found the time dependent Klebanov & Strassler solution in ten-dimensional type IIB supergravity, and studied the dynamics of moduli and supersymmetry breaking. We have shown that supersymmetry breaking is closely related to the moduli instability in the time dependent warped background. (Hideo Kodama and Kunihito Uzawa)

Gravitational Collapse

Cylindrical collapse: We studied the gravitational collapse of cylindrically distributed perfect fluid. We assumed the collapsing speed of fluid is very large and investigated such a situation by recently proposed high-speed approximation scheme. We showed that if the value of the pressure divided by the energy density is bounded below by some positive value, the high-speed collapse is necessarily halted. (Yoshiyuki Morisawa)

Higher-Dimensional Black Holes

Perturbations of Rotating Black Holes: We have studied the scalar field perturbations on six-dimensional ultra-spinning black holes. We have numerically calculated the quasinormal modes of rotating black holes. Our results suggest that such perturbations are stable. We have also computed the mass and angular momenta of Kerr anti-de Sitter spacetimes in Einstein-Gauss-Bonnet theory of gravity using KBL(Katz, Bicak, Lynden Bell) superpotential. (Yoshiyuki Morisawa)

We have also studied perturbations of the special Myers-Perry solution representing a black hole rotating in some two-dimensional plane with the help of the gauge-invariant formalism and have shown that such a black hole is stable against tensor perturbations.(Hideo Kodama)

Perturbations of Black Branes: We have developed a gauge-invariant formulation for perturbations of black branes and have shown that black branes are stable against tensor and vector perturbations, provided that there exists no normalizable mode with imaginary ω^2 for vector perturbations. We have also shown that the perturbation equations for the S-modes of scalar perturbations can be reduced to a Schrödinger-type eigen-value equation that has a much simpler structure than the one used by Gregory and Laflame. (Hideo Kodama)

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 (μK $\sim 10^3$K) 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 frustrated magnets, low-dimensional quantum spin systems, vortices in type-II superconductors and high-temperature superconductivity.

Anomalous low-temperature thermodynamics in frustrated magnets at high-fields: When magnetic field is applied to geometrically frustrated magnets to measure their magnetization process, many of them show one or several plateaus in the magnetization curve. The plateau phase is ascribed to solid of some elementary excitations carrying magnetization. Identification of the solidification and melting of these excitations is one of the central issues of the topic of frustrated magnets. We have succeeded in the asymptotically exact calculation of thermodynamic functions for the Kagomé antiferromagnet near saturation field. This is achieved by a mapping of its low-energy dynamics of magnon excitations to a hard-hexagon model on a triangular lattice. This hard-hexagon model is exactly solvable, and allows the quantitative description of the magnetothermodynamics of the Kagomé Heisenberg antiferromagnet up to exponentially small corrections. It also predicts the transition into a magnon crystal, and the critical behavior is identified as the universality class of three-state Potts model. With the same approach, the Heisenberg model on the sawtooth chain is mapped to a chain of hard dimers, and its thermodynamic functions are also calculated asymptotically exactly. (H. Tsunetsugu and M. E. Zhitomirsky)

Orbital and magnetic transitions in vanadium spinels: We have continued investigations on the two successive transitions in AV_2O_4 (A=Zn, Mg, Cd). We proposed that the high-temperature structure transition is orbital ordering and that the low-temperature antiferromagnetic order is stabilized by the modulation of exchange couplings driven by the orbital order. To check these scenario more closely, we have numerically investigated the effective low-energy Hamiltonian with Kugel-Khomskii type couplings of spin and orbital degrees of freedom. In the intermediate phase between the two transition temperatures, spin-spin correlations are short ranged and expected to show strong one-dimensionality. This is because the expected orbital order effectively reduces the dimensionality of exchange paths. Our Monte Carlo calculations demonstrated very large enhancement of spin fluctuations which show nearly critical behavior along chain direction but much faster decay in other directions. This result confirms the prediction of our scenario of successive transitions of orbital and spin orders. We have also studied detailed spin order pattern at low temperatures. One issue is the collinearity of order pattern. We have directly calculated collinearity parameters in the Monte Carlo calculations and identified that the antiferromagnetic phase has a collinear order. This is also consistent with the experimental result. (H. Tsunetsugu and Y. Motome)

A unifying approach to frustrated spin systems: Competition among several different orders sometimes leads to novel types of physics and rich phase diagrams. It is one of the most intriguing problems in condensed-matter physics to understand the nature of quantum phase transitions between the competing orders and then to map out the (global) phase diagram. While several approaches have been proposed in systems of itinerant electrons to better understand the problems of competing orders (e.g. antiferromagnetism and d-wave superconductivity in cuprates), similar approaches are rare in the field of localized magnetism.

In recent years, several unconventional phases have been found and discussed in low-dimensional quantum spin systems. In particular, possible new phases stabilized by multi-spin interactions, which are allowed by the Fermi statistics and Coulomb interactions among electrons, would be of great interest. As a first step toward a systematic study of these unconventional phases, we have picked up a kind of valence-bond phases and a more exotic (non-coplanar) phase with P and T broken, the latter of which has been sought for in conjunction with the statistics transmutation. The model that we have considered is a two-leg (i.e. two chains connected by rung bonds) spin ladder model. We have added 4-spin interactions which are sources of magnetic frustration and are believed to stabilize novel quantum phases.

We have first noted the fact that the maximal symmetry defined on a ladder geometry is SU(4), under which (anti)ferromagnetism, p-nematic, and n-nematic may be unified. Then, a low-energy effective field theory (the SO(6) Gross-Neveu model) has been constructed to describe our ladder model. We have applied renormalization-group analysis to the resulting model and mapped out a qualitative phase diagram. We also have carried out a simple but powerful variational analysis to obtain consistent results.

The quantum phase transitions among the competing phases are, in general, described by a kind of self-dual sine-Gordon models, for which non-perturbative analysis is necessary. By using bosonization, we have obtained exact non-perturbative solutions to this problem and determined the universality classes. (K. Totsuka and P. Lecheminant)

Specific heat and low-lying excitations in the vortex-lattice states: The vortex of the supercurrent, which is one of superconducting phenomena, has attracted many scientists and provided interests which are related to both fundamental physics and applications. Although some problems on vortices has been solved, the relationship between the specific heat and the density of states on the vortex-lattice state is still to be clarified. It is well-known that the thermodynamic relation associates the specific heat with the entropy and the internal energy of the system. Therefore, from the microscopic viewpoint, the temperature dependence of the specific heat reflects the energy dependence of the density of states. So far, the temperature dependence of the specific heat in the vortex-lattice states has not been discussed on the basis of the microscopic theory. On the other hand, the specific heat measurements have been studied for a long time, and the density of states has been studied by the scanning tunneling microscopy recently.

In order to understand the temperature dependence of the specific heat from the microscopic point of view, we have computed the specific heat on the basis of a quasi-classical theory. The quasi-classical theory is one of the methods to solve physical problems by mean-field theories. We have obtained the self-consistent numerical solutions of the quasi-classical theory. It is well-known from the mean-field theory that the temperature dependence of the specific heat without an applied field shows the exponential behavior. The present study revealed that for the vortex-lattice state it could be expressed as a power series of temperature.

New points which we have clarified are the existence of a T^2-term and the physical meaning of its coefficient. The coefficient can be understood as made up of two contributions; the energy-dependence of the density of states in the vortex-lattice state averaged over the real space and the temperature-dependence of the density of states at the Fermi level. This is associated with the core radius of the vortex, which is called the Kramer-Pesch effect. The latter contribution always exists in clean samples.

For the first time, we have given the relationship among the specific heat, the energy and the temperature-dependence of the density of states in the vortex-lattice states. Moreover, we succeeded in understanding the specific heat for the vortex-lattice states from the viewpoint of microscopic theories. (N. Nakai)

Half-Skyrmion picture in high-temperature superconductors: About two decades ago, high-temperature superconductivity was discovered in the copper-oxide compounds. Although there have been invested many experimental- and theoretical works, there is no established theory yet. High-temperature superconductors exhibit a variety of intriguing phases besides superconductivity at high transition temperatures. Since this rich physics is controlled by the doped hole concentration, it is inevitable to figure out a proper description of the holes to understand the physics of high-temperature superconductors.

To this end, we have considered a system doped with a single hole, since such a system is apparently the simplest to consider the effect of the hole doping and is closest to the well established undoped system. For the description of the spin system, we took the non-linear σ model (NLσM) because it describes well the low-energy properties of the spin system. For the coupling between the doped hole and the spin system, we have assumed that the Kondo coupling between them is so strong that the singlet pair, called Zhang-Rice singlet, is formed.

To analyze the spin texture formed by the hole, we have considered a vacancy introduced in the NLσM. Under a boundary condition where the staggered components of all spins at infinity should point the same direction, the field equation of the NLσM has been analyzed. From a simple calculation, we have found that the spin textures formed by the spin-up state and the spin-down state are the Skyrmion spin texture and the uniform configuration. This classical analysis suggests that the superposition of those spin configurations leads to a Skyrmion-like spin texture which is characterized by a non-zero topological charge.

The value of the topological charge is determined by considering quantum many body effect. One way of describing ($S = 1/2$) quantum spin systems may be in terms of the constrained Schwinger bosons and due to the constraint all Schwinger bosons should appear in pairs. By describing phase fluctuations about the condensate in terms of a U(1) gauge field, we have found that the Schwinger boson pairs carry the gauge charges two. In such a situation, similarly to conventional superconductors, the flux quantum is π, which corresponds to the one-half topological charge. Thus, the doped hole induces a half-Skyrmion spin texture in the spin system.

We have extended the above analysis to the case of a moving hole and obtained the dispersion relation. On the square lattice, the dispersion has the same form as that of the π-flux phase with a mass term, which was proposed by Affleck and Marston on basis of a mean field theory. In the original π-flux mean field theory, the excitation spectrum does not contain the mass term; the mass term is induced dynamically by including fluctuation effects in terms of a U(1) gauge field. In the half-Skyrmion picture, however, the mass term is just the creation energy of a half-Skyrmion spin texture. The excitation spectrum of the half-Skyrmion spin texture is in good agreement with that obtained by angle-resolved photoemission spectroscopy in the undoped compounds. (T. Morinari)

Non-equilibrium Physics

Open systems far from thermodynamic equilibrium, such as living systems, provide a wide variety of self-organizing cooperative processes leading to the spontaneous formation of spatial and temporal order. Our aim is to explain and predict their dynamics, and extract skeletons of mechanisms.

Entrainment and Modulation under spatio-temporal forcing: We study dynamics of traveling waves under spatio-temporal forcing in non-equilibrium systems. Based on the model equations where phase separation and chemical reactions take place simultaneously so that traveling waves are formed in a self-organized manner, we apply a space-time dependent external force. Entrainment and modulation of traveling waves are investigated numerically in one dimension. We develop theoretical analysis to understand the dynamics obtained. (H. Tokuda and T. Ohta)

Anomalous Synchronization of Integrate-and-Fire Oscillators with Global Coupling: We have studied the synchronization of pulse-coupled oscillators. In this system, all the oscillators are identical, and they are coupled globally. We have found that the time before synchronization exhibits anomalous behavior and becomes infinitely large for special values of the coupling strength. This is the case for an infinite number of oscillators, as long as the initial phases are broadly distributed. This result does not contradict that obtained by Mirollo and Strogatz, where they showed that synchronization is realized within a finite time for a finite number of oscillators, beginning from almost any initial conditions. (M. Ataka and T. Ohta)

Labyrinthine versus Straight-striped Patterns Generated by Two- dimensional Turing Systems: Some animals exhibit a striped pattern on their skin. Some of striped patterns are "straight-striped patterns," with many stripes running in parallel, while others are "labyrinthine patterns," in which the stripes often change direction, merge with each other, and frequently branch out. We studied the conditions under which either a labyrinthine or straight-striped pattern would emerge among the striped patterns generated by Turing-type models. By using an index for stripe-clearness, we revealed that labyrinthine patterns are formed when the maximum spatial period of unstable modes is more than twice that of the minimum spatial period of unstable modes; otherwise, straight-striped patterns are formed. (H. Shoji)

Phase transition in Soft matter physics: We are focusing on nano-mesoscopic structures and their dynamics. Block copolymers show a variety of ordered mesophases. We are investigating the morphologies transitions between ordered phases numerically and theoretically.

Kinetics of Morphological Transitions in Microphase-Separated Diblock Copolymers: In AB diblock copolymer systems, it is known that these four equilibrium morphology appear, such as lamellar structures, gyroid structures, hexagonal and spheres in body centered cubic (bcc) structures, because polymer chains joined together to form a single macromolecule in microscopic world of itself. We study morphological transitions between microphase separated structures in diblock copolymers. By means of the two-mode approximation, kinetics of order-disorder transitions (ODT) and order-order transitions (OOT) in the weak-segregation limit are investigated by solving numerically coupled set of the amplitude equation for the fundamental modes. Break-up and reconnection of domains during the morphological transitions are explored in detail. Furthermore, we identify the metastable or unstable intermediate structures which appear in the process of ODT and OOT. The linear stability analysis is also applied to see the most unstable mode when a lamellar structure is destabilized. (K. Yamada and T. Ohta)

Dynamical approach to microphase separation in ABCA-type tetra-block copolymers: We have studied microphase separation of ABCA-type tetra-block copolymers both in weak segregation and strong segregation limits by means of a coarse grained approach for polymer melts. Experiments by Y. Matsushita and his coworkers show that only the noncentrosymmetric (NCS) lamellar structure (with sequence ...ABCAABCA...) are observed although its local free energy is not different from that of the centrosymmetric (CS) lamellar structure (...ABCAACBA...). In order to clarify the origin of this phenomenon, we derive the free energy functional and the set of kinetic equations for ABCA tetra-block copolymers. By solving this numerically in one dimension, we explore how the NCS lamellar structure is selected. Next, we have calculated the free energy for NCS and CS phase in strong segregation limit and found that NCS is more stable than CS when the parameters are as symmetric as possible. This difference comes from the long range part of the free energy functional. (K. Kaga and T. Ohta)

Emergence of new level of inheritance systems: It is the central problem of the emergence of life when aggregation of matter obeying only elementary physical laws first began to constrain individual molecules to a collective behavior. Most studies on this problem have been focused on the emergence of self-replicating units. However, there must be one serious dilemma: without evolutionary process no evolving units arise, but without evolving units no evolutionary process could begin. To solve this dilemma, a new principle of endo-exo circulation has been proposed. Furthermore, opposite phenomena such as the onset of disease and the creation of new functional units can be simply interpreted in terms of different aspects of the same endo-exo circulating process. (M. Murase)

Biological effects of electromagnetic fields: Although electromagnetic fields produce biological responses at very low intensities, underlying mechanisms have not been identified yet. A hypothesis was proposed that electromagnetic fields cause hormonal effects. For living cells, signal transduction pathways are limited, whereas environmental factors are almost infinite. This means that the signal transduction pathways can interact synergistically, a phenomenon known as cross talk. This cross talk not only increases the degree of amplification of signal, but also enhances mutual interacting leading to the formation of feedback loops. In addition, there are the so-called amplifier enzymes like G-proteins. Once such enzymes are activated, they can transmit signal for a while.. All these mechanisms had evolved to detect and amplify various kinds of environmental factors. As a result, some responses to such environmental factors can help learning and adaptation, whereas others cause the onset of environmental illness. The present hypothesis predicted that some amplifier enzymes like G-proteins can be the targets for very weak electromagnetic fields. It is time to unify the diverse biological phenomena including the onset of environmental illness, the mechanism of cellular memory, and adaptation to changing external and/or internal environment. (M. Murase)

Nuclear Theory Group

Nuclear Physics is the subatomic physics which deals with the structure and the dynamics of nuclei, and is also recently encompassing those of hadrons and hadron-quark many-body systems. In short, modern nuclear physics may be identified with many-body physics of the aggregates of particles governed by the strong interaction. Since the fundamental theory of the strong interaction is Quantum Chromo Dynamics (QCD), the modern nuclear nuclear physics or subatomic physics includes the study of QCD, especially puts an emphasis of the study of its vacuum structure and phase transitions in extreme conditions.

Nuclear Structure Physics

The goal of nuclear structure physics is to construct the unified comprehensive microscopic framework which can describe i) bulk nuclear properties (such as masses, radii, moments, and nuclear matter), ii) nuclear excitations (the variety of nuclear collective phenomena), and iii) nuclear reactions. One of the recent important achievements in nuclear structure physics is that nuclei far from the stability line have now been accessible experimentally. There were not much activities in this field this year because of the movement of the researcher.

Nuclei whose atomic number is larger than 92 (uranium) are called super-heavy elements, **SHE**, which do not exist in nature, but can be synthesized in laboratories using nuclear fusion reactions. There has been a theoretical prediction that a nucleus with $Z = 114$ and $N = 184$ is the double magic nucleus next to ^{208}Pb. There was a great experimental achievement in this field in Japan, namely, the discovery of SHE with the atomic number 113 in RIKEN. Our model prediction is in a rather good agreement with the experiment. We had proposed a new approach to calculate fusion probabilities, where they are given by a product of probabilities for two distinct processes (the two-step approach): one is the barrier penetrability for a fusion barrier which has to be overcome in order for two fragments to form a touching (sticking) configuration, and the other is for overcoming of a conditional saddle where the sticking configuration evolves its shape to eventually form a compound nucleus. For the latter, we a Langevin equation is solved in order to describe the shape evolution dynamically. We had found that this model works remarkably well in reproducing the existing experimental data for residue cross sections, by a combined use of the new statistical decay code, KEWPIE[1].

Hadrons and hadron-quark matter

The aims of hadron physics based on QCD may be summarized as follows: (1) Understanding the properties of the QCD vacuum, especially the chiral symmetry breaking (or restoration) and the confinement mechanism of quarks and gluons. (2) Understanding the properties of hadrons, i.e., mass spectra, internal structures, interactions among them and so on. (3) Revealing the possible phases of the hadronic and/or quark matter at extreme conditions at finite temperature T, baryon density ρ and so on.

Lattice study of the pentaquark baryons Θ^+

After the discovery of $\Theta^+(1540)$, the identification of the properties of the particle is one of the central problems in hadron physics. While the isospin of Θ^+ is likely to be zero, the spin and the parity and the origin of its tiny width still remain open questions. In spite of many theoretical studies on Θ^+, the nature of this exotic particle, including the question about the existence of the particle, is still controversial. We studied $(I,J) = (0,\frac{1}{2})$ channel in quenched lattice QCD to search for the possible resonance state and to investigate the properties of Θ^+. We adopted two independent operators with $I = 0$ and $J = \frac{1}{2}$ and diagonalized the 2×2 correlation matrices by the variational method for all the combinations of lattice sizes and quark masses to extract the first excited state slightly above the NK threshold in this channel. After the careful separation of the states, we investigated the volume dependence of the energy as well as the spectral weight of each state so that we can distinguish the resonance state from NK scattering states. We carried out simulations on four different sizes of lattices: $8^3\times 24$, $10^3\times 24$, $12^3\times 24$ and $16^3\times 24$ with 2900, 2900, 1950 and 950 gauge configurations using the standard plaquette (Wilson) gauge action at $\beta = 5.7$ and the Wilson quark action. On these conditions, we can detect the possible resonance state lying a few hundreds MeV above the NK threshold avoiding the contaminations of NK scattering states. The hopping parameters for the quarks are $(\kappa_{u,d},\kappa_s)$=$(0.1600,0.1650)$, $(0.1625,0.1650)$, $(0.1650,0.1650)$, $(0.1600,0.1600)$ and $(0.1650,0.1600)$, which correspond to the current quark masses $(m_{u,d},m_s)\sim(240,100)$, $(170,100)$, $(100,100)$, $(240,240)$ and $(100,240)$, respectively in the unit of MeV. As a result, we have found a resonance state slightly above the NK threshold in $(I,J^P) = (0,1/2^-)$ channel, which is, in the chiral limit, as heavy as 120 % of the NK threshold.[2]

Various phases of heated hadron/quark matter at high density

Color superconductivity: Sufficiently cold and extremely dense quark matter is believed to be in a special phase of the color superconductivity, called the color-flavor locked (CFL) phase where all the quarks equally participate in pairing. it remains, however, still controversial which phase sets in next to the CFL down in density. The following two ingredients will play key roles for determining the secondary densest phase in QCD; (i) the strange quark mass Ms, and (ii) the charge neutrality constraints in addition to the β-equilibrium condition. Some theoretical studies suggest that the effect of (ii) in the CFL cancels that of (i) down to some critical density below which a window for a novel gapless CFL (**gCFL**) phase opens. In the realistic quark matter in compact stars, the effect of (ii) gives so strong constraint because of a long range nature of gauge interaction that such an exotic gapless phase may exist stably in contrast to the unstable Sarma state in the condensed matter physics.

The gCFL phase is claimed to be the most prominent candidate of next phase down in density at vanishing temperature in several studies, in which the effect of Ms has been treated as a parameter like an external magnetic field applied to a metallic superconductor. In QCD, however, the attraction in the scaler (q q̄) channel is strong enough to lead to the dynamical chiral symmetry breaking. The incorporation of the chiral condensation under charge neutrality constraints would bring quite a non-linear coupling between the effect of (i) and the constraints of (ii). We have investigated the competition between the chiral and diquark condensations in a four-Fermi model[3]: We have found that the phase appearing next to the CFL down in density is quite to the strength in the scaler diquark channel. This conclusion is qualitatively understandable and seems to be robust, being irrespective of the details of the models used.

The color superconductivity may be realized not only in the compact stars but also in the intermediate stage of the heavy-ion collisions. In order to consider the color superconductivity in these realistic systems, one should notice that they are at relatively low density where the strong coupling nature of QCD may show up. The strong coupling implies that there exist large fluctuations of the diquark-pair field, and hence the color superconductivity at low density may share some basic properties with the high-T_c superconductivity of cuprates rather than the usual superconductivity in metals. In fact, we have shown that the precursory fluctuations of the pair field can have a prominent strength even well above T_c[3] and the pseudogap manifest itself in the density of states of quarks near the Fermi energy as a precursory phenomenon of the color superconductivity[4].

In this year, we have explored other precursory phenomena of the color superconductivity. We have calculated the specific heat and the electric conductivity above T_c incorporating the pair fluctuations, and showed that there appear anomalous enhancement in these observables above T_c[5]. These anomalous behaviors can give rise to a experimental signature in the compact stars or the heavy-ion collisions. We have also investigated the quasiparticle picture of quarks near but above T_c. The quark self-energy is evaluated in the T-matrix approximation, and it was shown that the non-Fermi liquid behavior of the matter develops when the diquark coupling is varied from the weak-coupling to strong-coupling regime[5]. We elucidated that the non-Fermi liquid behavior of quarks can be understood in terms of the resonance scattering between the particles and holes near the Fermi surface.

Chiral density waves: It is interesting that particle-hole type instabilities also may manifest themselves in dense quark matter. In fact, we have shown [7]that a density wave may be realized in quark matter at finite temperature; this occurs along with the chiral condensation, and is described by a dual standing wave in scalar and pseudo-scalar condensates on the chiral circle, $\langle \bar{\psi}\psi \rangle = 3D\Delta\cos(\mathbf{Q}\cdot\mathbf{x})$, $\langle \bar{\psi} i\gamma_5 \psi \rangle = 3D\Delta\sin(\mathbf{Q}\cdot\mathbf{x})$. The mechanism is quite similar to that for spin-density waves proposed by Overhauser, and entirely reflects many-body effects: a deformed one-particle spectrum caused by the density wave lowers the free energy in comparison with the normal phase. As a result of numerical calculations, it is found that the chiral condensed phase with the density wave develops at a high-density region just outside the usual chiral-transition line in ρ_B-T phase diagram. We also found that a modulated magnetic order is synchronized with the density wave, which has a local flux strength $\sim O(10^{16})$ Gauss.

Diquark Bose-Einstein condensation: The quark matter at moderate densities is a strongly coupled system which may exhibit a superconductivity, i.e., the color superconductivity, as mentioned in a previous subsection. The attraction between quark is so strong, Bose-Einstein condensation (**BEC**) of diquark composites can be realized in quark matter at relatively low density[8]. Interestingly enough, the condensation occurs through a BCS-BEC crossover in the color superconductivity near the deconfinement phase transition, where it is assumed that dynamical pair fluctuations become bosonic composites $= 3D$ diquarks. We employ a quasi-chemical equilibrium theory between quark pairs and diquarks in a relativistic framework: the baryon number density is composed of quark and diquark densities, $\rho_B = 3D\rho_q(\mu,T) + 2\rho_{diq}(2\mu,t)$ and derive some analytic relations for diquark BEC in the equilibrium system. It is found that constituent-quark and diquark-composite masses play an essential role in determination of BEC, and for a set of these masses estimated by effective models the critical temperature for a fixed baryon number density is calculated to be about $T_c \sim 100$ MeV which is comparable with those of color superconductivity obtained from mean-field approximations: The threshold condition for BEC ($T_c \neq 0$) with quark and diquark masses, m_q, m_d is given by

$$\rho_B \geq \frac{N_c N_f}{3} \frac{1}{2\pi^2(\hbar\, c)^3} \left[\left(\frac{m_d c^2}{2} \right)^2 - \left(\frac{2 m_q c^2}{2} \right)^2 \right]^{3/2} .$$

Critical dynamics of the QCD phase transitions

Disoriented chiral condensate in the time-dependent variational approach: We have examined the effect of the isospin-isospin correlation on the domain formation of Disoriented Chiral Condensate, **DCC**. For this purpose, we have studied the dynamics of chiral phase transition in spatially inhomogeneous systems with mode-mode correlation in the framework of the time dependent variational approach with squeezed states for the 1+1 dimensional geometry.

We have found that the isospin-isospin correlation makes the DCC domain structure larger, but its effect is less conspicuous than that of the mode-mode correlation. The isospin-isospin correlation has almost negligible effects on the time evolution of the quantum fluctuation. Thus, the isospin-isospin correlation does not lead to further squeezing of the states.

Furthermore, we have also analyzed the two particle correlation function which was measured in relativistic heavy ion collision experiments. The bunching and anti-bunching phenomena were observed during the time evolution of the system. This suggest that the assumption which is currently used in analyzing the two particle correlation function from the experimental data might be too rough to search the domain structure of DCC.[9]

Overdamping phenomena near the critical points: We have studied the non-equilibrium (dynamic) critical phenomena of the chiral phase transition [10]. The dynamic universality class of the chiral transition was discussed in the literature on the basis of the classification scheme established by Hohenberg and Halperin; the dynamic universality class of the chiral transition can be identified with that of anti-ferromagnet. Contrary to this firm argument, a crucial difference between the two systems has been pointed out in Ref. [11]: The order parameter fluctuation in the chiral transition is a meson (pion and sigma) mode, which is a propagating (or oscillatory) mode, while in anti-ferromagnet, the order parameter fluctuation is known to give a diffusive (or purely damping) mode. This difference cannot be ignored and could even give rise to a counter example that violates Hohenberg and Halperin's rule.

We have made a close investigation of the order parameter fluctuation, using a renormalization group technique. It is found that the fixed point for the propagating mode is unstable to that for a diffusive mode, which means that the propagating mode asymptotically becomes overdamped, namely reduces to a diffusive mode as the critical point is approached. Thus our analysis predicts that pions and sigmas are not able to propagate and lose a particle-like nature near the chiral phase transition.

Actually, the critical point is known in condensed matter physics, at which this overdamping phenomenon does take place. It is a structural phase transition in solids [12]. The soft mode for the transition is a phonon mode, which is a vibration mode of lattice. It is experimentally observed that the phonon mode becomes overdamped near the critical point. Our analysis is successful in providing the first clear theoretical explanation to the phenomenon.

Our conclusion is that the meson field fluctuation turns from a propagating mode into a diffusive mode near the chiral transition and its dynamic universality class eventually reduces to that of anti-ferromagnet as discussed by Rajagopal and Wilczek. And also, we confirmed that Hohenberg and Halperin's classification scheme correctly works if the interest is restricted to the vicinity of the critical point.

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Particle Physics Group

The ultimate goal of particle physics is to construct the theory which can explain the nature from a fundamental principle, Theory of Everything (TOE). Superstring theory attracts many particle physicists as TOE, because superstring theory unifies the gravity with the other gauge forces. The discovery of the duality of the string theory gives us an clue to study the non-perturbative aspects of the string theory, such as true string vacuum and application to the model building. It is now even possible to study the gauge theory using the string theory and gravity. Study of constructive formulation of the string theory is also discussed.

On the other hand, low energy phenomena of particles are described correctly by Standard Model (Weinberg Salam model). However, the higgs boson predicted in the model has not been found so far, and theory is expected to face the hierarchy problem beyond TeV scale. Several theories beyond the SM is proposed and the new phenomena are predicted. They are tested in the various on-going and future experiments such as the B factory, LHC and cosmological observations. Possible signals that will be obtained by those experiments and their implication to the models at high energy scales are studied.

Finally, while Standard Model has been successful so far, better understanding of the non-perturbative aspects of QCD is required to see contributions from physics beyond the standard model. The dynamics of QCD at low energy is also very attractive by its own. Also, new phenomena are expected at finite temperature and/or finite density, which are not yet fully understood. Lattice simulation is applied to compute the weak matrix elements of the B meson system and the spectral functions in QGP. New methods to implement the lattice fermion with an exact chiral symmetry is also studied.

Field theory is also studied actively by our member. The supersymmetric field theory and integrable systems have interesting mathematical structures, and non-trivial non-perturbative structures can be studied. Field theory is also an important building block of the string theory. It is an important tool for condensed matter as well. The application to the QH effects are studied by our members.

Supersymmetry

In certain supersymmetric theories topological charges acquire a new type of quantum anomalies. I developed a superfield formulation of the central-charge anomalies for solitons last year and extended a superspace analysis to domain walls and vortices this year. The superspace approach tells us that the problem of topological-charge anomalies is essentially the problem of the supertrace of the supercurrent, and reveals a dual (bosonic/fermionic) character of these anomalies.(Shizuya)

Conformal field theory

The boundary dynamics of two dimensional conformal field theories, especially free-field representation of generic boundary CFTs and, marginal boundary deformation of orbifold branes, where the branes are located at orbifold fix points (fractional space-like branes) is investigated. The latter is motivated by a string-theoretical model of quantum cosmology. (Kawai)

String theory and quantum gravity

Superstrings in $\mathrm{AdS}_3 \times S_1$ using the hybrid formalism is studied in a manifest supersymmetric manner. The space-time supersymmetry is manifest and closed off-shell extending the infinite dimensional superconformal symmetry. I am also studying some extension of the twistor string. By reducing the number of supersymmetries, I am trying to include matter multiplets. (Kunitomo)

A holographic relation between Einstein Gauss-Bonnet gravity and its dual field theory is investigated. We found a holographic relation between entropies of an Einstein Gauss-Bonnet black hole in the bulk and the corresponding radiation on the brane in the high temperature limit. In particular, we find that the Hubble entropy evaluated when the brane crosses the horizon also coincides with the black hole entropy in the high temperature limit. (Ogushi)

A new way to realize four dimensional QCD in type IIA superstring theory is proposed and analyzed within the supergravity approximation. It was shown that various aspects of low energy behavior of (large N) QCD can be understood using probe D8-branes embedded in a curved supergravity background. (Sugimoto)

The $1/N$ corrections in the AdS/CFT correspondence and the integrability related to the correspondence were investigated. The black hole physics through an approach of string theory is also studied. (Yokoi)

Analytic classical solutions of the equation of motion of open string field theory is studied. These solutions are labeled by analytic functions obeying a certain conditions. Especially, it turns out that some nontrivial solutions are equivalent. They are related by regular transformations. (Zeze)

Integrable systems

The spin 1/2 - XYZ chain is studied. First, we derived a nonlinear integral equation for describing the vacuum and the first excited states of the system and for computing the eigenvalues of physical quantities on such states. Then, by using the nonlinear integral equation, we derived scattering amplitudes involving solitons/antisolitons excitations first, and bound states later. The latter case comes out as manifestly related to the Deformed Virasoro Algebra of Shiraishi et al., while the former case furnishes the S-matrix proposed by A.Zamolodchikov as plausible scattering description of an unknown integrable field theory. (Rossi)

Integrable many-particle dynamics and their properties at classical and quantum levels, and elliptic quantum groups and their applications are studied. In the former, deformation of the classical orthogonal polynomials (Meixner-Pollaczek, Askey-Wilson, etc) are obtained dynamically. In the latter, the central elements of the elliptic Z_n quantum group are determined and the elliptic Z_n Gaudin magnets with open boundary are solved. (Sasaki)

The possibility to introduce defects in integrable systems has been investigated. Such a defect has to be understood as a discontinuity localised at one point of the x-axis which links two, possibly different, field theories living on opposite sides with respect to the defect itself. Such a possibility has been explored for the sine-Gordon model, $a_r^{(1)}$ affine Toda field theory, non-linear Schr 雫"odinger and Korteweg de Vries equations. For each model the lagrangian defect potential which allows to preserve integrability has been found and its connection with the B 雫"acklnd transformation has been established. Using the Lax pair technique the conserved charge generator has been found for most of the models listed above. It turns out that even if translation invariance is broken, a generalised momentum is conserved. Interesting results arise from the investigation of the behaviour of the soliton solutions. For instance, for the sine-Gordon model a soliton can turn into an untisoliton and moreover it can be swallowed or emitted for particular value of the rapidity and the boundary parameter. Investigation of the quantum aspects of this problem is still work in progress. (Zambon)

Noncommutative geometry

A fuzzy sphere is analized in the context of the supermonopole whose mathematical structure is based on the the super 1-st Hopf map. On the fuzzy supersphere and on the noncommuataitve superplane, I constructed supersymmetrized quantum Hall systems is constructed their properties are investigated.(Hasebe) The time-evolution of noncommutive spaces is formulated based on non-unitary process. A way to extract the effective geometric quantities in noncommutative spaces is given through an approximate power-law expansion of the heat kernel. (Sasakura)

Phenomenology

Non-perturbative effect on dark matter pair annihilation is studied. The effect is important when the mass of the DARK matter is large and its mass is degenerated with its SU(2) partners. The pair annihilation cross section and the DM signal is enhanced drastically for some region of parameter space. Radiative effect of DM detection rate for wino like neutralino is also studied.(Nojiri)

A new mass reconstruction method for supersymmetric particles is proposed and studied. The method treats the kinematical equation exactly and solve sparticle masses and missing momentum. It is shown that sbottom and gluino masses are reconstructed as the peak of the distribution by using the new method.(Nojiri)

For some models of SUSY breaking, the next lightest supersymmetic particle is meta-stable. Placing the O(Kton) detector which stop the NLSP and detects the decays is shown to be extremely useful to reveal the nature of NLSP and gravitino LSP.(Nojiri)

The second lightest neutralino decay into sleptons are one of the most clean channel to study SUSY parameters at LHC. Flavor non-universality of the decay is considered. It is found that charge asymmery of the decay distribution and the brancing ratios are sensitive to very tiny LR mixing of scalar muons.(Goto and Nojiri)

Lattice QCD and strong interactions

A new method for the dispersive bound was proposed in collaboration with M. Fukunaga in Hiroshima Univ. By combining the form factors from quenched lattice QCD, the dispersive bounds, and the pion momentum dependence of B -¿ pi l nu decay experimental data by CLEO experiment, the CKM matrix element $|V_{ub}|$ can be determined with high accuracy . (Onogi)

The scalar and pseudoscalar condensations and the η' meson correlators of the two-flavor massive Schwinger model in the non-zero theta vacuum is studied using lattice QED with the domain-wall fermions. It is found that the pseudoscalar condensation is non-zero and there exists a long-range correlation of the η' meson, which is well described by the clustering property. (Fukaya, Onogi)

There are many discussions why the experimental value of the chamonium hyperfine splitting cannot be reproduced in lattice QCD; the lattice discretization errors, perturbative errors in NQCD, quenching errors and so on. Recently there is a new explanation is that OZI-suppressed diagrams may be the source of this disagreement. A first study of the contribution of the OZI-suppressed diagrams to the hyperfine splitting of charmonium with QCD-Taro collaboration. It is found that no contribution of the disconnected diagram is seen in the vector meson channel. In the pseudo-scalar channel and for valence quark masses around the strange quark, the disconnected contribution induces a considerable increase of the meson mass. This contribution quickly decreases as the quark mass increases. For charmonium the effect is very small although a decrease of the pseudoscalar mass induced b y the disconnected contribution cannot be ruled out. (Umeda)

By assigning the newly observed charmed strange scalar meson with a narrow width to one of the iso-triplet four-quark mesons, decays of the multiplet members are investigated and, as the consequence, existence of additional narrow scalar mesons is predicted. It is demonstrated that four-quark mesons can play an important role in hadronic weak decays of charm mesons. (Terasaki)

The $D_s^+\pi^0$ and D_s^{*+} gamma decays of the $D_{s0}^+(2317)$ are studied under the vector-meson dominance hypothesis. Its assignment to the four-quark meson with $(I,I_3)=(1,0)$ is consistent with experimental data on these decays, while those to $I=0$ states (a four-quark and a conventional $c\bar{s}$) are not favored. (Terasaki)

A possibility that there coexist two scalar mesons of different structures (a conventional meson and a four-quark meson) in the recently observed broad bumps just below the large peak of the tensor meson in the D-π mass distribution is proposed in collaboration with Dr. McKeller (Melbourne Univ.), based on the interpretation of the charm-strange scalar meson of mass 2317 MeV as a four-quark meson. (Terasaki)

2.2 Research Highlights

Color superconductivity affected by chiral condensates under charge neutrality constraints

Hiroaki Abuki (YITP)

On the basis of the asymptotic-free nature of QCD and the attraction between quarks due to a gluon exchange, we now believe that the ground state of the extremely cold dense quark matter is in the color-flavor locked (CFL) phase where all the quarks equally participate in pairing [1]. In contrast, it remains still controversial which phase sets in next to the CFL as the density is decreased.

The following two ingredients are considered to play crucial roles for determining the secondary densest phase in QCD [2]; (i) the strange quark mass M_s, and (ii) the charge neutrality constraints in addition to the β-equilibrium condition. The former tends to bring a Fermi momenta mismatch between the light and strange quarks, while the latter tends to match the Fermi momenta of all the species by tuning the charge chemical potentials. Some theoretical studies suggest that the effect of (ii) in the CFL completely cancels that of (i) down to some critical density (chemical potential) $\mu = \mu^*$ below which a window for a novel *gapless* CFL (gCFL) phase opens [3]. The gCFL is analogous to the unstable *Sarma* state in the condensed matter physics [4]. In the realistic quark matter in compact stars, the effect of (ii) gives so strong constraint because of a long range nature of gauge interaction that such an exotic phase may exist stably. The gCFL phase has been extensively studied and claimed to be the most prominent candidate of next phase down in density at vanishing temperature [5]. It should be also noted that the possible existence of the gCFL phase in a compact star lead to astronomically interesting consequences [6].

So far, the effect of M_s has been treated as a parameter like an external magnetic field applied to a metallic superconductor. In QCD, however, the strong attraction exists in the scaler $(q\bar{q})$ channel, which leads to a non-perturbative phenomenon called the dynamical chiral condensation. It would be interesting to ask how the incorporation of the dynamical formation of the chiral condensates affects color superconducting phases under charge neutrality constraints. This incorporation brings quite a non-linear coupling between the effect of (i) and the constraints of (ii) discussed above. Along this line, the competition between the chiral and diquark condensations is investigated in a four-Fermi interacting model [7]. In this work, it is shown that the phase appearing next to the CFL phase down in density strongly depends on the strength in the scaler diquark channel. In particular, the gCFL phase is realized only in a weak coupling regime, which is nicely understood in terms of the competition between the chiral and diquark condensations and is expected to hold generically, not depending on the detail of the model used. Figure 2.1 shows the phase diagram obtained in this work. The gCFL phase, as the secondary densest phase, is successively taken over by the UQM, g2SC and 2SC phases with increasing diquark coupling.

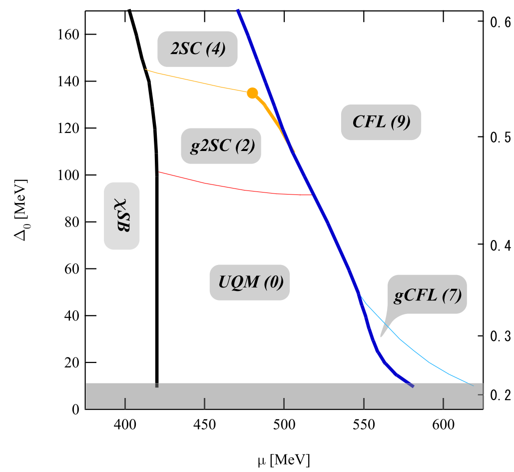

Figure 2.1: Phase diagram in (Δ_0, μ) plane. Δ_0 is a measure of the scaler diquark (qq) coupling, G_d. The scale put on the right-hand side represents the ratio of G_d to the scaler $(q\bar{q})$ coupling G_s, $\eta = G_d/G_s$. The number in a parenthesis attached to each phase name denotes the number of gapped quasi-quarks.

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The anomalous synchroniazation of integrate-and-fire oscillators with global coupling

Masayuki Ataka (YITP, Hiroshima Univ.) and Takao Ohta (YITP)

The integrate-and-fire model is one of the simplest models for nonlinear oscillators. Mirollo and Strogatz[1] have studied synchronization of pulse-coupled integrate-and-fire oscillators generalizing Peskin's model[2] and have proved that an assembly of finite number of oscillators is synchronized for almost all initial conditions within a finite time.

Let $\mathscr{O} = \{O_1, \ldots, O_N\}$ be a set of N oscillators, where each oscillator O_i is characterized by a phase ϕ_i and a state variable x_i, given by $x_i = f(\phi_i)$, where $f\colon [0,1] \to [1,0]$ is smooth, monotonic increasing, and concave down, i.e., $f' > 0$ and $f'' < 0$, and satisfies $f(0) = 0$ and $f(1) = 1$. We assume that the functions f are identical. When x_i exceeds a threshold at $x_i = 1$, the ith oscillator fires, and its state variable is instantaneously reset to zero, after which another cycle begins.

The interaction between oscillators is introduced as follows. When the ith oscillator fires, a small amount ε is added to the state variable x_j of all other oscillators $j(\neq i)$. In this sense there is a global coupling among the oscillators. If $x_j + \varepsilon > 1$, this oscillator fires so that these two have the same state variable 0. That is,

$$x_i(t) = 1 \to x_j(t^+) = \min(1, x_j(t) + \varepsilon_i) \quad \forall j \neq i. \tag{1}$$

We assume that this resetting occurs instantaneously without any time delay. When n oscillators fire simultaneously, the factor of ε/n is added to the state variable of other oscillators. We use the strength ε normalized in this way. We have found that the infinite pulse-coupled oscillators with global coupling split immediately into a finite number of clusters when we start with a uniform phase distribution. This enables us to simulate an infinite population of oscillators as finite number of clusters.

For numerical simulations, we used Leaky Integrate-and-Fire Model [2],

$$\tau \frac{dx_i}{d\phi} = S - x_i, \qquad 0 \le x_i \le 1, \quad i = 1, \ldots, N, \tag{2}$$

where S is a constant satisfying $S > 1$ and $\tau = \ln[S/(S-1)]$. The time variable ϕ is normalized such that x_i becomes unity at $\phi = 1$ starting $x_i = 0$ at $\phi = 0$.

The result of numerical simulation is displayed in Fig. 2.2, which indicate that time before synchronization is singular as a function of the coupling strength ε as the number of oscillators is increased. We have found that the time before synchronization exhibits anomalous behavior and becomes infinitely large for special values of the coupling strength. This is the case for an infinite number of oscillators, as long as the initial phases are broadly distributed. This result does not contradict that obtained by Mirollo and Strogatz[1], where they showed that synchronization is realized within a finite time for a finite number of oscillators, beginning from almost any initial conditions.

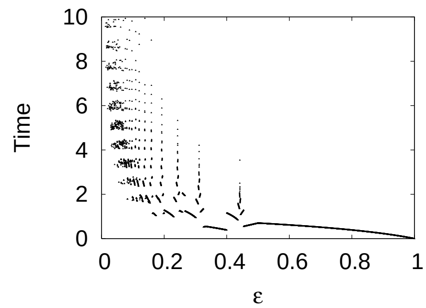

Figure 2.2: Time before synchronization of infinite oscillators for $0 < \varepsilon < 1$ and $S = 1.2$.

As mentioned above, the infinite number of oscillators come to form a finite number of clusters. We consider the case of two, three, and four clusters. Fig. 2.3 shows that three clusters, which occurs for $1/3 < \varepsilon < 1/2$, always synchronize except at

$$f(1-\phi^*) + \varepsilon = f(\phi^*). \tag{3}$$

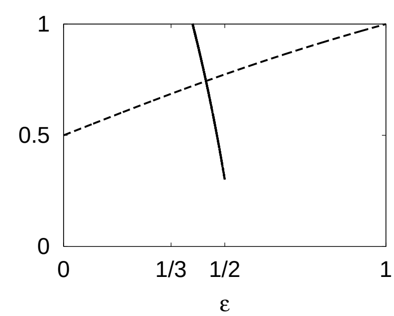

Figure 2.3: The phase as a function of ε. Solid curve represents the phase just after three clusters have become two clusters, where the phase of either cluster is 0. Dashed curve represents fixed point of two oscillators.

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Exact quantities and scattering amplitudes for the spin 1/2 - XYZ chain

Davide Fioravanti (York University) and Marco Rossi (YITP)

The spin 1/2-XYZ model with periodic boundary conditions is a (lattice) spin chain with hamiltonian written in terms of Pauli matrices $\sigma^{x,y,z}$,

$$\mathscr{H} = -\frac{1}{2}\sum_{n=1}^{N}\left(J_x\sigma_n^x\sigma_{n+1}^x + J_y\sigma_n^y\sigma_{n+1}^y + J_z\sigma_n^z\sigma_{n+1}^z\right), \quad (1)$$

where the three real coupling constants J_x, J_y and J_z are customarily reparametrised in terms of elliptic functions. This model is integrable, in the sense that it possesses as many commuting independent quantities as the degrees of freedom (N in this case). Diagonalization of this set of commuting observables has been achieved through the Algebraic Bethe Ansatz technique in the important paper [1]. The (nonlinear) Bethe-like equations arising in this procedure as a characterization of the eigenstates of the observables can be rephrased in terms of the so-called nonlinear integral equation - introduced in [2] for the sine-Gordon model - satisfied by the counting function describing a state. The nonlinear integral equation is a useful tool in order to perform numerical computations of physical quantities (i.e. eigenvalues of observables) and to study finite size corrections to eigenvalues in the thermodynamic limit ($N \to \infty$).

In our paper [3] we initially derive a nonlinear integral equation for the vacuum counting function of the spin 1/2-XYZ chain in the disordered regime, thus paralleling similar results by Klümper [4], achieved through a different technique in the antiferroelectric regime. In terms of the counting function we obtain the usual physical quantities, like the energy and the transfer matrix (eigenvalues) in a form which separates the term proportional to N to its finite size corrections. Then, we introduce a double scaling limit which appears to describe the sine-Gordon theory on cylindrical geometry, so generalising famous results in the plane by Luther [5] and Johnson et al. [6]. Furthermore, after extending the nonlinear integral equation to excitations, we derive scattering amplitudes involving (elliptic deformations of) solitons/antisolitons first, and bound states later. The latter case comes out as manifestly related to the Deformed Virasoro Algebra of Shiraishi et al. [7]. Although this nonlinear integral equations framework was contrived to deal with finite geometries, we prove it to be effective for discovering or rediscovering S-matrices. As a particular example, we prove that this unique model furnishes explicitly two S-matrices, previously proposed as plausible scattering descriptions of unknown integrable field theories: one (which coincides with Baxter's elliptic R-matrix) was introduced by Zamolodchikov in the paper [8], the other (which coincides with the structure function of the Deformed Virasoro Algebra) was independently analyzed by Lukyanov in [9] and by Mussardo and Penati in [10] .

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Half-flat compactifications and KKLT models

Sébastien Gurrieri (YITP)

Discovering realistic models in 4 dimensions obtained from compactifications of higher dimensional supergravities is one of the main goals of string theory today. In this context, we have been interested in compactifications of heterotic supergravities on half-flat manifolds, and in particular to models similar to KKLT [1].

One important problem to solve is the stabilization of moduli. In standard Calabi-Yau compactifications, the potential does not fix the various scalars appearing in the reduction, and thus a lot of predictive power is lost as to the couplings in 4 dimensions. Recently, there has been a lot of work on flux compactifications, since it was discovered that these new methods of reduction can lead to masses for the scalars [2]. While particular schemes have been considered that can fix many of the moduli [3], there is at present no model based only on fluxes that could potentially fix all moduli. In flux compactifications of heterotic theories, the Kähler volume as well as the dilaton remain unfixed. This is where the KKLT models enter the game.

By combining generic arguments about flux compactifications with quantum non-perturbative effects such as gaugino condensation, KKLT could show that in principle all moduli could be fixed in a supersymmetric way, while adding D-brane effects could lift the potential to a small positive value yielding de Sitter vacua.

This very interesting proposal has received a lot of attention in the last few months and years, and our work is situated in this domain. As suggested above, the argument given by KKLT about the flux part deserves special care. They did not consider a particular compactification model, but argued that their conclusion should hold in a large number of cases. Our goal has been to consider definite models and explore whether or not they satisfy the conditions used by KKLT.

A first necessary step was to obtain a model from 10 dimensions fixing as many scalars as possible from standard use of fluxes. We considered heterotic supergravities reduced on half-flat manifolds with fluxes [4]. Fluxes generally are expected to fix the complex structure moduli (CSM), while the parameters of the torsion in the half-flat geometry, as was discovered in [5] in the context of Mirror Symmetry, play the role of fluxes which may fix the Kähler moduli (KM). We reduced the heterotic action on half-flat manifolds first, and proved that the action is $N = 1$ supersymmetric by exhibiting the superpotential, which we showed to be in agreement with Gukov's formula. Then we turned on the fluxes, and again, the action was found to be $N = 1$ with a superpotential in perfect agreement with Gukov's formula. This superpotential contains all the moduli (except the dilaton), and was thus expected to be a promising starting point for a possible KKLT model. From the simple argument of the existence of the superpotential, we found that not all flux configurations are allowed when both NS-NS and half-flat fluxes are taken into account. Note that from the gauge point of view, this compactification is expected to break the 10 dimensional group E_8 down to $SO(10)$ which is of particular interest in the framework of GUT theories.

Following KKLT [1], we then started from this model by including a gaugino condensate at one loop, and we have been studying the resulting potential, looking for Anti-de Sitter vacua. Preliminary results [6] show that, although it is quite clear that all moduli are fixed and that there exist many vacua, it is far from obvious to obtain satisfactory values for them. In particular, these values must respect the large volume limit, and we find that this is a very constraining condition reducing the number of solutions. An other constraint comes from the compatibility of NS-NS and half-flat fluxes, which, as noted in [7], must satisfy certain conditions in order for the Bianchi Identity to hold. Under these various constraints, we have not yet found a proper vacuum. Once the constraint is removed, we find many satisfactory solutions. One possible way to justify the relaxation of the flux constraint would be to include magnetic half-flat fluxes, whose exact formulation is not known at present, though the superpotential they would produce is known. We have studied this case and found that these magnetic half-flat fluxes, yielding cubic terms in the superpotential, improve the behaviour of the solutions giving more satisfactory solutions.

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Effects of Precursory Pair-Fluctuations of Color Superconductivity on Some Observables

Masakiyo Kitazawa and Teiji Kunihiro (YITP)

The extremely dense and cold quark matter undergoes the phase transition to the color-superconducting phases[1, 2]. The color superconductivity may be realized in the compact stars and/or the heavy-ion collisions[3]. In order to consider the color superconductivity in these realistic systems, one should notice that they are at relatively low density where the strong coupling nature of QCD may show up. The strong coupling implies that there exist large fluctuations of the diquark-pair field, and hence the color superconductivity at low density may share some basic properties with the high-T_c superconductivity of cuprates rather than the usual superconductivity in metals. In fact, we have shown that the precursory fluctuations of the pair field can have a prominent strength even well above T_c[3] and the pseudogap manifest itself in the density of states of quarks near the Fermi energy as a precursory phenomenon of the color superconductivity[4].

In this year, we have explored other precurosry phenomena of the color superconductivity[5]. We have calculated the specific heat and the electric conductivity above T_c incorporating the pair fluctuations.

The specific heat per unit volume c_V is calculated from the thermodynamic potential. As for the thermodynamic potential of the diquark-pair fluctuations, we considered the ring diagrams shown in Fig. 2.4. We show the behavior of the specific heat in the free fermionic system c_V^0 and the effects of the fluctuations of the pair field $c_\mathrm{V}^{\mathrm{fl.}}$ above T_c in Fig. 2.5;. the total specific heat of the system is $c_\mathrm{V} = c_\mathrm{V}^0 + c_\mathrm{V}^{\mathrm{fl.}}$. One sees from the Figure that $c_\mathrm{V}^{\mathrm{fl.}}$ diverges as T is lowered toward T_c. A clear enhancement of $c_\mathrm{V}^{\mathrm{fl.}}$ is seen already at $\varepsilon \equiv (T - T_c)/T_c = 0.05 \simeq 0.1$, which is two or three-order larger ε than that of the electric superconductors[5]. It is, therefore, interesting to consider the effect of the enhancement of the specific heat on the cooling procedure of the compact stars; since the temperature of the newborn compact stars just after the supernovae can exceed 40MeV, the dense matter in the interior of the compact stars may possibly undergo the color superconducting phase transition.

It is known in the condensed matter physics that the pair fluctuations above T_c cause an anomalous excess of the electric conductivity known as the paraconductivity[6]. In the case of the color superconductivity, the anomalous excess above T_c may be seen in the color and electric conductivities, since the diquark-Cooper pairs carry both the color and electric charges. Because the color conductivity, unfortunately, would not be detectable experimentally, we explored the effect of the diquark-pair fluctuations on the electric condocutivity. We employed the so-called Aslamasov-Larkin term[6] for the current-current correlator and calculated the electric conductivity above T_c using the Kubo formula. The numerical calculation shows that the electric conductivity diverges as $\varepsilon^{-1/2}$ near but above T_c.

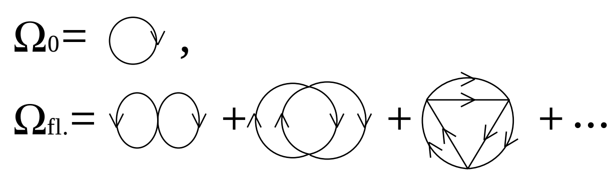

Figure 2.4: The diagrams taken into account in the calculation of the thermodynamic potential. $\Omega_{\mathrm{fl.}}$ is a contribution from the fluctuations of the pair field.

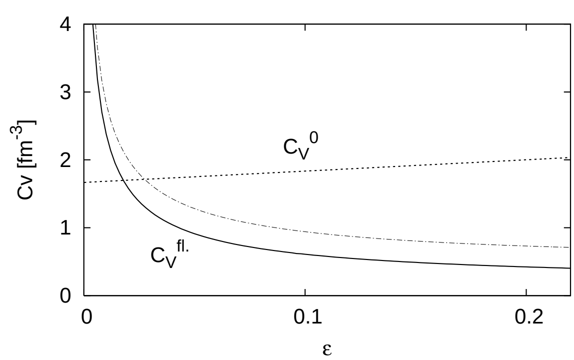

Figure 2.5: The specific heat per unit volume in the free fermionic system c_V^0 and the effects of the fluctuations of the pair field $c_\mathrm{V}^{\mathrm{fl.}}$. One sees that there appears an enhancement of $c_\mathrm{V}^{\mathrm{fl.}}$ from $\varepsilon = 0.05 \sim 0.1$[5].

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Half-skyrmion picture for high-temperature superconductors with antiferromagnetic long-range order

Takao Morinari

High-temperature superconductivity is characterized by its rich phase diagram: There are the Mott insulating phase, the antiferromagnetic (AF) long-range ordered phase, the spin-glass like phase, the d-wave superconducting phase, the Fermi liquid like phase, and the pseudogap phase.[1] The important fact is that the phase diagram is controlled by the doping hole concentration x. However, it is far from clear what the appropriate description is in a system with many holes because of strong correlations between doped holes and AF spin fluctuations. Contrastingly, the system with a single hole is the simplest system to investigate the behavior of a doped hole. Furthermore, the AF long-range ordered phase, which is the ground state of the undoped parent compound, is the most established phase.[2] Experimentally, angle resolved photoemission spectroscopy on the parent compounds provides useful information on the properties of the single hole doped system.[3]

In this short note, it is argued that the half-skyrmion is created by the doped hole.[4] We assume that the Zhang-Rice singlet[5] is formed between the doped hole and a localized spin moment. Because the wave function of the Zhang-Rice singlet has the form of superposition of the different d-orbital spin states, we expect that the spin configuration around the Zhang-Rice singlet is given by superposition of the spin configurations created by each spin state. In the presence of the AF long-range order, the one spin state creates a skyrmion excitation in the localized spin system, and the other spin state does not affect the neighboring spins. These solutions are obtained from analysis of the non-linear σ model. The spin configurations suggest that superposition of them is characterized by a topological charge Q with $0 < |Q| < 1$. The value of Q is determined by making use of the fact that the AF long-range ordered state is described by Bose-Einstein condensation of the Schwinger bosons. In the CP^1 representation, it turns out that the topological charge corresponds to the gauge flux $2\pi Q$. Because of Bose-Einstein condensation, Q takes a quantized value. Since the spin $1/2$ excitation is confined in the AF long-range ordered phase, all those bosons are paired, and so the flux quantum is π. Due to the constraint on the value of Q inferred from the analysis of spin configurations, we may conclude that $|Q| = 1/2$. Thus, we obtain the half-skyrmion which is schematically shown in Fig. 2.6.

Since the CP^1 model is Lorentz invariant with the spin wave velocity $c_{\rm sw}$ being the speed of "light," the moving half-skyrmion solution is constructed by applying a Lorentz transformation to the static half-skyrmion solution. Calculating energy-momentum tensors, we obtain the excitation spectrum of the half-skyrmion:

$$\varepsilon_k^{\pm} = \pm\sqrt{c_{\rm sw}^2(\cos^2 k_x + \cos^2 k_y) + (mc_{\rm sw})^2}. \qquad (1)$$

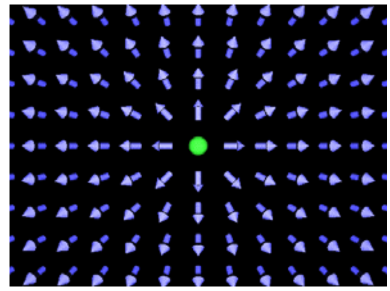

Figure 2.6: The half-skyrmion spin configuration. The arrows represent staggered moments and the circle represents the Zhang-Rice singlet.

This excitation spectrum is qualitatively in good agreement with the experimentally obtained spectrum. The band width is estimated to $\sim 1.5J$, while experimentally estimated value is $\sim 2.2J$. The discrepancy would be associated with the deviation of the real system from the non-linear σ model that is justified only for long-length and low-energy physics.

The effective theory of the half-skyrmion is given by a system of a Dirac fermion with a U(1) gauge field interaction. This gauge field is associated with AF spin fluctuations. We expect that the strong coupling effect associated with the gauge field leads to a broad peak. In the AF long-range ordered phase, there is a logarithmic potential between a half-skyrmion and an anti-half-skyrmion. Due to this logarithmic potential, half-skyrmions and anti-half-skyrmions are confined. Since the half-skyrmions behave as a vortex introduced in condensate, the AF long-range order is suppressed by increasing x.

In the absence of the AF long-range order, the topological charge is no more quantized. Instead, the spin texture created by doped holes would be characterized by Q with $0 < |Q| < 1/2$. If this is the case, we can apply a mechanism of d-wave superconductivity based on a skyrmion-like spin texture.[6]

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Super-critical Accretion Flows around Black Holes

Ken Ohsuga (Rikkyo University)

It is widely believed that accretion flow onto black holes drives major activities of astrophysical black holes, such as active galactic nuclei, Galactic black hole candidates, and possibly gamma-ray bursts. The standard-disk model proposed by Shakura & Sunyaev [1] has had some success in describing optically thick accretion flow structure. However, this model breaks down in the high-luminosity regimes, in which mass-accretion rates becomes comparable to or exceeds the critical mass-accretion rate. Such near- or super-critical accretion flows have been suggested to be energy sources of several very luminous objects. Moreover, the super-critical accretion might resolve the formation history of the supermassive black holes in the galactic nuclei, since the growth timescale of the black holes is very short in the super-critical accretion phase. Thus, it is of great importance to study the super-critical disk accretion flows around the black holes.

What makes the super-critical accretion flows distinct from the standard-disk-type flow is the presence of photon trapping [2], by which photons are trapped within accretion flow and are swallowed by a black hole, with little being radiated away. Since the photon trapping is basically a multi-dimensional effect, we thus need at least two-dimensional treatment. Whereas the slim-disk model (one-dimensional model) has been believed to be the solution of the supercritical disk accretion flow [3], it has been shown that this model does not fully consider the photon trapping effects [4]. The simulations of super-critical flows around black holes were pioneered by Eggum, Coroniti, & Katz [5] and was improved by Okuda [6]. However, the quasi-steady state had not been achieved by their simulations. Also, the photon-trapping have not been investigated. Hence, the quasi-steady structure of the super-critical accretion flows still remains to be an open issue.

The quasi-steady structure of super-critical accretion flows around a black hole is studied based on the two-dimensional radiation-hydrodynamical (2D-RHD) simulations [7]. The super-critical flow is composed of two parts: the disk region (with mostly inflow) and the outflow regions above and below the disk. The two regions are separated by a sharp density jump. The gas outflow driven by the strong radiation pressure is produced around the rotation axis. Within the disk region the circular motion as well as the patchy density structure are observed, which is caused by Kelvin-Helmholtz instability and probably by convection (see Figure 1). The photon-trapping plays an important role in the super-critical accretion regime. The advective energy transport is substantial, and the large amount of photons generated inside the disk is swallowed by the black hole without radiated away. The mass-accretion rate onto the black hole increases with increase of the absorption opacity (metalicity) of the accreting matter. This implies that the black hole tends to grow up faster in the metal rich regions as in starburst galaxies or star-forming regions.

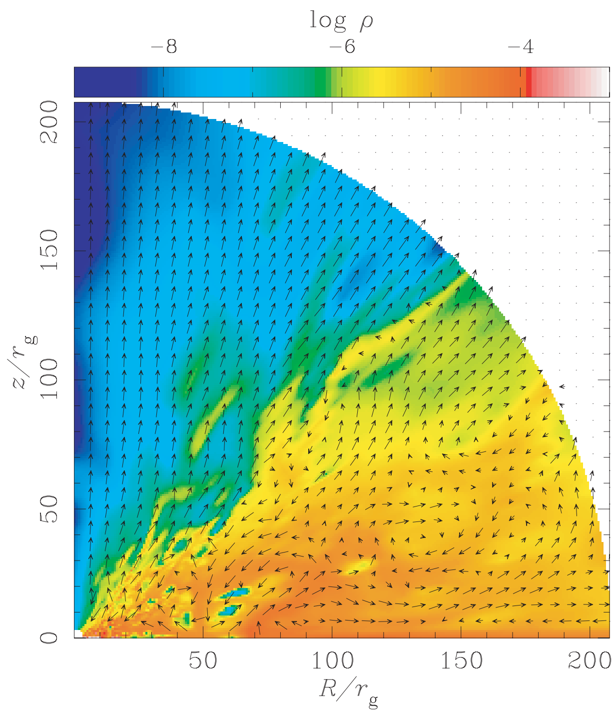

Figure 2.7: The 2D density distribution overlaid with the velocity vectors (with arrows).

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Model Independent Determination of the Cabibbo-Kobayashi-Maskawa matrix element $|V_{ub}|$

Tetsuya Onogi (YITP)

Precise determination of the Cabibbo-Kobayashi-Maskawa (CKM) matrix elements from the B, D, and K decays is one of the major goals in flavor physics. By measuring both the sides and the angles of the unitarity triangle, one can test the consistency of the standard model, which can either verify the standard model or probe a signal of new physics. Despite its importance, the CKM matrix element $|V_{ub}|$ is one of the most poorly known quantities at present.

There are two ways to determine $|V_{ub}|$, i.e. the determination from the inclusive semileptonic decay $B \to X_u l \nu$, [1, 2] and the determination from the exclusive semileptonic decay $B \to \pi l \nu$ or $B \to \rho l \nu$. Since both methods still suffer from large theoretical errors, improvements in the theoretical method are needed.

The weak matrix element of the exclusive heavy-to-light semileptonic decay $B \to \pi l \nu$ is parameterized as

$$\begin{aligned} \langle \pi^+(k)|V^\mu(0)|B^0(p)\rangle &= \left(p+k-q\frac{m_B^2-m_\pi^2}{q^2}\right)^\mu f^+(q^2) \\ &\quad +q^\mu \frac{m_B^2-m_\pi^2}{q^2} f^0(q^2), \end{aligned}$$

where $V^\mu = \bar{q}\gamma^\mu b$ and q^2 ranges from 0 to $q^2_{max} = (m_B - m_\pi)^2$. The differential decay rate is written as

$$\frac{d\Gamma(B\to \pi l \nu)}{dq^2} = \frac{G_F^2}{24\pi^3}|V_{ub}|^2[(v\cdot k)^2 - m_\pi^2]^{3/2}|f^+(q^2)|^2.$$

In order to determine $|V_{ub}|$ from experimental data one needs to know the form factor, which can be computed with lattice QCD [3, 4, 5, 6]. However, at large recoil, the cutoff effects become non negligible so that the precise computation of the form factor is limited only for large q^2 region. Although B factory experiments can measure the differential decay rate at high q^2 regime, they are statistically limited while the rich experimental data for the low q^2 region will remain untouched. Lellouch proposed a statistical method in which one uses the form factor values with theoretical errors for $B \to \pi l \nu$ at high q^2 from lattice QCD to give a distribution of the dispersive bound for the form factors for the small q^2 region [7]. Although attractive, his original method can give a very loose bound for the form factor and therefore useless in practice.

Recently CLEO gave the q^2 dependence of the $B \to \pi l \nu$ decay [8]. In this work [9], we proposed a method to improve Lellouch's idea. The idea is to use the information on the q^2 dependence of the $B \to \pi l \nu$ from the experiment to restrict the statistical distribution of the dispersive bound. We show that this additional input leads to a better determination of $|V_{ub}|$. As as result, assuming uncorrelated Gaussian errors for the lattice data we obtained

$$|V_{ub}| = [3.73 \pm 0.53] \times 10^{-3}.$$

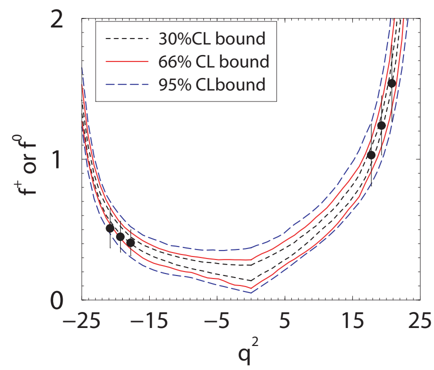

Figure 2.8: Confidence level (CL) bound for $f^+(q^2)$. Here we used JLQCD's lattice input, and CLEO's experimental data.

This can be compared to the conventional $|V_{ub}|$ determination using only the raw lattice data and the CLEO result at highest q^2 bin. For example, if we use the JLQCD results of the differential decay rate for $q^2 > 16$ GeV^2, we obtain $|V_{ub}| = [3.1 \pm 0.9] \times 10^{-3}$. This means that the $|V_{ub}|$ error of 30% in the conventional method is reduced to 14 % in our new method. As a by product we also obtained a 66% confidence level bound for the form factor at small q^2,

$$0.293 \quad < f(0) < 0.126$$

which will be very useful for predicting the two body decay rate in QCD factorization.

Further improvement of $|V_{ub}|$ using the form factors from unquenced lattice QCD and the experimental data from Belle and BaBar should be made in near future.

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Effective geometry in fuzzy spaces and heat kernel expansions

Naoki Sasakura (YITP)

The space-time in general relativity is a continuous manifold with metric. But some thought experiments [1] in semi-classical quantum gravity and string theory suggest that, because of the large quantum fluctuation of the metric at Planck scale, this classical notion should be replaced with a quantum one. At present we do not know what it is.

Noncommutative geometry or fuzzy spaces [2] are the interesting candidates. In the commutative case, the Gel'fand-Naimark theorem tells that one can reconstruct a space from the algebra of the functions on it. The fuzzy spaces are defined by generalizing the algebras, namely noncommutative (and nonassociative) algebras as the algebras of the functions on them. Since they are defined algebraically, the notion of geometry is a secondary object hidden in such spaces. Since the fundamental degrees of freedom of the general relativity is the metric, one might be interested in what is the geometry in fuzzy spaces. This would be helpful in formulating their gravitational dynamics.

In the classical particle mechanics, the geometry can be obtained by observing the trajectory of a particle. In the same way, one may construct geometry by observing the behavior of a field in quantum field theory. Now let me consider a scalar field. The heat kernel expansion in a continuous space is known to have the following power-law asymptotic expansion for $t \to +0$ [3],

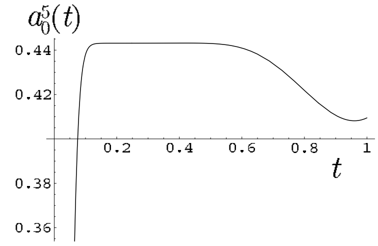
$$\mathrm{Tr}(h\,e^{-tA}) \simeq \sum_{j=0}^{\infty} t^{j-\nu/2} a_{2j}(h), \qquad (1)$$

where A is the minus of the Laplacian $A = -\Delta$, ν is the dimension of the space, h is a smooth function, and

$$\begin{aligned} a_0(h) &= \frac{1}{(4\pi)^{\nu/2}} \int d^\nu x \sqrt{g}\, h, \qquad (2) \\ a_2(h) &= \frac{1}{(4\pi)^{\nu/2}} \int d^\nu x \sqrt{g}\, h \frac{R}{6}, \end{aligned}$$

for $j = 0, 1$. Therefore one can extract some physically interesting geometric quantities if the heat kernel trace can be computed. Note that the local geometric quantities can be extracted by choosing an h with a local support.

This idea in continuum theory cannot be used for a compact fuzzy space. This is because the number of the degrees of freedom on such a fuzzy space is finite, and the heat kernel trace is a regular function of t. Thus there is no asymptotic expansion for $t \to +0$. On the otherhand, it is physically expected that the usual continuous description holds well at a scale enough larger than the scale of fuzziness. Therefore the heat kernel trace should have a region $t_{min} \lesssim t \lesssim t_{max}$, where it can be well approximated by the power-law expansion (1). The minimum t_{min} comes from the scale of fuzziness, while the maximum t_{max} comes from the whole size of a fuzzy space.



Then the coefficients of the approximate power-law expansion will give the effective geometric quantities of a fuzzy space [4].

To extract these coefficients it is more convenient to define the following 'coefficient functions',

$$a^N_{h,2j}(t) = \sum_{i\geq j}^{N-1} \frac{(-t)^{i-j}}{j!(i-j)!} f_h^{(i)}(t),$$

where $f_h^{(i)}(t)$ denotes the i-th derivative of $f_h(t)$ defined by $f_h(t) = t^{\nu/2}\mathrm{Tr}(h\,e^{-tA})$. The effective geometric quantities can be found as the values at the 'stable region', where the coefficient functions take almost constant values. In the figure, the behavior of the coefficient function with $j = 0$ for a fuzzy three-sphere is shown. There clearly exists the 'stable region', and the value there can be shown to agree very well with the continuum value (2), namely the volume of a unit three-sphere.

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Labyrinthine versus Straight-striped Patterns Generated by Two-dimensional Turing Systems

Hiroto Shoji (YITP), Yoh Iwasa (Kyushu Univ.)

Some animals exhibit a striped pattern on their skin, as exemplified by the coats of zebras and tigers. The animal coat patterns formation has been studied mathematically using the Turing type of reaction-diffusion model[1][2] ; which is represented by a pair of partial differential equations. Especially, the patterns in fish skin could be explained very well by Turing system[4] , where Turing [3] specifically considered two chemical systems, an activator u and an inhibitor v as following:

$$\begin{aligned} \partial u/\partial t &= \nabla^2 u + au - v, \\ \partial v/\partial t &= d\nabla^2 v + bu - v. \end{aligned} \qquad (1)$$

in which γ represents the scale parameter and a, b and d are the positive parameters. For the model to generate a stationary periodic distribution, we need to add constrain terms to keep variables within a finite range: $u_{min} \leq u \leq u_{max}$, where u_{min} and u_{max} are constants. According to Shoji et al.[5], a Eq. (1) with the interval constraint of u is able to generate striped patterns if the equilibrium of the linear kinetics is located in the middle of the interval. Among the striped patterns generated by Turing models, some are "straight-striped patterns," with many stripes running in parallel (as illustrated in Fig.(a)), while others are "labyrinthine patterns," in which the stripes often change direction, merge with each other, and frequently branch out (as shown in Fig. (d)). Here, we report the condition under which either a labyrinthine or straight-striped pattern would emerge.

First, we defined an index for stripe clearness function S_h by using the spatical colleration function. The index S_h indicates large values for straight-striped patterns or indicates the small values for labyrinthine patterns as shown in Fig.(e).

We then derived criteria for the prediction whether a labyrinthine or a straight-striped pattern would be generated, as based on unstable modes of Eq. (1). By analyzing growing modes of deviation from the uniform steady state, there is a range of spatial periods that correspond to unstable modes; D_k indicates the width of this range. D_k successfully predicts the pattern to be generated. If the D_k value is small, unstable modes should be very similar spatial periods to each other, and the striped patterns that form are those with straight stripes. In contrast, if the value is large, a wide range of spatial periods may correspond to unstable modes, and labyrinthine patterns are formed. Figure (f) shows the relation between D_k and stripe-clearness S_h. For the parameters in the lower right group, the model generates labyrinthine patterns. For the parameters in the upper left group, straight-striped patterns are generated. We also examined other types of modes with nonlinear reaction terms, and we demonstrated that the same conclusion hold with respect to the conditions required for labyrinthine versus straight-striped patterns.

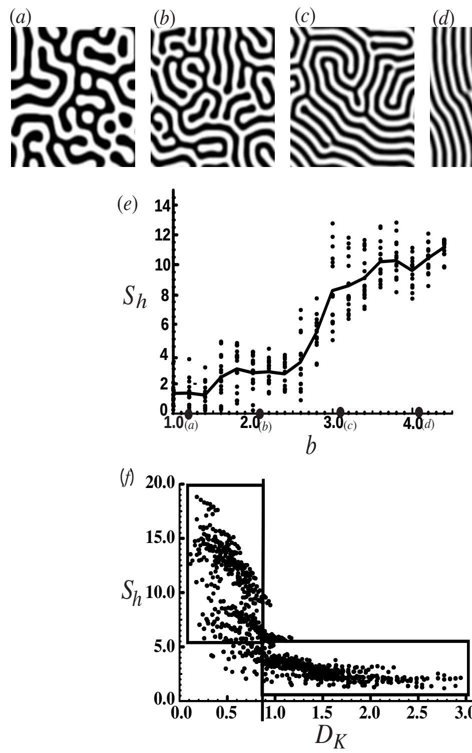

Figure 2.9: (a)-(d) Striped patterns generated by Eq. (1) The parameters were identical, except for b. (a)b=1.20, (b)b=2.20, (c)b=3.20, (d)b=4.20. (e)The plot of stripe-clearness: S_h respect to b. (f) The correlation between the heuristic values D_k and stripe-clearness S_h

We concluded that the heuristic index D_k successfully predicts the pattern to be generated where systems far from critical points have no way to detect the dynamics. [6]

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QCD and String Theory

Shigeki Sugimoto

Since Maldacena proposed the duality between string theory in AdS space and conformal field theory [1], there have been various attempts to extend this idea to more general situations. A natural question one would ask is whether we can analyze the realistic QCD using this technique.

A key step toward this direction was given by Witten in [2], in which a supergravity dual of the four dimensional pure Yang-Mills theory was proposed. The basic idea is to use D4-branes compactified on a supersymmetry breaking circle to realize four dimensional Yang-Mills theory and replace the D4-branes with the corresponding supergravity solution to obtain a holographic dual description. Though it is in general quite difficult to obtain a rigorous result in the duality of such non-supersymmetric theory, a lot of non-trivial evidence for the duality has been found and it encourages us to further investigate along this line toward the analysis of QCD via supergravity or superstring theory.

Recently, Kruczenski et al. proposed an interesting model (KMMW model) which is supposed to be a holographic dual of (large N_c) QCD.[3] Their model is constructed by adding probe D6-branes, which corresponds to adding quarks, in the above supergravity background representing pure Yang-Mills theory.

In our recent paper [4], we proposed another holographic dual of QCD with massless flavors. The construction of our model is quite similar to the KMMW model, but we use D8-branes as the probes instead of the D6-branes. One of the advantages of our model is that the chiral $U(N_f)_L \times U(N_f)_R$ symmetry is manifestly realized and we can argue its spontaneous breaking and the appearance of the associated Nambu-Goldstone bosons, which are interpreted as pions. Moreover, massive (axial-) vector mesons are also found in the meson spectrum. We calculated some of the masses and couplings of these mesons and compared them with the experimental data. We should, however, keep in mind that the classical analysis in the supergravity side can only be trusted if the number of color and the 't Hooft coupling are large enough, which might sound still a bit far from the realistic situation. Nevertheless our model seems to nicely catch various features of QCD.

Here is a short list of our main results.

- **Chiral symmetry breaking**

  The chiral $U(N_f)_L \times U(N_f)_R$ symmetry is realized as a part of the gauge symmetry of the probe D8-brane. The spontaneous breaking of this symmetry can be understood geometrically and the associated massless NG modes are found in the gauge field of the D8-brane.

- **Unification of mesons**

  Not only the pions, an infinite tower of vector mesons (ρ meson, a_1 meson, etc.) is found in the meson spectrum. They are elegantly unified in the gauge field of the D8-brane.

- **Meson spectrum**

  The masses of the vector mesons found in our model are calculated numerically. We obtained

$$\frac{m^2_{a_1(1260)}}{m^2_\rho} \simeq \begin{cases} 2.4 & \text{(our model)} \\ 2.51 & \text{(experiment)} \end{cases}$$

$$\frac{m^2_{\rho(1450)}}{m^2_\rho} \simeq \begin{cases} 4.3 & \text{(our model)} \\ 3.56 & \text{(experiment)} \end{cases}$$

etc. We think the agreement is not bad as a first attempt.

- **Effective action**

  We found that the effective action of the pion field derived from our model coincides with that of the Skyrme model. We also analyzed the 3 point coupling $g_{\rho\pi\pi}$ of the ρ meson and two pion fields, which contributes to the $\rho \to \pi\pi$ decay amplitude. Our numerical result is compared with the experimental data as

$$\frac{4g^2_{\rho\pi\pi}f^2_\pi}{m^2_\rho} \simeq \begin{cases} 1.3 & \text{(our model)} \\ 2.0 & \text{(experiment, KSRF relation)}\ . \end{cases}$$

- **Baryon**

  A baryon is constructed as a D4-brane wrapped on the S^4 as proposed in [5]. This wrapped D4-brane is realized as the instanton on the D8-brane world-volume and shown to be equivalent to the soliton (Skyrmion) in the Skyrme model.

- **Chiral anomaly and WZW term**

  The chiral anomaly and the WZW term in QCD are reproduced from the CS-term on the probe D8-brane embedded in the D4-brane background.

- **$U(1)_A$ anomaly and η' meson mass**

  The $U(1)_A$ anomaly is understood in the supergravity description. Taking this anomaly into account, the mass of the η' meson is estimated and shown to satisfy the Witten-Veneziano formula

$$m^2_{\eta'} = \frac{2N_f}{f^2_\pi}\chi_g\ ,$$

where χ_g is the topological susceptibility.

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Dynamics of Traveling Waves under Spatio-Temporal Forcing

Hidekazu Tokuda and Takao Ohta (YITP)

We study dynamics of traveling waves under spatio-temporal forcing in non-equilibrium systems. Based on the model system where phase separation and chemical reactions take place simultaneously so that traveling waves are spontaneously formed, we apply a spatially periodic external force which propagates at a constant velocity. Entrainment and modulation of traveling waves are investigated numerically in one dimension. We develop a theoretical analysis to understand the dynamics obtained.

We employ the model system of phase separation undergoing chemical reactions introduced previously [1]. This mixture is composed of three chemical components A, B and C where A and B species tend to segregate each other and there is a cyclic chemical reaction

$$A \xrightarrow{\gamma_1} B \xrightarrow{\gamma_2} C \xrightarrow{\gamma_3} A \tag{1}$$

with the reaction rates γ_1, γ_2 and γ_3. We assume that other components are also involved in the chemical reaction such that is not violated the thermodynamic law. By introducing the local concentrations ψ_A, ψ_B and ψ_C of A, B and C components respectively, the time-evolution equations are given by [1]

$$\frac{\partial \psi}{\partial t} = \nabla^2 \frac{\delta F}{\delta \psi} + f(\psi, \phi), \tag{2}$$

$$\frac{\partial \phi}{\partial t} = g(\psi, \phi). \tag{3}$$

where $\psi = \psi_A - \psi_B$ and $\phi = \psi_A + \psi_B$. The last terms in eqs. (2) and (3) arise from the chemical reaction (1) and F is a free energy functional of the Ginzburg-Landau type.

The spatio-temporal forcing is added to eqs. (2) and (3) as

$$\Gamma(x,t) = \varepsilon \cos(q_f x - \Omega t). \tag{4}$$

This is a sinusoidal force traveling to the right at the velocity Ω/q_f. Here we suppose that the external force (4) is realized such that the system is exposed through a periodically arrayed slits by illuminating light with an oscillating intensity. As a result, we assume that the reaction rate γ_3 is modified such that $\gamma_3 \to \gamma_3 + \Gamma$. Fig. 2.10 summarizes the behavior on the $\Omega - \varepsilon$ plane. This phase diagram is obtained by the asymptotic behavior of the traveling wave after imposing the external force. The region indicated by $+$ shows that the traveling wave is entrained with the external force so that it propagates at the velocity Ω/q_f. We have performed theoretical analysis based on the amplitude equation to understand the dynamics of entrained traveling wave. The stability limit shown by the solid lines in Fig. 2.10 is consistent with simulations. Various modulated behaviors are shown in the space-time plot of the concentration ψ in Fig. 2.11. Besides the special case where the external frequency is equal to zero, i.e, motionless external forcing is investigated both by numerical simulations and theoretically. We have showed that the trapped oscillation can be understood by a phase dynamic approach. To be summarized, we have investigated, for the first time, entrainment and modulation of a traveling wave under external forcing which depends on both space and time.

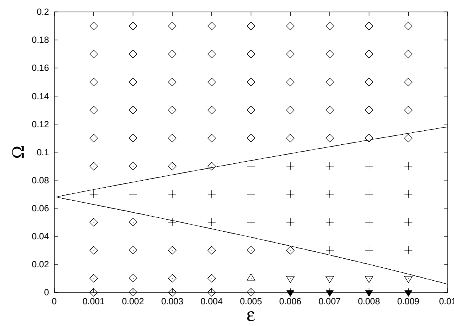

Figure 2.10: The solid line is the theoretically obtained stability limit of the entrained traveling wave having the same velocity as the external force.

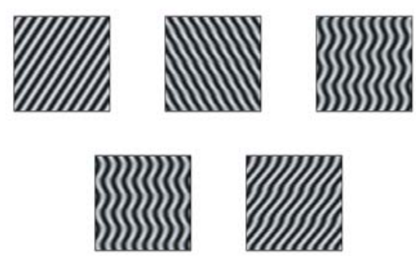

Figure 2.11: Space-time plot of ψ. The value of ψ is large (small) for lighter (darker) regions. The top-left figure is entrained traveling wave, others are various modulated waves.

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Moduli Instability in Warped Compactifications

Kunihito Uzawa and Hideo Kodama(YITP)

With the practical confirmation of the inflationary universe scenario of the early universe and the discovery of the accelerating expansion of the present universe [1, 2], it is now the most challenging problem to construct a consistent cosmological model that explains these observational facts, on the basis of supergravity and string theory, which are the only viable unified fundamental theories at present. The main obstacle to this problem is the fact that these theories require the spacetime to be higher dimensional; in order to obtain a four-dimensional universe at low energies, we have to find a natural way to conceal extra dimensions, which is usually called a compactification. This compactification gives rise to various new problems. One of the most serious problems is the moduli stabilisation [3], that is, the problem "Why is the size of an internal space kept constant and small?". Another is the no-go theorem against accelerating expansion of the universe in simple Kaluza-Klein-type or stationary warped compactification with a smooth compact internal space [4].

Recently, a new progress in resolving these problems has been made by Kachru et al [5]. Utilising a conifold-type flux compactification of the IIB supergravity that realises the stabilisation of all complex moduli, they proposed a model in which all moduli are potentially stabilised and an accelerating expansion of the universe is realised for a sufficiently long time. There is, however, one subtle weak point in their model. It is the stability of the moduli degree of freedom corresponding to the scale of the Calabi-Yau internal space [3]. They argued that this degree of freedom would be stabilised by quantum non-perturbative effects [6]. However, their argument is based on a four-dimensional effective theory that does not take into account the warping and assumes the supersymmetric background.

In order to see whether this treatment is appropriate or not, we have studied the dynamical stability in the moduli sector of supersymmetric solutions for the conifold-type warped compactification of the ten-dimensional type IIB supergravity, by looking for extensions of supersymmetric solutions to those that depends on the four-dimensional coordinates [7]. We have found that for many of the well-known solutions compactified on a conifold [8], resolved conifold or deformed conifold [9], such extensions exist and exhibit a dynamical instability. Further, this instability is associated with supersymmetry breaking. This feature is expected to be shared by a quite wide class of supersymmetric solutions, because the result has been obtained by analysing the general structure of solutions for warped compactification with flux of the type IIB supergravity under ansatz that is natural to include supersymmetric solutions as a special case.

The dynamical solutions we found can be always obtained by replacing the constant modulus in the warp factor for supersymmetric solutions by a linear function of the four-dimensional coordinates [7]. This type of instability in the moduli sector itself is not surprising, because constant moduli have flat potentials in effective four-dimensional theories. However, it is not expected generally in the effective theories that such instabilities give rise to significant changes in the structures of the four-dimensional spacetime structure and of the internal space. It is because most effective theories do not take account of the warped structure [3, 5]. In fact, we have found that, in the conifold-type examples, the instability is most enhanced at infinity, while near the conifold singularity or in the region with a large warp factor for the deformed-conifold case, the instability is strongly suppressed [7]. Thus, the moduli stability is closely connected with the large warp factor, which has been used to resolve the hierarchy problem in the context of the flux compactification [3]. We have also found that the degree of supersymmetry breaking is also closely related to the warp factor [7], which can be interpreted as the cosmic scale factor in the cosmological context. Hence, the cosmic expansion, the hierarchy and the supersymmetry breaking are tightly connected. Although the examples we considered do not provide realistic cosmological models, this feature may be utilised to solve the hierarchy problem and the supersymmetry breaking problem in a realistic higher-dimensional cosmological model.

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Defects in integrable field theories

Cristina Zambon (YITP)

The interest in studying the feasibility to introduce some sort of boundary in integrable systems has started in the late 80s (Cardy, Ghoshal, A. Zamolodchikov and others) with the idea to restrict these field theories to a half line. Although this area of research is still nowadays object of investigation with many outstanding problems, in more recent year the attention has been also focused on a different kind of boundary problem, that is the defect. From our point of view the defect has to be understood as a discontinuity localised at one point of the x-axis and is supposed to link two, possibly different, field theories living on opposite sides with respect to the defect itself.

Using a lagrangian approach the boundary potential which allows to preserve integrability has been found for the the sine-Gordon model [1], $a_r^{(1)}$ affine Toda field theory [2], non-linear Schrödinger and Korteweg de Vries equations (unpublished). The aim of finding the suitable boundary potential has been pursued using two different methodologies which are complementary: the explicit calculation of conserved charges [3] and the formulation of modified Lax pairs [4]. The Lax pair are the two components of a gauge potential associated with the field theory which play a central role in finding the conserved charges of the theory, since they provide an expression for the charge generator. However it has to be said that such an investigation is still not complete for the system described by the Korteweg de Vries equation. The fact that the boundary conditions turn out to be non-local makes this model different from the others from a defect point of view.

Consequences of such an investigation were remarkable. First of all, even if translation invariance is broken, a generalised momentum is conserved. Moreover, thinking of the affine Toda theories, the pattern of the conserved charges is different for the sine-Gordon model with respect to the other affine Toda theories with several scalars which are in the same series a_r (from a point of view of the Lie algebra). Maybe this is not surprising since the sine-Gordon model is somehow peculiar in several respects. Another interesting fact is that the boundary conditions found have the form of Bäcklund transformations restricted to one point. This connection between defects and Bäcklund transformations throws a new light on the Bäcklund transformation itself.

It was verified that no reflection is allowed, only transmission and consequently classical transmission coefficients were calculated. The behaviour of the single soliton solutions have also been investigated. The main effect of the defect is to cause a delay in the soliton when it passes through, however the defect has also the ability to change a soliton into an antisoliton or vice versa, when the rapidity value is within a certain range of values. Surprisingly, it was also found that for special values of the rapidity the soliton can be swallowed by the defect. Moreover, at least for the sine-Gordon model the defect can also emit a soliton. Consequently, topological charge is not conserved and the defect allows topological charge to change by ± 1 or ± 2.

Looking at the sine-Gordon model we also found that when more solitons approach the defect they interact separately with the defect itself, each of them being delayed independently. This fact, together with the peculiar behaviour of solitons passing through a defect, suggested the possibility to use the defects to build logic gates [5]. Quantum aspects of the defect problem are under investigation concerning the sine-Gordon model. A solution of the transmission Yang-Baxter equation has been proposed in the past by Konik and LeClair [6]. Whether or not their solution matches our problem is left to be found.

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2.3 Publications

2.3.1 YITP preprints (January∼December 2004)

04-1 Naoki Sasakura, *Field theory on evolving fuzzy two-sphere* (January) Class. Quant. Grav. **21** (2004) 3593-3610.

04-2 K. Hagino and A. Vitturi, *Reaction dynamics for fusion of weakly-bound nuclei* (January) Prog. Theor. Phys. Suppl. **154** (2004) 77-84.

04-3 Yoshiaki Kato, Mitsuru Hayashi and Ryoji Matsumoto, *Formation of Semi-relativisitc Jets from Magnetospheres of Accreting Neutron Stars: Injection of Hot Bubbles into a Magnetic Tower* (January) Astrophys. J. **600** (2004) 338-342.

04-4 Yoshiaki Kato, Shin Mineshige and Kazunari Shibata, *Magnetohydrodynamical Accretion Flows: Formation of Magnetic Tower Jet and Subsequent Quasi-Steady State* (January) Astrophys. J. **605** (2004) 307-320.

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04-9 Hiroaki Abuki, *Role of Strange Quark Mass in Pairing Phenomena in QCD* (February) Compact stars: Quest for new state of dense matter, D.K. Hong et al., World Scientific (ISBN 981-238-954-7).

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04-11 Teiji Kunihiro, *Some Recent Topics on Possible Chiral Restoration in Nuclear Medium* (February) Prog. Theor. Phys. Suppl. **153** (2004) 15-25.

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04-13 Shigeki Sugimoto and Kazuyoshi Takahashi, *QED and String Theory* (March) JHEP **0404** (2004) 051.

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04-18 Hidenori Fukaya and Tetsuya Onogi, θ *vacuum effects on the chiral condensation and the* η' *meson correlators in the two-flavor massive* QED_2 *on the lattice* (March) Phys. Rev. **D70** (2004) 054508.

04-19 Hideo Kodama, *Uniqueness and Stability of Higher-Dimensional Black Holes* (March) J. Korean Phys. Soc. **45** (2004) S68-S76.

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04-31 Hiroshi Kunitomo, *Hybrid Superstring on AdS_3 and Space-Time Superconformal Symmetry* (June) Prog. Theor. Phys. **112** (2004) 699-736.

04-32 Masaru Fukunaga and Tetsuya Onogi, *A model independent determination of $|V_{ub}|$ using the global q^2 dependence of the dispersive bounds on the $B \to \pi l \nu$ form factors* (August) Phys. Rev. **D71** (2005) 034506.

04-33 Naoki Sasakura, *Evolving fuzzy CP^n and lattice n-simplex* (June) Phys. Lett. **B599** (2004) 319-325.

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04-53 Yasuhisa Abe, Bertrand Bouriquet and Grigori Kosenko, *Theoretical Predictions of Excitation Functions for Synthesis of the Superheavy Elements* (September) Proc. International Symposium on EXON2004, Peterhof, Russia, 5-12 July 2004 (World Scientific Publishing).

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04-55 S. Odake and R. Sasaki, *Shape Invariant Potentials in "Discrete Quantum Mechanics"* (October) J. Nonlinear Math. Phys. Suppl. **12** (2005) 507-521.

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04-58 D. Fioravanti and M. Rossi, *From finite geometry exact quantities to (elliptic) scattering amplitudes for spin chains: the* $1/2$*-XYZ* (December) hep-th/0504122.

04-59 Antonino Flachi, Alan Knapman, Wade Naylor and Misao Sasaki, *Zeta Functions in Brane World Cosmology* (October) Phys. Rev. **D70** (2004) 124011.

04-60 S. Odake and R. Sasaki, *Equilibrium Positions, Shape Invariance and Askey-Wilson Polynomials* (October) J. Math. Phys. **46** (2005) 063513.

04-61 Hiroshige Kajiura and Jim Stasheff, *Homotopy algebras inspired by classical open-closed string field theory* (October) math.QA/041H0291.

04-62 Wataru Hikida, Sanjay Jhingan, Hiroyuki Nakano, Norichika Sago, Misao Sasaki and Takahiro Tanaka, *A new analytical method for self-force regularization II. Testing tHhe efficiency for circular orbits* (October) Prog. Theor. Phys. **113** (2005) 283-303.

04-63 A. Hayashigaki and K. Terasaki, *Isospin quantum number of* $D_{s0}^{+}(2317)$ (November) hep-ph/0410393.

04-64 Naoki Sasakura, *Heat kernel coefficients for compact fuzzy spaces* (November) JHEP **0412** (2004) 009.

04-65 Wade Naylor and Misao Sasaki, *Quantum Fluctuations for de Sitter Branes in Bulk* AdS_5 (November) Prog. Theor. Phys. **113** (2005) 535-554.

04-66 Mihoko M. Nojiri, *Supersymmetry at the LHC and Beyond –Ultimate Targets–* (November) Proc. 12th International Conference on SUSY04, Tsukuba, Japan, 17-23 Jun 2004 (Tsukuba 2004, Supersymmetry and unification of fundamental interactions) 101-116.

04-67 David H. Lyth, Karim A. Malik and Misao Sasaki, *A general proof of the conservation of the curvature perturbation* (November) JCAP **0505** (2005) 004.

04-68 Kazuki Hasebe, *Supersymmetric Quantum Hall Effect on Fuzzy Supersphere* (November) Phys. Rev. Lett. **94** (2005) 206802.

04-69 Sebastien Gurrieri, *Compactifications on Half-flat manifolds* (December) Fortsch. Phys. **53** (2005) 278-336.

04-70 Tadakatsu Sakai and Shigeki Sugimoto, *Low energy hadron physics in holographic QCD* (December) Prog. Theor. Phys. **113** (2005) 843-882.

04-71 J. J. Mckenzie-Smith and Wade Naylor, *Partition function for a singular background* (December) Phys. Rev. **B610** (2005) 159-164.

04-72 Takeru K. Suzuki and Shigehiro Nagataki, *Alfvén Wave-Driven Proto-Neutron Star Winds And R-Process Nucleosynthesis* (December) Submitted to Astrophys. J.

04-73 Junji Hisano, Shigeki. Matsumoto, Mihoko M. Nojiri and Osamu Saito, *Non-Perturbative Effect on Dark Matter Annihilation and Gamma Ray Signature from Galactic Center* (December) Phys. Rev. **D71** (2005) 063528.

04-74 Yoshiyuki Morisawa and Daisuke Ida, *Scalar field perturbation on six-dimensional ultra-spinning black holes* (December) Phys. Rev. **D71** (2005) 044022.

04-75 Yoshinobu Habara, Holger B. Nielsen and Masao Ninomiya, *Negative Energy (Dirac-like) Sea for Bosons and Supersymmetry* (December) hep-th/0501095.

2.3.2 Publications and Talks by Regular Staff (April 2004 — March 2005)

Daisuke Jido

Journal Papers

1. T. Hyodo, S. i. Nam, D. Jido and A. Hosaka, "*Detailed analysis of the chiral unitary model for meson baryon scatterings with flavor SU(3) breaking effects*", Prog. Theor. Phys. **112** (2004) 73.
2. S. I. Nam, H. C. Kim, T. Hyodo, D. Jido and A. Hosaka, "*Regularization dependence of $S = 0$ and $S = -1$ meson baryon system in the chiral unitary model*", J. Korean Phys. Soc. **45** (2004) 1466.
3. H. Nagahiro, D. Jido and S. Hirenzaki, "*η-mesic nuclei in chiral models*", Prog. Theor. Phys. Suppl. **153** (2004) 340.

Books and Proceedings

1. D. Jido, J.A. Oller, E. Oset, A. Ramos, U.-G. Meissner, "*Chiral dynamics of the two Lambda(1405) states*", NSTAR 2004, edited by J.P. Bocquet, V. Kuznetsov, D. Rebreyend, World Scientific, 428p (2004).
2. A. Ramos, C. Bennhold, A. Hosaka, T. Hyodo, D. Jido, U.-G. Meissner, J.A. Oller, E. Oset, M.J. Vicente-Vacas, "*Dynamical baryon resonances from chiral unitarity*", NSTAR 2004, edited by J.P. Bocquet, V. Kuznetsov, D. Rebreyend, World Scientific, 428p (2004).

Invited Talks at International Conferences

1. Daisuke Jido, "*Chiral dynamics of the two Λ (1405) states*", KEK Workshop on Nuclear Chiral Dynamics, March 18-20, 2004, Tsukuba, Japan.

Yoshiko Kanada-En'yo

Journal Papers

1. Y. Kanada-En'yo, Y. Akaishi, "*New effective nuclear forces with a finite-range three-body term and their application to antisymmetrized molecular dynamics*", Phys.Rev. C **68**, 034306 (2004).
2. Y. Kanada-En'yo, M. Kimura, H. Horiuchi, "*Clustering in stable and unstable nuclei in p-shell and sd-shell regions*", Nucl. Phys. A **738**, 3 (2004).
3. Y. Kanada-En'yo Y, M. Kimura, H. Horiuchi, "*Clustering in stable and unstable nuclei in sd- and pf-shell regions*", Nucl. Phys. A **734**, 341 (2004).
4. Y. Kanada-En'yo, O. Morimatsu, and T. Nishikawa, "*Narrow $J^\pi = 1/2^+$, $3/2^+$, and $3/2^-$ states of Θ^+ in a Quark model with Antisymmetrized Molecular Dynamics*", Phys. Rev. C **71**, 045202 (2005).
5. Y. Kanada-En'yo, "*Deformation of C isotopes*", Phys. Rev. C **71**, 014310 (2005).
6. Y. Kanada-En'yo, "*Deformations in $N = 14$ isotones*", Phys. Rev. C **71**, 014303 (2005).
7. T. Nishikawa, Y. Kanada-En'yo, O. Morimatsu, and Y. Kondo, "*Θ^{++} from the QCD sum rule*", Phys. Rev. D **71**, 016001 (2005).
8. T. Nishikawa, Y. Kanada-En'yo, O. Morimatsu, and Y. Kondo, "*Spin-3/2 pentaquark in the QCD sum rule approach*", Phys. Rev. D **71**, 076004 (2005).

Hideo Kodama

Journal Papers

1. Kodama H. and Ishibashi A., "*Master equations for perturbations of generalized static black holes with charge in higher dimensions*", Prog. Theor. Phys. **111**, 29-73 (2004).
2. Kodama H., "*Uniqueness and Stability of Higher-Dimensional Black Holes*", J. Korean Phys. Soc. **45**, S68-S76 (2004).
3. Kodama H., "*Perturbative Uniqueness of Black Holes near the Static Limit in All Dimensions*", Prog. Theor. Phys. **112**, 249-274 (2004).

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1. Kodama H. and Ishibashi A., "*Stability of generalised static black holes in higher dimensions*", Relativity Today, Proc. of the Seventh Hungarian Relativity Workshop, ed. by I. Rácz, Akadémiai KIadó, 3-18 (2004).

Invited Talks at International Conferences

1. Kodama H., "*Perturbative Uniqueness of Black Holes in Four and Higher Dimensions near the Static Maximally Symmetric Limit*", The 17th Int. Conf. on General Relativity and Gravity, 19-23 July 2004, Dublin, Ireland.

Taichi Kugo

Journal Papers

1. M. Bando, T. Kugo, A. Sugamoto and S. Terunuma, "*Pentaquark Baryons in String Theory*", Prog. Theor. Phys. **112** (2004), 325 – 355.

Teiji Kunihiro

Journal Papers

1. M. Kitazawa, T. Koide, T. Kunihiro and Y. Nemoto, "*Pre-critical phenomena of two-flavor color superconductivity in heated quark matter: Diquark-pair fluctuations and non-Fermi liquid behavior of quarks*", Prog. Theor. Phys. **114** No.1, (2005), in press.

2. H. Abuki, M. Kitazawa and T. Kunihiro, "*How do chiral condensates affect color superconducting quark matter under charge neutrality constraints?*", Phys. Lett. **B**, (2005), in press..

3. M. Kitazawa, T. Koide, T. Kunihiro and Y. Nemoto, "*Non-equilibrium critical dynamics and precursory phenomena in color superconductivity*", Prog. Theor. Phys. Suppl. **156**, 176 (2004).

4. T. Kunihiro, "*Some recent topics on possible chiral restoration in nuclear medium*", Prog. Theor. Phys. Suppl. **153**, 15 (2004).

5. M. Kitazawa, T. Koide, T. Kunihiro and Y. Nemoto, "*Pseudogap of color superconductivity*", Prog. Theor. Phys. Suppl. **153**, 301 (2004).

6. T. Kunihiro, S. Muroya, A. Nakamura, C. Nonaka, M. Sekiguchi and H. Wada, [SCALAR Collaboration], "*Scalar mesons in lattice QCD*", Phys. Rev. D **70**, 034504 (2004).

7. M. Kitazawa, T. Koide, T. Kunihiro and Y. Nemoto, "*Pseudogap of color superconductivity in heated quark matter*", Phys. Rev. D **70**, 056003 (2004).

Books and Proceedings

1. H. Suganuma, N. Ishii, M. Oka, H. Enyo, T. Hatsuda, T. Kunihiro and K. Yazaki, "*CONFINEMENT2003*", Proceedings for International Conference, Confinement 2003, Wako, Japan, July 21-24, 2003, (World Scientific, 2004).

Invited Talks at International Conferences

1. Teiji Kunihiro, "*A Summary and Concluding Remarks*", Invited talk at International workshop on Chiral Restoration in Nuclear Medium (Chiral05), RIKEN, Japan, February 15-17, 2005.

2. Teiji Kunihiro, "*Soft Modes and Quasi-particles above the Critical Temperature of the QCD Phase Transitions*", Invited talk at 2004 International workshop on Dynamical Symmetry Breaking, Nagoya University, Nagoya, Japan, December 21-22, 2004.

3. Teiji Kunihiro, "*Change in the Quasi-particle Picture in Association with QCD Phase Transitions*", Invited talk at Korea-Japan Joint Workshop for Nuclear Physics, Jeju University, Jeju, Korea, October 21-22, 2004.

4. Teiji Kunihiro, "*QCD Phase Transitions and Soft Modes*", Invited talk at INT Workshop on QCD and Dense Matter: From Lattice to Stars, INT, Seattle, Washington University, USA, Mrach 29 - June 18, 2004.

Hiroshi Kunitomo

Journal Papers

1. Hiroshi Kunitomo, "*Hybrid Superstrings on AdS_3 and Space-Time Superconformal Symmetry*", Prog. Theor. Phys. **112**, 699–736 (2004).

Shin Mineshige

Journal Papers

1. Kato, Y., Mineshige, S., and Shibata, K. 2004, "*Magnetohydrodynamical Accretion Flows: Formation of Magnetic Tower Jet and Subsequent Quasi-Steady State*", ApJ, **605**, 307–320.

2. Ishioka, R., Mineshige, S., Nogami, D., Kato, T. 2004, "*Spectacular Line-Profile Variations during an Eclipse of a Dwarf Nova, IP Peg*", PASJ, **56**, 481–485.

3. Wang, J.-M., Mineshige, S., and Watarai, K. 2004, "*Hot Disk Corona and Magnetic Turbulence in Radio-Quiet Active Galactic Nuclei: Observational Constraints*", ApJ, **607**, L107–L110.

4. Ohsuga, K., Kato, Y., and Mineshige, S. 2005, "*Spectral Properties of Three-Dimensional Magnetohydrodynamical Accretion Flows*", ApJ, **627**, 782–789.

5. Ohsuga, K., Mori, M., Nakamoto, T., and Mineshige, S. 2005, "*Super-Critical Accretion Flows around Black Holes: Two-Dimensional, Radiation-Pressure-Dominated Disks with Photon-Trapping*", ApJ, **628**, 368–381.

Books and Proceedings

1. Mineshige, S., and Makishima, K. 2004 (ed), "*Stellar-Mass, Intermediate-Mass and Supermassive Black Holes*", PTP Supple. **155**, 482pp.

2. Mineshige, S., and Ida, S. 2005 (ed), "*Origins: From Early Universe to Extrasolar Planets*", PTP Supple. **158**, 200pp.

Invited Talks at International Conferences

1. Minegshige, S., " *Microquasars: Disk Models*", The fifth microquasar workshop, 7-11 June 2004, Beijin.

2. Minegshige, S., "*Magnetized accretion flow, jets, and coronae*", Ringberg castle workshop on AGN physics, 22-25 Nov. 2004, Munchich..

Takao Morinari

Journal Papers

1. T. Morinari, "*Evolution of Néel order and localized spin moment in the doped two-dimensional Hubbard model*", J. Mag. Mag. Materials. **281**, 188-194 (2004).

Shigehiro Nagataki

Journal Papers

1. S.Nagataki, "*High-Energy Neutrinos Produced by Interactions of Relativistic Protons in Shocked Pulsar Winds*", Astrophysical Journal, 600, 894-903 (2004).

2. Matsuura, S., Dolgov, A. D., Nagataki, S., Sato, K., "*Affleck-Dine Baryogenesis and Heavy Element Production from Inhomogeneous Big Bang Nucleosynthesis*", Progress of Theoretical Physics 112 (2004) 971-981.

3. Yoshiguchi, H., Nagataki, S., Sato. K., "*Method for calculating arrival distribution of ultra-high-energy cosmic rays with modifications by the galactic magnetic field*", Nuclear Physics B 136 (2004) 250-255.

4. Takiwaki, T., Kotake, K., Nagataki, S., Sato, K., "*Magneto-driven Shock Waves in Core-Collapse Supernovae*", Astrophysical Journal 616 (2004) 1086-1094.

5. Yoshiguchi, H., Nagataki, S., Sato, K., "*Statistical Significance of Small-Scale Anisotropy in Arrival Directions of Ultra-High-Energy Cosmic Rays*", Astrophysical Journal 614 (2004) 43-50.

6. Kohri, K., Yamada, S., Nagataki, S., "*Anisotropic kinetic pressure in ideal MHD and application to entropy production in neutrino-driven wind in supernovae*", Astroparticle Physics 21 (2004) 433-441.

7. Yoshiguchi, H., Nagataki, S., Sato, K., "*Numerical Study on the Propagation of Ultra-High-Energy Cosmic Rays in the Galactic Magnetic Field*", Astrophysical Journal 607 (2004) 840-847.

8. Sendouda, Y., Kohri, K., Nagataki, S., Sato, K., "*Sub-GeV galactic cosmic-ray antiprotons from primordial black holes in the Randall-Sundrum braneworld*", Physical Review D, 71, (2005) 063512.

Books and Proceedings

1. Shigehiro Nagataki, "*High-Energy Neutrinos Produced by Interactions of Relativistic Protons in Shocked Pulsar Winds*", Proceedings of the 6th RESCEU International Symposium "Frontier in Astroparticle and Cosmology", eds. K. Sato, S. Nagataki (Universal Academy Press, Tokyo, 2004) p.331.

2. A. Kawachi, T. Naito, S. Nagataki, "*High Energy Emissions from the PSR1259-63/SS2883 Binary System*", Proceedings of the 2nd International Symposium: High Energy Gamma-Ray Astronomy, eds. F.A. Aharonian, H.J. Volk, and D. Horns (American Institute of Physics, New York, 2005) p.353.

Invited Talks at International Conferences

1. Shigehiro Nagataki, "*Effects of Rotation on the Dynamics of Collapse-driven Supernovae and Gamma-Ray Bursts*", Post Nishinomiya-Yukawa Symposium: Origins: From First Objects to Extrasolar Planets, 4-6 November, 2004, Kyoto.

2. Shigehiro Nagataki, "*Effects of Rotation on the Dynamics of Collapse-driven Supernovae and Gamma-Ray Bursts*", International Workshop on Magnetohydrodynamic (MHD) Accretion Flows and Jets, 25-27 January, 2005, Kyoto.

3. Shigehiro Nagataki, "*High Energy Neutrinos from Supernovae and Gamma-Ray Bursts*", International Workshop on Particles and Radiation from Cosmic Accelerators, 2-4 March, 2005, Chiba.

Masao Minomiya

Journal Papers

1. Masafumi Fukuma, Hikaru Kawai and Masao Ninomiya, "*LIMITING TEMPERATURE, LIMITING CURVATURE AND THE CYCLIC UNIVERSE*", Int.J.Mod.Phys.A19:4367-4386,2004.

2. Yoshinobu Habara, Holger B.Nielsen and Masao Ninomiya, "*BOSON SEA VERSUS DIRAC SEA: GENERAL FORMULATION OF BOSON SEA THROUGH SUPERSYMMETRY*", Int.J.Mod.Phys.A19:5561-5584,2004.

3. Holger B. Nielsen and Masao Ninomiya, "*DIRAC SEA FOR BOSONS. 1: FORMULATION OF NEGATIVE ENERGY SEA FOR BOSONS*", Prog.Theor.Phys.113:603-624,2005.

4. Holger B. Nielsen and Masao Ninomiya, "*DIRAC SEA FOR BOSONS II: STUDY OF THE NAIVE VACUUM THEORY FOR THE PLAYGROUND WORLD PRIOR TO FILLING THE NEGATIVE ENERGY SEA*", Prog.Theor.Phys.113:625-643,2005.

Books and Proceedings

1. Yoshinobu Habara, Holger B. Nielsen and Masao Ninomiya, "*NEGATIVE ENERGY (DIRAC-LIKE) SEA FOR BOSONS AND SUPERSYMMETRY*", In the proceedings of the International Workshop "Bled 2004", Bled, Slovenia, July 1-15, 2004.

2. Holger B. Nielsen and Masao Ninomiya, "*Compactified Time and Likely Entropy-The World Inside a Time Machine:Closed Time-like Curve-*", To Appear in the Proceedings of the International Workshop, Bled 2005, Slovenia, 19-29 Jul 2005.

3. Yoshinobu Habara, Holger B. Nielsen and Masao Ninomiya, "*DIRAC SEA FOR BOSONS ALSO AND SUSY FOR SINGLE PARTICLES*", To appear in the proceedings of International Workshop on Frontier of Quantum Physics, Kyoto, Japan, 17-19 Feb 2005.

4. Yoshinobu Habara, Hikaru Kawai, Masao Ninomiya, "*CYCLIC UNIVERSE A LA STRING THEORY*", To appear in the proceedings of International Workshop on Frontier of Quantum Physics, Kyoto, Japan, 17-19 Feb 2005.

Invited Talks at International Conferences

1. Masao Ninomiya, "*Dirac Sea for Bosons and Supersymmetry*", the 7th International Workshop 'What comes beyond the Standard Model', July 19-30, 2004, Bled.Croatia.

Mihoko Nojiri

Journal Papers

1. J. Hisano, S. Matsumoto and M. M. Nojiri, "*Explosive dark matter annihilation*", Phys. Rev. Lett. **92**, 031303 (2004).
2. K. Desch, J. Kalinowski, G. Moortgat-Pick, M. M. Nojiri and G. Polesello, "*SUSY parameter determination in combined analyses at LHC/LC*", JHEP **0402**, 035 (2004).
3. K. Kawagoe, T. Kobayashi, M. M. Nojiri and A. Ochi, "*Study of the gauge mediation signal with non-pointing photons at the CERN LHC*", Phys. Rev. D **69**, 035003 (2004).
4. T. Goto, K. Kawagoe and M. M. Nojiri, "*Study of the slepton non-universality at the CERN Large Hadron Collider*", Phys. Rev. D **70**, 075016 (2004).
5. K. Hamaguchi, Y. Kuno, T. Nakaya and M. M. Nojiri, "*A study of late decaying charged particles at future colliders*", Phys. Rev. D **70**, 115007 (2004).
6. J. Hisano, S. Matsumoto, M. M. Nojiri and O. Saito, "*Direct detection of the Wino- and Higgsino-like neutralino dark matters at one-loop level*", Phys. Rev. D **71**, 015007 (2005).
7. K. Kawagoe, M. M. Nojiri and G. Polesello, "*A new SUSY mass reconstruction method at the CERN LHC*", Phys. Rev. D **71**, 035008 (2005).
8. Y. Kato, K. Fujii, T. Kamon, V. Khotilovich and M. M. Nojiri, "*Mass and cross-section measurements of chargino at linear colliders in large tan(beta) case*", Phys. Lett. B **611**, 223 (2005).
9. J. Hisano, S. Matsumoto, M. M. Nojiri and O. Saito, "*Non-perturbative effect on dark matter annihilation and gamma ray signature from galactic center*", Phys. Rev. D **71**, 063528 (2005).

Books and Proceedings

1. J. Feng and M. M. Nojiri, "*Linear Collider Physics in the New Millennium(Section 'Supersymmetry and the Linear Collider')*", ed. Keisuke Fujii, Amarjit Soni & David J Miller, (World Scientific, 2005).
2. M. M. Nojiri, "*Supersymmetry at the LHC and beyond: Ultimate targets*", Proceedings of 12th International Conference on Supersymmetry and Unification of Fundamental Interactions(SUSY 04) Jun 2004. page 101-116, ed. Kaoru Hagiwara, Junichi Kanzaki and Nobuchika Okada, KEK Proceedings 2004-12, High Energy Accelerator Research Organization (2004) 960 page..
3. M. M. Nojiri, "*Les Houches 'Physics at TeV Colliders 2003' beyond the standard model working group: Summary report*", page 34-52 and 60-64, ed. Allanach, B et al (119 page).
4. M. M. Nojiri, "*Implication of Dark Matter Searches to Particle Physics*", Proceedings of the 6th RESCEU International Symposium on "Frontier in Astroparticle Physics and Cosmology", page 261-267, ed. K.Sato & S. Nagataki, Universal Academy Press,INC, Tokyo, Japan, 545 page.

Invited Talks at International Conferences

1. M. M. Nojiri, "*Supersymmetry at the LHC and beyond: Ultimate targets*", To appear in the proceedings of 12th International Conference on Supersymmetry and Unification of Fundamental Interactions(SUSY 04) Jun 2004.
2. M. M. Nojiri, "*SUSY dark matter: A collider physicist's perspective*", Invited talk at 9th International Symposium on Particles, Strings and Cosmology (PASCOS 03), Mumbai (Bombay) India, 3-8 Jan 2003.
3. M. M. Nojiri, "*Implication of Dark Matter Searches to Particle Physics*", Invited talk at the 6th RESCEU International Symposium on "Frontier in Astroparticle Physics and Cosmology", University of Tokyo, Japan, Nov. 4-7 2003.

Takao Ohta

Journal Papers

1. N. Yamazaki, M. Motoyama, M. Nonomura and T. Ohta, "*Morphology of microphase separated domains in rod-coil copolymers*", J. Chem. Phys. **120**, 3949 (2004).
2. K. Yamada, M. Nonomura and T. Ohta, "*Kinetics of morphological transitions in diblock copolymer melts*", Macromolecules **37**, 5762-5777 (2004).
3. M. Ataka and T. Ohta, "*Anomalous Synchronization in integrate-and-fire oscillators with global coupling*", Prog. Theor. Phys. **113**, 55 (2005).
4. T. Ohta and T. Yoshimura, "*Statistical Pulse Dynamics in an excitable reaction diffusion system*", Physica D (in press).

Books and Proceedings

1. Y. Oono and T. Ohta (eds. P. M. Goldbart et al), "*Coarse-grained approach to polymer physics in Stealing the Gold*", Oxford Univ Press, 300 (2005).

Invited Talks at International Conferences

1. Takao Ohta, "*Microphase separation in rod-coil copolymers*", Third international conference on engineering of chemical complexity, 2004. 5.5-5.7, Berlin.
2. Takao Ohta, "*Microphase separation in rod-coil copolymers*", International workshop on Physics of Soft Matter Complexes, 2004, 11.30-12.3, Tokyo.
3. Takao Ohta, "*Dynamics of traveling waves under spatio-temporal forcing*", Chaos and nonlinear dynamics in quantum and macroscopic systems, 2004, 12.8-12.10, Kyoto.
4. Takao Ohta, "*Formation of periodic minimal surfaces in polymeric materials*", International workshop on Quantum Physics, 2005, 2,17-2,19, Kyoto.

Tetsuya Onogi

Journal Papers

1. N. Tsutsui *et al.* [CP-PACS Collaboration], "*Lattice QCD calculation of the proton decay matrix element in the continuum limit*", Phys. Rev. D **70**, 111501 (2004).
2. H. Fukaya and T. Onogi, "*theta vacuum effects on the chiral condensation and the eta' meson correlators in the two-flavor massive QED(2) on the lattice*", Phys. Rev. D **70**, 054508 (2004).
3. M. Fukunaga and T. Onogi, "*A model independent determination of $|V(ub)|$ using the global q**2 dependence of the dispersive bounds on the $B \rightarrow$ pi l nu form factors*", Phys. Rev. D **71**, 034506 (2005).

Invited Talks at International Conferences

1. Tetsuya Onogi, "*Heavy Quark Physics on Anisotropic Lattice*", DESY German-Japanese Symposium, November 2004 Zeuthen, Germany.

Misao Sasaki

Journal Papers

1. W. Naylor and M. Sasaki, "*Quantum fluctuations for de Sitter branes in bulk AdS(5)*", Prog. Theor. Phys. **113**, 535 (2005).
2. W. Hikida, S. Jhingan, H. Nakano, N. Sago, M. Sasaki and T. Tanaka, "*A new analytical method for self-force regularization. II: Testing the efficiency for circular orbits*", Prog. Theor. Phys. **113**, 283 (2005).
3. A. Flachi, A. Knapman, W. Naylor and M. Sasaki, "*Zeta functions in brane world cosmology*", Phys. Rev. D **70**, 124011 (2004).
4. N. Kogo, M. Sasaki and J. Yokoyama, "*Reconstructing the Primordial Spectrum with CMB Temperature and Polarization*", Phys. Rev. D **70**, 103001 (2004).
5. M. Minamitsuji and M. Sasaki, "*Linearized gravity on the de Sitter brane in the Einstein Gauss-Bonnet theory*", Prog. Theor. Phys. **112**, 451 (2004).
6. H. Takahashi *et al.* [TAMA Collaboration], "*Coincidence analysis to search for inspiraling compact binaries using TAMA300 and LISM data*", Phys. Rev. D **70**, 042003 (2004).
7. H. Nakano, H. Takahashi, H. Tagoshi and M. Sasaki, "*An Improved Search Method for Gravitational Ringing of Black Holes*", Prog. Theor. Phys. **111**, 781 (2004).
8. A. M. Green, A. R. Liddle, K. A. Malik and M. Sasaki, "*A new calculation of the mass fraction of primordial black holes*", Phys. Rev. D **70**, 041502 (2004).
9. M. Minamitsuji and M. Sasaki, "*Local conservation law and dark radiation in cosmological braneworld*", Phys. Rev. D **70**, 044021 (2004).
10. N. Kogo, M. Matsumiya, M. Sasaki and J. Yokoyama, "*Reconstructing the primordial spectrum from WMAP data by the cosmic inversion method*", Astrophys. J. **607**, 32 (2004).
11. W. Hikida, S. Jhingan, H. Nakano, N. Sago, M. Sasaki and T. Tanaka, "*A new analytical method for self-force regularization. I: Scalar charged particle in Schwarzschild spacetime*", Prog. Theor. Phys. **111**, 821 (2004).
12. K. Ioka and M. Sasaki, "*Relativistic stars with poloidal and toroidal magnetic fields and meridional flow*", Astrophys. J. **600**, 296 (2004).

Invited Talks at International Conferences

1. Misao Sasaki, "*Linearized gravity in the Einstein Gauss-Bonnet braneworld*", International Workshop on String and Brane Cosmology, 1-29 June 2004, Paris.
2. Misao Sasaki, "*Effective gravity on de Sitter brane in Einstein Gauss-Bonnet theory*", UK Cosmology Workshop, 2-4 Sept. 2004, Edinburgh.
3. Misao Sasaki, "*Cosmology and Gravity in the Braneworlds*", COSMO-04: International Workshop on Particle Physics and the Early Universe, 17-21 Sept. 2004, Tronto.
4. Misao Sasaki, "*Conservation of nonlinear curvature perturbations on super-Hubble scales*", The 11th International Symposium on Particles, Strings and Cosmology, 30 May - 4 June 2005, Sough Korea.

Ryu Sasaki

Journal Papers

1. O. Ragnisco and Ryu Sasaki, "*Quantum vs Classical Integrability in Ruijsenaars-Schneider Systems*", J. Phys. **A37** (2004) 469 - 479.

2. I. Loris and Ryu Sasaki, "*Quantum vs Classical Mechanics, role of elementary excitations*", Phys. Lett. **A327** (2004) 152-157.

3. I. Loris and Ryu Sasaki, "*Quantum & Classical Eigenfunctions in Calogero & Sutherland Systems*", J. Phys. **A37** (2004) 211 - 237.

4. W.-L. Yang and Ryu Sasaki, "*Exact solution of Z_n Belavin model with open boundary condition*", Nucl. Phys. **B679** (2004) 495-520.

5. A. Khare, I. Loris and Ryu Sasaki, "*Affine Toda-Sutherland Systems*", J. Phys. A **37** (2004) 1665-1680.

6. B.-Y. Hou, Ryu Sasaki and W.-L. Yang, "*Eigenvalues of Ruijsenaars-Schneider models associated with A_{n-1} root system in Bethe ansatz formalism*", J. Math. Phys. **45** (2004) 559-575.

7. W.-L. Yang and Ryu Sasaki, "*Solution of the dual reflection equation for $A^{(1)}_{n-1}$ SOS model*", J. Math. Phys. **45** (2004) 4301-4309.

8. S. Odake and Ryu Sasaki, "*Equilibria of 'discrete' integrable systems and deformations of classical orthogonal polynomials*", J. Phys. **A37** (2004) 11841-11876.

9. S. Odake and Ryu Sasaki, "*Polynomials Associated with Equilibria of Affine Toda-Sutherland Systems*", J. Phys. **A37** (2004) 11401-11405.

10. W.-L. Yang, Ryu Sasaki and Y.-Z. Zhang, "*Z_n elliptic Gaudin model with open boundaries*", JHEP 0409 (2004) 046.

11. S. Odake and Ryu Sasaki, "*Shape Invariant Potentials in 'Discrete Quantum Mechanics'*", J. Nonlinear Mathematical Physics **12** Supplement 1 (2005) 507-521.

12. W.-L. Yang, A. Belavin and Ryu Sasaki, "*Central elements of the elliptic Z_n monodromy matrix algebra at roots of unity*", Nucl. Phys. **B710** [FS] (2005) 614-628.

Books and Proceedings

1. Ryu Sasaki, "*Quantum Calogero-Moser Systems*", Springer Encyclopedia of Mathematical Physics (2005).

2. Ryu Sasaki, "*Quantum vs Classical Calogero-Moser Systems*", in the Proceedings of *NATO Advanced Research Workshop "Bilinear Integrable Systems - from Classical to Quantum, Continuous to Discrete*, p. v. Moerbeke ed. (Kluwer Academic Publishers, 2005).

Invited Talks at International Conferences

1. Ryu Sasaki, "*Generalised Supersymmetry and Quasi-Exactly Solvable Quantum Mechanical Systems*", International Conference: New Frontiers in Quantum Mechanics - PT symmetry, Exact WKB and Quasi-Exact Solvability-, 4 –8 July, 2004, Shizuoka, Japan.

2. Ryu Sasaki, "*Classical and Quantum Integrability in Multi-particle Dynamics*", AMSI Workshop: Foundations and Methodologies of Mathematical Physics, 30 November–4 December 2004, Coolangatta, Australia.

3. Ryu Sasaki, "*Shape invariant discrete quantum mechanics and equilibria of the Calogero-Sutherland-Ruijsenaars-Van Diejen systems*", Workshop "Solitons, boomerons and isochronous solutions to nonlinear systems" 4-5 February 2005, Rome Italy.

4. Ryu Sasaki, "*Invited Talk: Explicit integration of Calogero & Sutherland dynamics for any root systems*", Third FENOMEC Mini-Workshop "Selected Topics in mathematical Physics", 10–12 November, Cocoyoc, Mexico.

Naoki Sasakura

Journal Papers

1. N. Sasakura, "*Non-unitary evolutions of noncommutative worlds with symmetry*", JHEP **0401**, 016 (2004).

2. N. Sasakura, "*Field theory on evolving fuzzy two-sphere*", Class. Quant. Grav. **21**, 3593 (2004).

3. N. Sasakura, "*Evolving fuzzy CP(n) and lattice n-simplex*", Phys. Lett. B **599**, 319 (2004).

4. N. Sasakura, "*Heat kernel coefficients for compact fuzzy spaces*", JHEP **0412**, 009 (2004).

5. N. Sasakura, "*Effective local geometric quantities in fuzzy spaces from heat kernel expansions*", JHEP **0503**, 015 (2005).

Invited Talks at International Conferences

1. Naoki Sasakura, "*Geometry in fuzzy spaces and heat kernel expansions*", An International Meeting 'Noncommutative Geometry, K-theory and Physics 2005' , March 4 - March 7, 2005, Hayama.

2. Naoki Sasakura, "*An invariant approach to dynamical fuzzy spaces with a three-index variable*", IV. International Symposium 'Quantum Theory and Symmetries', August 15 - August 21, 2005, Varna.

3. Naoki Sasakura, "*De Sitter domain wall solutions and their analytic continuations*", KEK Theory Workshop 2002, March 18 - March 20, 2002, Tsukuba.

Ken-ichi Shizuya

Journal Papers

1. K. Shizuya, "*Superfield formulation of central charge anomalies in two-dimensional supersymmetric theories with solitons*", Phys. Rev. D **69**, 065021 1-10 (2004).

2. K. Shizuya, "*Topological-charge anomalies in supersymmetric theories with domain walls*", Phys. Rev. D **70**, 065003 1-9 (2004).

3. K. Shizuya, "*Central charge and renormalization in supersymmetric theories with vortices*", Phys. Rev. D **71**, 065006 1-9 (2005).

Books and Proceedings

1. K. Shizuya, "*Effective theory of the fractional quantum Hall effect*", International Symposium on New Trends of Physics 20-24 Jan. 2003, Hokkaido Univ., Sapporo.

Shigeki Sugimoto

Journal Papers

1. Tsuguhiko Asakawa, Shigeki Sugimoto and Seiji Terashima, "*Exact description of D-branes in K-matrix theory*", Prog. Theor. Phys. Suppl. **152**, 93 (2004).

2. Shigeki Sugimoto and Kazuyoshi Takahashi, "*QED and String Theory*", JHEP **04** (2004) 051.

3. Tadakatsu Sakai and Shigeki Sugimoto, "*Low energy hadron physics in holographic QCD*", Prog. Theor. Phys. **113** (2005) 843–882.

Invited Talks at International Conferences

1. Shigeki Sugimoto, "*Low Energy Hadron Physics in Holographic QCD*", 2004 Internal Workshop on "Dynamical Symmetry Breaking", December 21-22, 2004, Nagoya, Japan.

2. Shigeki Sugimoto, "*Analysis of QCD via Supergravity*", International workshop "Windows to New Paradigm in Particle Physics", February 14-16, 2005, Sendai, Japan.

3. Shigeki Sugimoto, "*Analysis of QCD via Supergravity*", International workshop "Spring Mini-Workshop on Field Theories", May 12-13, 2005, Seoul, Korea.

4. Shigeki Sugimoto, "*Analysis of QCD via Supergravity*", International conference "Strings 2005", July 11-16, 2005, Toronto, Canada.

Keisuke Totsuka

Journal Papers

1. P.Lecheminant and K.Totsuka, "*Phases of the generalized two-leg spin ladder: A view from the SU(4) symmetry*", Phys.Rev.B **71**, 020407 (2005).

Invited Talks at International Conferences

1. K. Totsuka and P. Lecheminant, "*Competing orders and hidden symmetry in spin ladder systems*", Yukawa International Seminar 2004 "Physics of Strongly Correlated Electron Systems", Nov.1-Nov.19, 2004 Kyoto, Japan.

2. K. Totsuka and P. Lecheminant, "*Effects of 4-spin interactions in generalized spin ladders -global phase structure and quantum phase transitions*", "International Symposium on Quantum Spin Systems (QSS04)" Nov.30-Dec.3, 2004, Shonan, Japan.

Hirokazu Tsunetsugu

Journal Papers

1. Yukitoshi Motome and Hirokazu Tsunetsugu, "*Spin Frustration and Orbital Order in Vanadium Spinels*", J. Phys. Soc. Jpn. **74** Suppl., 208 (2005).

2. Yukitoshi Motome and Hirokazu Tsunetsugu, "*Orbital ordering and one-dimensional magnetic correlation in vanadium spinel oxides AV_2O_4 (A=Zn, Mg, or Cd)*", Physica B **359-361**, 1222 (2005).

3. Yukitoshi Motome, Hirokazu Tsunetsugu, Toshiya Hikihara, Nic Shannon, and Karlo Penc, "*Interplay among Spin, Orbital and Lattice Degrees of Freedom in t_{2g} Electron Systems with Edge-Sharing Network of Octahedra*", Suppl. Prog. Theor. Phys., in press.

4. Yukitoshi Motome and Hirokazu Tsunetsugu, "*Orbital and magnetic transitions in geometrically frustrated vanadium spinels: Monte Carlo study of an effective spin-orbital-lattice coupled model*", Phys. Rev. B **70**, 184427 (2004).

5. M. E. Zhitomirsky and Hirokazu Tsunetsugu, "*Exact low-temperature behavior of a kagome antiferromagnet at high fields*", Phys. Rev. B **70**, 100403 (2004).

Invited Talks at International Conferences

1. Hirokazu Tsunetsugu, "*Low-energy quantum dynamics and complex order in a 3D frustrated magnet*", Yukawa International Seminar (YKIS) on "Physics of Strongly Correlated Electron Systems", 1-19 Nov. 2004, Kyoto.

2.4 Seminars, Colloquia and Lectures

▷ 2004.4.1 — 2005.3.31

4.16 Shinsuke Kawai (YITP): *Free field representation of WZW-branes*

4.20 Holger Nielsen (Niels Bohr Institute): *Hierarchy Problem and condensing bound states of 6 top and 6 anti-top quarks*

4. 23 Serguey Petcov (SISSA/INFN, YITP, INRNE): *YITP Colloquium: Neutrino Masses, Mixing, Oscillations and the Nature of Massive Neutrinos*

4. 26 Hiroaki Kouno (Saga University): *Relation between effective hadron masses and effective interactions*

4. 28 Kazuaki Ohnishi (YITP): *Mode coupling theory for the dynamic aspect of the chiral phase transition*

4. 30 Yasushi Nara (Arizona University): *From Color Glass Condensate to QGP at RHIC*

5. 6 K. Hattori (Osaka University): *Quasi-particle interactions for f^2 impurity Anderson model*

5. 7 Naoto Yokoi (YITP): *Wheeler-De Witt Equation in AdS/CFT Correspondence*

5. 21 Shigehiro Nagataki (YITP): YITP Colloquium: *Origin of Gamma-ray Bursts and Explosive Nucleosynthesis*

5. 25 Makoto Tsubota (Osaka City University): *Dynamics of quantized vortices in superfluid helium and rotating Bose-Einstein condensate*

5. 27 Jerzy Dudek (IReS Strasbourg, France): *Nuclear Shroedinger Equation Solved Using the Random Walk Concept*

5. 28 Shuichi Murakami (Department of Applied Physics, University of Tokyo): *Intrinsic spin Hall effect*

5. 28 M. Luscher (CERN): *SU(N) gauge theories and the bosonic string*

6. 2 Kanada-En'yo Yoshiko (KEK): *Narrow Pentaquark States in a Quark Model with Antisymmetrized Molecular Dynamics*

6. 4 Hidehiko Shimada (University of Tokyo/ YITP): *Matching gauge theory and string field theory: Three point functions of BMN operators*

6. 8 D.N. Voskresensky (Moscow Institute for Physics and Engineering): *Thermal Fluctuations of Color-Superconducting Gap*

6. 10 Ranabir Dutt (Visva Bharati University): *SUSYQM - a novel Factorisation Method in Quantum Mechanics*

6. 11 Kentaro Hori (Toronto Univ./RIMS): *Orientifolds of Gepner models*

6. 18 Satoshi Watamura (Tohoku University): *Monopole on the Fuzzy CPn*

6. 22 M. Chernodub (ITP, Moscow): *Breaking of the chromoelectric string inside mesons and baryons in finite temperature QCD*

6. 22 Luc lanchet (IAP/YITP): YITP Colloquium: *Theory of Gravitational Radiation*

6. 22 Luc lanchet (IAP/YITP): *Theory of Gravitational Radiation*

6. 24 Ryuichiro Kitano (IAS): *Anomaly mediation, electroweak symmetry breaking and baryo/leptogenesis*

6. 25 Luc Blanchet (IAP/YITP): *Relativistic Dynamics of Binary Systems*

7. 2 David Tong (MIT/RIMS) : *Vortices, Strings and Vortex Strings*

7. 2 Yoji Ohashi (Tsukuba University): *BCS-BEC crossover in a trapped gas of Fermi atoms with a Feshbach resonance*

7. 5 Yutaka Fujita (NAO): *Problems of Cooling Flow in Cluste of Galaxies*

7. 6 R.D. Vaidya (National Central Univesity): *Some Novel Contributions to Radiative B decay in Supersymmetry without R-parity*

7. 9 Miloslav Znojil (Institute of Nuclear Physics, Rez): *Large-D limit approach to quasi-exact bound states*

7. 15 Kazunori Kohri (Osaka Univ.): *Hadronic decay of SUSY particles and problems in cosmology*

7. 22 Takao Ohta (YITP): *YITP Colloquium: Formation of mesoscopic structures in soft materials*

7. 22 Goetz Uhrig (Universitaet zu Koeln): *Excitations in spin liquids: From spin chains to stripes in high-Tc superconductors*

7. 23 Yoshiyuki Saito (Waseda University): *Kinetics of microstructural evolutions in materials*

7. 23 Yoshifumi Hyakutake (Osaka University): *Entropy Counting of Supertube*

7. 30 Jun-Ichi Noaki (RIKEN): *Calculation of Kaon Matrix Elements on the Lattice with Domain-Wall Fermion and DBW2 Gauge Action*

7. 30 Kenji Fukushima (MIT/The University of Tokyo): *Heating (Gapless) Color-Flavor Locked Quark Matter*

8. 3 F.R. Klinkhamer (ITP, University of Karlsruhe): *Spacetime foam and the CPT anomaly*

8. 4 Seiji Terashima (Rutgers University): *On matix models based on unstable D-branes*

8. 5 Tadakatsu Sakai (Ibaraki University): *Non-critical String and Quiver Gauge Theories*

8. 20 Katsuaki Kodama (ISSP, The University of Tokyo): *NMR studies on 2D orthogonal dimer spin system SrCu2(BO3)2 at high magnetic field*

8. 27 Naokazu Shibata (The University of Tokyo): *Exotic Ground State in Quantum Hall Systems*

8. 27 Issaku Kanamori (Hokkaido University): *Supersymmetric model on a lattice from twisted superspace*

8. 30 Keisuke Totsuka (YITP): *YITP Colloquium: Quantized Magnetization in Low-Dimensional Magnets – rational numbers in magnetization*

9. 2 David Andelman (Tel Aviv University): *DNA aggregation in presence of multivalent and monvalent counterions*

9. 2 Damien Baigl (Kyoto University, Department of Physics): *Hydrophobic polyelectrolytes*

9. 7 Yoshifumi Hyakutake (Osaka University): *A Geometric Look on the Microstates of Supertubes – Counting Black Brane Entropy –*

9. 16 Motoki Kino (SISSA): *Physical properties of jets in active galactic nuclei*

9. 20 Chris Sachrajda (Southampton University): *QCD factorization in nonleptonic B decays*

9. 21 Koji Hashimoto (University of Tokyo): *Spectrum and Interaction in BSFT and Its Application to Tachyon Condensation*

9. 24 Laszlo Feher (Szeged University): *Dynamical r-matrices and Poisson-Lie symmetries on the chiral WZNW phase space*

9. 30 Takuma Ohashi (Osaka University): *Dynamical mean field study of the Kondo lattice model in a magnetic field*

9. 30 Mami Machida(NAO): *Formation of Low-beta Disks During State Transition in Black Hole Accretion Flows*

10. 1 Kazunori Itakura (Saclay, France): *Recent progress in QCD at high energies*

10. 4 Yukiko Ohtake (Affiliation:Ochanomizu University): *Non-Perturbative Aspects of KK Modes in 5D SQCD on* S^1

10. 5 Chiho Nonaka (Duke University): *Hydrodynamical evolution near the QCD critical end point (1)*

10. 6 Chiho Nonaka (Duke University): *Hydrodynamical evolution near the QCD critical end point (2)*

10. 7 Takashi Hotta (JAERI): *Microscopic theory for magnetism and superconductivity of f-electron compounds based on a j-j coupling scheme*

10. 7 Osamu Seto (National Chiao Tung University): *Dark matter in brane cosmology*

10. 8 Shoichi Kawamoto (Niels Bohr Institute): *The Geometry of ZZ-branes*

10. 8 Kosuke Morita (RIKEN): YITP Colloquium: *Synthesis of the new element of atomic number 113*

10. 15 Matthias Neubert (Cornell University, LNS): *Soft-Collinear Factorization and the Theory of* $B \to X_s \gamma$ *Decay*

10. 18-19 Shinsuke Mochizuki Nishigaki (Shimane University): *Lecture Series: Random Matrix Theory and Related Topics*

10. 19 Shinsuke Mochizuki Nishigaki (Shimane University): *Replica Treatment of Calogero-Sutherland Model*

10. 21 Dmitri Kazakov (CERN & Dubna, JINR): *SUSY Dark Matter*

10. 21 Kohji Yoshikawa (University of Tokyo): *Hunt for the cosmic missing baryon through its soft X-ray emission*

10. 22 T.M. Rice (Theoretical Physik ETH Zurich): *YITP Colloquium: The Search for Unconventional Superconductors: A Long Story with a Happy End*

10. 25 Edward Corrigan (York University/YITP): *Integrable Field Theory with Defects and Boundary*

10. 26 K. Sasaki (IMR, Tohoku University): *Kinematics of persistent currents in carbon tubes and tori – Time-reversal symmetric gauge field and its application –*

10. 27 T.A. Rijken (Nijmegen University): *Soft-core baryon-baryon Interactions*

11. 9 Emiko Hiyama (Nara Women's University): *Five-body calculation of pentaquark (Theta+) under the boundary condition of the K+N scattering channel with the constituent quark model*

11. 12 Michael I. Tribelsky (Moscow State Institute of Radioengineering, Electronics and Automation (Technical University)): *Drift Bifurcation in Dissipative Systems*

11. 16 Nathalie Deruelle (IHES, France): *The mass of a Kerr-anti-de Sitter spacetime in D dimensions*

11. 17 Masaaki Takashina (RIKEN): *Study of the 16C+208Pb inelastic scattering using a microscopic wave function of 16C*

11. 18 Junpei Takata (Yamagata University) *An electrodynamical outer-gap model for gamma-ray pulsars*

11. 23 Anthony J. Leggett (2003 Nobel Laureate in Physics/Macarthur Professor, University of Illinois at Urbana-Champaign): *Superfluidity, phase coherence and the new Bose-condensed alkali gases*

11. 24 R. Chakrabarti (University of Madras): *Some aspects of quantum algebras*

11. 24 Yoko Ogawa (RCNP, Osaka University): *Chiral Symmetry and Finite Pion Mean Field in Nuclei*

11. 24 Tarun Souradeep (IUCAA): *Primordial power spectrum from WMAP*

11. 24 Hirokazu Tanaka (Columbia Unviersity): *Computational Theories of Reaching Movements : What Computations are Solved in the Brain When We Reach Out?*

11. 25 Tomo Takahashi (ICRR, University of Tokyo): *Toward Understanding the Dark Side of the Universe*

11. 26 Shinji Mukohyama (University of Tokyo): *Ghost Condensation and Gravity in Higgs Phase*

12. 1 J.E. Horvath (IAG, Sao Paulo University, Brazil): *Strangelets and strange stars in the galaxy*

12. 6 Webber, Bryan R. (Cambridge University): *YITP Colloquiium: Preparing for new physics at the Large Hadron Collider*

12. 8 Andrei Marshakov (Lebedev Inst. & Moscow, ITEP): *Integrable systems and the AdS/CFT duality*

12. 9 Tomizawa, Shinya (TITECH): *Multi-pole moment and uniqueness of a black hole in high dimension spacetime*

12. 9 Hans-J"urgen Mikeska (Hannover University): *Low-dimensional gapped magnets in high magnetic fields*

12. 10 Shigeki Matsumoto (ICRR, University of Tokyo): *Non-perturbative effects in the dark matter pair annihilation and the gamma ray signals from the center of our galaxy*

12. 22 Kazushi Iwasawa (IoA, Univ. of Cambridge): *Modulating X-ray iron line emission in the Seyfert galaxy NGC3516: relativistic effects and implications for the black hole mass*

1. 7 Yukitaka Ishimoto (RIKEN, Wako): *Logarithmic Correlation Functions and Logarithmic CFT in Minimal String Theory*

1. 13 Kaiki Taro Inoue (Kinki University): *Deciphering Imprints of CDM Substructure:Current Status and Future Prospects*

1. 13 Caiwan Shen (China Institute of Atomic Energy): *Screening of 1S0 Pairing in Nuclear Matter*

1. 13 Tomohiro Matsuda (Saitama Institute of Technology): *Cosmological Brane Defects (Monopoles, Domain Walls, Strings, Q-balls and Necklaces)*

1. 14 Debashis Ghoshal (Harish-Chandra Res. Inst./ Univ. of Tokyo): *Liouville D-branes of 2D strings: Correlators and SFT*

1. 14 Ryuichi Shindou (University of Tokyo) : *Noncommutative geometry and non-abelian Berry phase in the wave-packet dynamics of Bloch electrons*

1. 18 King-mang Cheung (National Tsing Hua University): *Fine Tuning and Split supersymmetry*

1. 19 Sergei D. Odintsov (IEEC/ICREA, Barcelona): *The final state of (phantom) dark energy universe*

1. 21 So Matsuura (RIKEN): *Open String Tachyon in Classical Solution of Supergravity*

1. 25 Taekoon Lee (Seoul National University): *Chiral radiative corrections and D_s(2317)/D(2308) mass puzzle*

1. 26 Tamiki, Umeda (Kobe University): *Theoretical analysis of open-shaped liposome*

1. 28 Syoji Zeze (YITP): *Marginal Deformations and Closed String Couplings in Open String Field Theory*

1. 31 Shigeki Sugimoto (YITP, Kyoto University): *YITP Colloquium: Analysis of QCD via Supergravity*

2. 4 Bernard de Wit (Utrecht University/ YITP): *Maximal D=5 supergravities and beyond*

2. 4 Antti Niemi (Uppsala University): *Do spin and color charge separate in Yang-Mills?*

2. 8 Artem Starodubtsev (Perimeter Institute): *Background independent perturbative quantum gravity*

2\. 9 Gerardus ’t Hooft (Utrecht University, 1999 Nobel Laureate in Physics): *Topological and non-topological causes for the absolute confinement of quarks in the theory of Quantum Chromodynamics*

2\. 14 Anne Taormina (University of Durham): *Higher-level Appell functions as building blocks of characters*

2\. 15 Gerhard Börner (MPI munchen; Resceu, U. Tokyo): *Dark matter Halos: Growth and Structure*

2\. 18 Christophe Grojean (Saclay): *Higgsless Electroweak Symmetry Breaking*

2\. 22 Akihiro Ishibashi (Chicago University): *Comparison between various notions of conserved charges in asymptotically AdS-spacetimes*

2\. 22 Pierre Tolédano (University of Picardie): *Theory of Reconstructive Phase Transitions*

2\. 24-26 Katsushi Ito (Tokyo Institute of Technology): *Lecture Series: Multi-instanton calculus in N=2 Supersymmetric Yang-Mills theory*

2\. 24 Atsunori Yonehara (University of Tokyo): *Searching structures of galaxies with multiple gravitational lensing images of quasars*

2\. 28 Bernard de Wit (Utrecht University/ YITP): *YITP Colloquium: Supersymmetric Black Holes*

3\. 1 Jos Vermaseren (NIKHEF): *Three loop QCD structure functions: physics results*

3\. 7 Masakiyo Kitazawa (YITP): *Quasiparticle picture of quarks near chiral and color-superconducting phase transitions*

3\. 8 Giovanni Landi (Trieste U. & INFN, Naples): *Noncommutative Spheres and Instantons*

3\. 8-10 Yosuke Imamura (University of Tokyo): *Lecture Series: Analysis of QCD via string theory*

3\. 9-10 Tetsuya Shiromizu (Tokyo Institute of Technology): *Lecture Series: Braneworlds and Black holes*

3\. 10 Masahito Yamazaki (Shizuoka University): *Effect of Electrostatic Interactions on Stability of Nonbilayer Structures of Biomembranes*

3\. 11 Annual Presentation on YITP Research Activities

3\. 14 Ken Kubo (Aoyama Gakuin University): *Flat energy bands on generalized partial line graphs*

3\. 15 Shinji Watanabe (ISSP, University of Tokyo): *Algorithm of path integral renormalization group method and its application*

3\. 15 Nobuhiro Okabe (Tohoku University): *Wibel instability driven by temperature gradient*

3\. 15 S. Ando (TRIUMF): *Neutron beta-decay in effective field theory*

3\. 15 Tsunehiko N. Kato (NAO): *Weibel instability and its saturation mechanism in a collisionless shock wave*

3\. 16 Tetsufumi Hirano (Columbia University): *Dynamical Modeling of Relativistic Heavy Ion Collisions*

3\. 18 Kunihiko Terasaki (YITP): *YITP Colloquium: Spectroscopy of mesons and their hadronic weak interactions – some puzzles –*

3\. 28 Yukio Tomozawa (University of Michigan): *Black Holes, Information Paradox and Gamma Rays/Neutrinos from AGN*

2.5 Visitors (2004)

YITP Visitor Program

Tetsuji Kimura
(KEK, PD)
2004.7.5–2004.7.23
Elementary Particles Physics

Shinsuke Mochizuki Nishigaki
(Shimane University, AP)
2004.10.17–2004.10.20
Elementary Particles Physics

Atsunori Yonehara
(University of Tokyo, PD)
2005.2.22–2005.2.26
Astro Physics

Nobuyuki Sakai
(Yamagata University, AP)
2005.3.7–2005.3.13
Astro Physics

Shigeo Ohkubo
(Kochi Women's University, P)
2005.3.14–2005.3.17
Nuclear Physics

Atom-type Visitors

Hidehiko Shimada (E)
2004.5.21 — 2004.6.18

Takuma Ohashi (C)
2004.9.27 — 2004.10.27

Shinya Tomizawa (A)
2004.11.24 — 2004.12.23

Short Visitors

Bertrand Bouriquet
(GANIL)
2004.3.26 — 2004.4.5

Yasushi Nara
(University of Arizona)
2004.4.29 — 2004.5.1

Martin Luscher
(CERN)
2004.5.22 — 2004.5.29

Jerzy Dudek
(IReS Strasbourg)
2004.5.26 — 2004.5.30

Ranabir Dutt
(Visva Bharati University)
2004.6.9 — 2004.6.10

Giacomo Polesello
(CERN)
2004.6.13 — 2004.6.16

Maxim Chernodub
(ITP, Moscow)
2004.6.21 — 2004.6.26

Ryuichiro Kitano
(IAS)
2004.6.23 — 2004.6.25

Michael E. Peskin
(SLAC)
2004.6.24 — 2004.7.7

Charles M. Sommerfield
(Yale University)
2004.7.5 — 2004.7.9

Patrick Dorey
(University of Durham)
2004.7.8 — 2004.7.19

Miloslav Znojil
(Institute of Nuclear Physics, Rez)
2004.7.8 — 2004.7.15

Goetz Uhrig
(University of Cologne)
2004.7.21 — 2004.7.23

Jnandeya Maharana
(Institute of Physics, Bhubaneswar)
2004.7.28 — 2004.8.4

F.R. Klinkhamer
(University of Karlsruhe)
2004.8.1 — 2004.8.7

Seiji Terashima
(Rutgers University)
2004.8.2 — 2004.8.6

Yi-Zhong Zhuo
(CIAE)
2004.8.4 — 2004.8.9

Umberto Lombardo
(Catania University)
2004.9.16 — 2004.9.20

Aldo Bonasera
(INFN)
2004.9.16 — 2004.9.20

Laszlo Feher
(Szeged University)
2004.9.24 — 2004.9.26

Kazunori Itakura
(Saclay)

2004.9.30 — 2004.10.5

Chiho Nonaka
(Duke University)
2004.10.5 — 2004.10.6

Matthias Neubert
(Cornell University, LNS)
2004.10.15 — 2004.10.17

Dmitri Kazakov
(CERN Dubna, JINR)
2004.10.20 — 2004.10.22

Michael I. Tribelsky
(Technical University)
2004.11.12 — 2004.11.16

R. Chakrabarti
(University of Madras)
2004.11.22 — 2004.11.26

Hirokazu Tanaka
(Columbia University)
2004.11.23 — 2004.11.25

Tarun Souradeep
(IUCAA)
2004.11.23 — 2004.12.4

Kensuke Yoshida
(University of Rome)
2004.11.25 — 2004.12.4

J.E. Horvath
(IAG, Sao Paulo University)
2004.11.30 — 2004.12.2

Andrei Marshakov
(Lebedev Institute Moscow, ITEP)
2004.12.6 — 2004.12.8

Hans-Jurgen Mikeska
(Hannover University)
2004.12.8 — 2004.12.12

Bruce H.J. McKellar
(Melbourne University)
2005.1.11 — 2005.1.21

Debashis Ghoshal
(Harish-Chandra Res. Inst./Univ. of Tokyo)
2005.1.13 — 2005.1.20

Taekoon Lee
(Seoul National University)
2005.1.21 — 2005.1.28

Artem Starodubtsev
(Perimeter Institute)
2005.2.7 — 2005.2.11

Gerardus 'tHooft
(Utrecht University)
2005.2.8 — 2005.2.10

Ann Taormina
(University of Durham)
2005.2.13 — 2005.2.16

Gerhard Boerner
(MPI Munchen/RESCEU, U. Tokyo)
2005.2.14 — 2005.2.16

Christophe Grojean
(CEA-Saclay)
2005.2.17 — 2005.2.20

Akihiro Ishibashi
(Chicago University)
2005.2.21 — 2005.2.24

Jos Vermaseren
(NIKHEF)
2005.3.1 — 2005.3.5

Giovanni Landi
(Trieste University/INFN, Naples)
2005.3.7 — 2005.3.10

Chiang-Mei Chen
(Nationl Central University, Taiwan)
2005.3.12 — 2005.3.16

Kazushi Iwasawa
(University of Cambridge)
2005.3.12 — 2005.3.23

S. Ando
(TRIUMF)
2005.3.14 — 2005.3.15

Tetsufumi Hirano
(Columbia University)
2005.3.14 — 2005.3.18

Chapter 3

Workshops and Conferences

3.1 International Workshops and Conferences

Since 1978, we have held a series of international physics workshops every one or two years, called *Yukawa International Seminar (YKIS)*. We also support *the Nishinomiya Yukawa Memorial Project* sponsored 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 is held every year in Nishinomiya city, and its post/pre-workshop is held at YITP.

In addition to these regular annual conferences, we hold international workshops and conferences of various sizes and of periods from several days to more than one month every year.

Here, we give the list of main international workshops and conferences held in 2004.

Yukawa International Seminar (YKIS)

YKIS2004: Physics of Strongly Correlated Electron Systems
1 – 19 Nov. 2004, chaired by H. Shiba, 106 participants (68 from abroad)
Proceedings: *Prog. Theor. Phys. Suppl.* No.160 (2005).

Nishinomiya Yukawa Symposium

Origins: From Early Universe to Extrasolar Planets
1 – 2 Nov. 2004, 117 participants (24 from abroad)
Proceedings: *Prog. Theor. Phys. Suppl.* No.158 (2005).

3.2 YITP workshops

YITP workshops are one of our main activities. The aim of them is to open new research fields and stimulate mutual collaborations. Workshop plans can be proposed by any researcher and are selected by the Committee on Research Projects of our institute. We also support small workshops and summer schools to educate young researchers.
In the past 5 years, we had more than 20 workshops and 1500 participants per year. The list of the workshops and the number of participants for the last 2 years are given below.

▷ 2004.4.1 — 2005.3.31

YITP-W-04-01
Biological Effects of Electromagnetic Fields: Toward the Clarification of Underlying Mechanisms, Jun. 24, 2004 - Jun. 26, 2004, organized by M. Murase (YITP). *63* attendance.
(Bussei Kenkyu 84-2)

YITP-W-04-02
LFT mini workshop, May 24, 2004 - May 28, 2004, organized by H. Suzuki (Ibaraki U), Y. Kikukawa, T. Onogi. *50* attendance.

YITP-W-04-03
Quantum Field Theory 2004, Jul. 13, 2004 - Jul.16, 2004, organized by T. Takahashi (Nara Women's U), H. Awata, M. Sakamoto, Y. Satoh, S. Sugimoto, H. Kunitomo, M. Kato, H. Ishikawa, Y. Imamura, N. Ohta. *148* attendance.
(Soryushiron Kenkyu 110-3)

YITP-W-04-04
Progress in Particle Physics, Jun. 29, 2004 - Jul. 2, 2004, organized by Y. Yamada (Tohoku U), N. Okada, T. Ohta, S. Kaneko, T. Kobayashi, J. Sato, Y. Shimiziu, Y. Taniguchi, K. Ishikawa, K. Izawa. *96* attendance.
(Soryushiron Kenkyu 110-4)

YITP-W-04-05
Physics of Soft Matter 2004 — Flow and Deformation —, Jul. 26, 2004 - Jul. 28, 2004, organized by T. Taniguchi (Yamagata U), T. Araki, A. Matsuyama, Y. Masubuchi, Y. Tanaka, M. Takenaka, M. Doi, Y. Kimura, H. Seto, T. Okuzono. *104* attendance.
(Bussei Kenkyu 83-3)

YITP-W-04-06
The 49th Summer Seminar for young reserchers of condensed-matter physics, Jul. 29, 2004 - Aug. 2, 2004.
(Bussei Kenkyu 83-5)

YITP-W-04-07
Thermal Quantum Field Theories and Their Applicaitons, Aug. 9, 2004 - Aug. 11, 2004, organized by H. Yokota (Nara U), Y. Tsue, Y. Yamanaka, T. Inagaki, M. Sakagami, H. Sawayanagi, Y. Yabu, S. Muroya, A. Niegawa, K. Nakagawa. *61* attendance.
(Soryushiron Kenkyu 110-5)

YITP-W-04-08
Summer Institute 2004, Aug. 12, 2004 - Aug. 11, 2004, organized by M. Tanimoto (Niigata U). *54* attendance.
(Soryushiron Kenkyu 110-6)

YITP-W-04-09
Summer School on Astronomy and Astrophysics 2004, Aug.14, 2004 - Aug.18, 2004.

YITP-W-04-10
YONUPA Summer School, Aug.2, 2004 - Aug.7, 2004.

YITP-W-04-11
Origins: From First Objects to Extrasolar Planets, Nov. 4, 2004 - Nov. 6, 2004, organized by S. Mineshige (YITP), S. Ida, S. Inutsuka, M. Umemura, Y. Suto, F. Takahara, T. Nakamura, S. Nagataki. *141* attendance.
(Soryushiron Kenkyu 110-3)

YITP-W-04-12
International Symposium on Spin-Triplet Superconductivity and Ruthenate Physics (STSR2004), Oct. 25, 2004 - Oct. 28, 2004, organized by Y. Maeno (Kyoto U). *84* attendance.

YITP-W-04-13
The 14th workshop on General Relativity and Gravitation, Nov. 29, 2004 - Dec. 3, 2004, organized by T. Tanaka (Kyoto U), M. Sasaki.

YITP-W-04-14
Chaos and Nonlinear Dynamics in Quantum-Mechanical and Macroscopic Systems, Dec.8, 2004 - Dec.10, 2004, organized by K. Nakamura (Osaka City U), K. Takatsuka, I. Ohba. *115* attendance.

YITP-W-04-15
Quantum Field Theories: Fundamental Problems and Applications, Dec.16, 2004 - Dec.18, 2004, organized by I. Tsutsui (KEK), H. Yabu, H. Suzuki, Y. Kawamura, S. Tanimura, A. Shimizu, K. Harada, K. Fujikawa, N. Sakai, A. Iwazaki, K. Shizuya, J. Goryo. *157* attendance.
(Soryushiron Kenkyu)

YITP-W-04-16
International Workshop on MHD Accretion Flows and Jets, Jan.25, 2005 - Jan.27, 2005, organized by

S. Mineshige (YITP). *57* attendance.
(Soryushiron Kenkyu 111-2)

YITP-W-04-17
Non-equilibrium dynamics in the QCD phase transitions, Feb.22, 2005 - Feb.24, 2005, organized by T. Kunihiro (YITP), H. Fujii, K. Ohnishi, N. Ikezi. *41* attendance.

YITP-W-04-18
Complexity and Nonextensivity–New Trends in Statistical Mechanics, Mar.14, 2005 - Mar.18, 2005, organized by M. Sakagami (Kyoto U), S. Abe.

YITP-W-04-19
New Approach to Lattice Gauge Theory, Dec. 8, 2004 - Dec.10, 2004, organized by T. Onogi (YITP), H. So. *48* attendance.

YITP-W-04-20
Physics in LHC era, Dec.13, 2004 - Dec.15, 2004, organized by M. Nojiri. *90* attendance.

YITP-W-04-21
CP Violation and Matter and Anti-matter Asymmetry, Jan.12, 2005 - Jan.14, 2005, organized by T. Morozumi (Hiroshima U), K. Funakubo, T. Kurimoto, S. Kaneko, M. Tanimoto, T. Yoshikawa. *36* attendance.

YITP-W-04-22
New Trends of Monte Carlo Simulations III, Feb. 28, 2005 - Mar. 2, 2005, organized by Y. Iba (Inst.Stat.Math.), Y. Tomita, K. Harada, H. Takano, M. Kikuchi, K. Fukushima. *28* attendance.

YITP-W-04-23
Nano-Bio dyanmics, Mar.4, 2005 - Mar.5, 2005, organized by T. Shibata (Hiroshima U), M. Sano, K. Fujimoto, M. Sasai, Y. Sako, T. Ohta, N. Shimamoto, M. Murase . *60* attendance.
(Bussei Kenkyuu)

YITP-W-04-24
New Development in Stellar Astrophysics – Science Opened by Polarimetric, High-Dispersion Spectroscopic, and High-Speed Observations –, Mar.7, 2005 - Mar.8, 2005, organized by D. Nogami (Kyoto U), S. Mineshige. *103* attendance.

3.3 Regional Schools supported by YITP

▷ 2004.4.1—2005.3.31

YITP-S-04-01
Hokuriku-Shinetsu Particle Physics Theory Group Meeting, Kigoyama Fureainosato Kenshu-kan (Ishikawa), 2004.5.21-23.
Invited speakers: M. Oka (Tokyo Inst. of Technology), M. Koashi (Osaka Univ.)
Participating univ.: Kanazawa Univ., Niigata Univ., Toyama Univ., Fukui Univ.

YITP-S-04-02
Chubu Summer School 2004, Yamanakako Seminar House (Tokai Univ.), 2004.8.28-31.
Invited speakers: M. Kawasaki (Univ. of Tokyo)
Participating univ.: Tokai Univ., Shizuoka Univ., Shinshu Univ., Shizuoka Prefectural Univ.

YITP-S-04-03
Niigata-Yamagata School, Yamagata-ken Seinen no Ie, 2004.11.5-7.
Invited speakers: K. Yoshioka (Kyushu Univ.)
Participating univ.: Niigata Univ., Yamagata Univ., Joetsu Univ. of Education, Univ. of Aizu

YITP-S-04-04
The 27th Shikoku-seminar, Ehime Univ., 2004.12.27-28.
Invited speakers: N. Ohta (Osaka Univ.)
Participating univ.: Ehime Univ., Tokushima Univ., Kochi Univ., Kagawa Univ.

YITP-S-04-05
Takino '04 -18th Workshop in Hokkaido Nuclear Theory Group -, Takino Suzuran Koen Seinen no Ie (Hokkaido), 2005.2.11-13.
Invited speakers: Y. Akaishi (Nihon Univ.), T. Fukuda (Osaka Electro-Communication Univ.)
Participating univ.: Hokkaido Univ., Hokusei Gakuen Univ., Wakkanai Hokusei Gakuen Univ., Sapporo Gakuin Univ.

YITP-S-04-06
Kita-Tohoku Nuclear Theory Seminar, Akita National College of Technology, 2005.1.8-9.
Invited speakers: Y. Abe (YITP)
Participating univ.: Tohoku Univ., Aomori Univ., Akita Univ., Iwate Univ.