GCOE 国際会議　報告書

2013 年 1 月 31 日
文責：國友　浩

開催会議名：　Yukawa International Seminar (YKIS) 2012
"From Gravity to Strong Coupling Physics"
開催日時：　2012 年 10 月 15 日　～　2012 年 10 月 19 日
開催場所：　京都大学　基礎物理学研究所

主催：京都大学　基礎物理学研究所
共催:京都大学グローバル COE プログラム「普遍性と創発性から紡ぐ次世代物理学」
後援：財団法人　湯川記念財団

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会議の意義、内容、成果等の概要

ゲージ・重力双対性は、当初、究極の統一理論として期待される超弦理論の研究を通じて、AdS/CFT 対応という形で、発見された。これは 4(=1+3) 次元の超対称ゲージ理論と 5(=1+4) 次元の反ド・ジッター(AdS) 空間における超重力理論の間に存在する対応関係で、超弦理論の研究者によって研究されてきた。しかしながら、近年、この異なる次元で定義された二つの理論の間に存在する一見奇妙な対応関係は、より一般的に「ゲージ・重力双対性」という形で非常に広い応用範囲を持つことが次第に明らかになってきた。即ち、一般の D 次元空間の系の強結合における振る舞いを、1 次元高い D+1 次元空間における重力理論の古典的な振る舞いとして記述できると言うのである。

このゲージ・重力対応は弦理論における開弦・閉弦双対性として古くから知られていたが、長らくこの双対性は弦理論に特有のもので、弦の振動モードについて無限に足し上げることで初めて成り立つものと考えられていた。しかし Maldacena は、同じ D-ブレインに開弦を用いた記述と超重力理論におけるブラックブレイン解を用いた記述の二つがあり、前者の低エネルギー極限である超共形超対称ゲージ理論と後者の近地平面極限である反ド・ジッター空間（と高次元球面の直積）上の超重力理論が同じ対称性を持つことから、両者の間に一定の対応が存在すると予想した。この対応は、その後 Gubser-Klebanov-Polyakov 及び Witten により精密化され、AdS/CFT 対応、あるいは更に拡張され、ゲージ・重力双対性として多くの超弦理論研究者によって精力的に研究されるようになった。

一方、超弦理論に限らず物理学一般においても、相互作用（相関）の強い系を記述することは一般に非常に難しく、これをいかにして記述するかは重要な問題である。ゲージ・重力双対性の方法は、このようなより一般の強結合の場の量子論をも弱結合の重力理論に写像して記述する可能性を持っており、従って強相関系全般の研究に関して統一的で強力な手法となり得るものである。実際、ゲージ・重力双対性やブレインを用いた解析は、超弦理論のみならず超対称性を持つゲージ理論の強結合における動力学の解明に大きな役割を果たしている。また素粒子論以外にも、クォーク・グルオンプラズマの粘性率の計算やホログラフィック QCD を用いたカイラル対称性への新

しい知見など原子核理論分野やブレーン宇宙模型やホーキング輻射に対する新解釈など宇宙論分野へも大きな影響を与えている。また最近では、超伝導現象やフェルミ流体などの強相関物性系をゲージ・重力双対性を用いた解析なども試みられており、その適用範囲の広さがいよいよ明らかになり始めている。

以上のような観点からゲージ重力双対性の方法は、理論物理学の幅広い分野において、摂動論で理解できない、強結合の物理を解析し、新しい統一的な見方を与える手法としてますます大きくな期待を集めており、この機会に内外の著名な研究者を招待したシンポジウムを基礎物理学研究所で開催することで、研究成果を交換し、相互に交流を深めることは非常に有意義である。

このような背景を踏まえ、本シンポジウムではゲージ・重力双対性の方法における最近の発展に関して広い分野の研究者を集め、外国人 16 名を含む 23 名による招待講演と外国人 8 名を含む 24 名によるポスター発表が行われた。招待講演について幾つか具体的に述べると、まずは可解性という顕著な性質を通じた超弦理論の解析に関する発展として、AdS 背景の超弦理論の相関関数を計算する新しい一般的な手法と、それを用いた、いくつかの具体的相関関数の計算結果が発表された。この方法は非常に強力で、より一般の相関関数に適用することでゲージ重力対応に関するより深い理解を得るための有力な手法を与えるものである。一方、N=4 超対称ゲージ理論の解析については、散乱振幅の隠れた対称性として、双対超共形対称性について報告された。この対称性は摂動展開における全ての項（の被積分関数）を規定するもので、散乱振幅をウイルソンループや相関関数と関連づける非常に重要な役割を果たしている。またこの対称性は N=8 超重力理論にも存在することが明らかになりつつあり、その（摂動的）有限性を示すものとして、ますます重要となって行くことように思われる。この他、周辺分野への応用としては、超流動物質、非フェルミ液体や超伝導転移などの強相関凝縮系に対する AdS/CFT 対応を用いた解析結果の報告があり、依然としてゲージ重力双対性の手法の凝縮系物理への応用が活発であることが示された。最後に、近年（超）弦理論と類似でより簡単な模型として注目されている、無限の高階スピンを含む 3 次元（超）重力理論に関しても最新の成果が発表された。これについては、今後、ここで得られた定式化を用いることでエントロピーの計算など、より具体的な進展が期待される。ポスターセッションも活況で、部屋には熱心に議論する多くの研究者の熱気が立ちこめていたことも書き加えておく。

なお、この YKIS 2012 は、滞在型研究会 ″Gauge/Gravity Duality″（９月２４日～１０月２６日）と連動して、その 4 週目に開催された。滞在型研究会では、比較的長期滞在が可能な中堅から若手の研究者を中心に、シンポジウムとは対照的に、週二日、それぞれ２～３のセミナーを行うといったゆったりとした日程で、ゲージ・重力対応

に関連したより広い分野に関してじっくりと議論され、こちらも大変好評であった。

本シンポジウムではこの分野最新の成果に関する集中的な議論を通じて多くの研究者が相互に交流を深めることができた。ここで生まれた研究者ネットワークが、今後新しい共同研究などの形で分野を牽引する新しい成果を生み出していくことが期待される。ゲージ・重力対応は 21 世紀の新しい手法として、20 世紀を通じて高度に専門家・細分化されてきた理論物理学を再び統一する共通言語の役割を果たしていくと思われる。

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Program of YKIS 2012 "From Gravity to Strong Coupling Physics"

15 Oct. (Mon.)

Chair person: Tohru Eguchi (Rikkyo)

9:50 - 10:00 Taichiro Kugo (YITP)
"Opening Address"

10:00 - 11:00 Daniel Jafferis (Harvard)
"Exact results for five-dimensional superconformal field theories with gravity duals"

11:00 - 11:20 COFFEE BREAK

11:20 - 12:20 Yosuke Imamura (Titech)
"S^3/Z_n partition function and dualities"

12:20 - 14:00 LUNCH

Chair person: Kazutoshi Ohta (Meiji Gakuin)

14:00 - 15:00 Kimyeong Lee (KIAS)
"On M5 Branes"

15:00 - 16:00 Shinji Hirano (Nagoya)
"ABJ partition function"

16:00 - 16:30 COFFEE BREAK

16:30 - 17:30 Yu Nakayama (Caltech)
"Holographic judgment on recent debates over scale vs conformal invariance"

16 Oct. (Tue.)

Chair person: Katsushi Ito (Titech)

10:00 - 11:00 Pedro Vieira (Perimeter Institute for Theoretical Physics)
"Tailoring three-point functions and integrability"

11:00 - 11:20 COFFEE BREAK

11:20 - 12:20 Yuji Satoh (Tsukuba)
"Gluon scattering amplitudes from gauge/string duality and integrability"

12:20 - 14:00 LUNCH

Chair person: Sanefumi Moriyama (Nagoya)

14:00 - 15:00 Gregory Korchemsky (Saclay)
"Hidden symmetries of scattering amplitudes and correlation functions in N=4 SYM"

15:00 - 16:00 Yoichi Kazama (Tokyo, Komaba)
"Holographic correlation functions at strong coupling from integrability"

16:00 - 16:30 COFFEE BREAK

16:30 - 17:30 Romuald Janik (Jagiellonian)
"Numerical relativity and boost-invariant plasma thermalization"

17 Oct. (Wed.)

Chair person: Shigeki Sugimoto (Kavli IPMU)

10:00 - 11:00 Carlos Nunez (Swansea)
"Aspects of gauge-strings duality"

11:00 - 11:20 COFFEE BREAK

11:20 - 12:20 Koji Hashimoto (Osaka/RIKEN)
"Holographic Magnetars"

12:20 - 14:00 LUNCH

Chair person: Tadakatsu Sakai (Nagoya)

14:00 - 15:00 Jacob Sonnenschein (Tel Aviv)
"Baryonic popcorn - on holographic nuclear interaction, nuclear matter and crystals of ADHM multi-instantons"

15:00 - 15:30 COFFEE BREAK

15:30 - 17:30 Poster presentation (at room Y206 and Y306)

18 Oct. (Thu.)

Chair person: Makoto Natsuume (KEK)

10:00 - 11:00 Gary Horowitz (UC Santa Barbara)
"Transport in holographic lattices"

11:00 - 11:20 COFFEE BREAK

11:20 - 12:20 Jerome Gauntlett (Imperial College)
"Holographic superfluids and the dynamics of symmetry breaking"

12:20 - 14:00 LUNCH

Chair person: Shin Nakamura (Kyoto)

14:00 - 15:00 Sean Hartnoll (Stanford)
"The Pauli exclusion principle at strong coupling"

15:00 - 16:00 Veronika Hubeny (Durham)
"CFT probes of bulk geometry and causal holographic information"

16:00 - 16:30 COFFEE BREAK

16:30 - 17:30 Mukund Rangamani (Durham)
"Black brane hydrodynamics and the membrane paradigm"

18:00 - 20:00 BANQUET (at restaurant *"Camphora"*)

19 Oct. (Fri.)

Chair person: Masaki Shigemori (Nagoya)

10:00 - 11:00 Rajesh Gopakumar (Harish-Chandra Research Institute)
"What can we learn from coset CFTs and their duals?"

11:00 - 11:20 COFFEE BREAK

11:20 - 12:20 Yasuaki Hikida (Keio)
"Higher spin supergravity dual of Kazama-Suzuki model"

12:20 - 14:00 LUNCH

Chair person: Yutaka Matsuo (Tokyo)

14:00 - 15:00 Xi Yin (Harvard)
"From higher spins to strings"

15:00 - 16:00 Nikolay Gromov (King's College)
"Analytic solution of bremsstrahlung TBA"

16:00 - 16:30 COFFEE BREAK

16:30 - 17:30 Jan de Boer (Amsterdam)
"(Entanglement) Entropy in 3d higher spin theories"

List of poster presentations

1.

"Towards A Holographic Model of D-Wave Superconductors"

Jiunn-Wei Chen (National Taiwan University)

The current status of building bottom up holographic D-wave superconductors will be reviewed.

2. 3.

"Novel parity violating transport coefficients in 2 + 1 dimensions from holography"

Shou-Huang Dai (Chung Yuan Christian University)
Debaprasad Maity (National Taiwan University)

We construct a 3+1 dimensional holographic model dual to a parity violating hydrodynamic system in 2+1 dimensions. Our model contains gravitational and electrodynamic Chern-Simons terms coupled to a neutral pseudo scalar θ, and a potential composed of quadratic and quartic terms in θ. The background is a charged black brane. We study the hydrodynamics to first order in spacetime derivatives near the probe limit of the pseudo scalar, by extracting the transport coefficients from the scalar, vector, and tensor modes of bulk perturbations. We study two mechanisms for breaking the parity of the boundary fluid: the parity is either spontaneously broken by the nonzero vev of the dual pseudo scalar operator, or by the pseudo scalar source on the boundary. We discover some novel temperature-dependent behaviors of the transport coefficients. It would be interesting to find these behaviors being realized in the real world materials.

4.

"On gravity dual for a correlation function of a Wilson loop and a chiral primary operator"

Takayuki Enari (Nihon University)

In the context of AdS/CFT correspondence, we construct a gravity solution which corresponds to a correlation function between a 1/4 BPS Wilson loop and a chiral primary operator. This solution reproduces the behavior of the correlation function in the large R-charge limit. Concretely, the behavior means a saddle point on the steepest decent path of appropriate integral expression for modified Bessel function. Moreover, we find another solution that becomes complex in a certain section. This can be interpreted, in gauge theory side, as a saddle point which does not exist on the steepest decent path. We see that each solution reduces to previously known stable and unstable string configuration respectively in the zero R-charge limit.

5.

"Anti-de Sitter space as topological insulator and holography"

Shih-Hao Ho (National Center for Theoretical Science)

We argue that the Anti-de Sitter (AdS) space can be thought as a topological insulator with the asymptotic AdS boundary as a co-dimensional one defect. Combining the bulk/edge correspondence for the topological insulators and the AdS/CFT correspondence, the fermionic topological phases for the dual conformal field theories (CFTs) can then be classified in the same way as classifying the topological phases of the massive free fermions in the co-dimensional one higher Minkowski spaces. The latter can then be obtained in Kitaev's framework of the K-theory analysis

in classifying the topological insulators/superconductors. Our framework provides a way of classifying the symmetry-protected topologically ordered phases for the strongly interacting gapless systems, of which the classification is intractable in the context of strongly correlated condensed matters devised mainly for gapped systems.

6.

"Creation of D9-brane–anti-D9-brane Pairs from Hagedorn Transition of Closed Strings"

Kenji Hotta (Hokkaido University)

It is well known that one-loop free energy of closed strings diverges above the Hagedorn temperature. One explanation for this divergence is that a 'winding mode' in the Euclidean time direction becomes tachyonic above the Hagedorn temperature. The Hagedorn transition of closed strings has been proposed as a phase transition via condensation of this winding tachyon. But we have not known the stable minimum of the potential of this winding tachyon so far. On the other hand, we have previously calculated the finite temperature effective potential of open strings on D-brane–anti-D-brane pairs, and shown that a phase transition occurs near the Hagedorn temperature and D9-brane–anti-D9-brane pairs become stable. In this poster, we present a conjecture that D9-brane–anti-D9-brane pairs are created by the Hagedorn transition of closed strings, and describe some circumstantial evidences. Based on BSFT and BCFT, we show that the cylinder amplitude with some closed string vertex insertions in the closed string vacuum limit at the Hagedorn temperature approaches to the sphere amplitude with two more winding tachyon insertion near the Hagedorn temperature. We also show that the potential energy at the open string vacuum decreases limitlessly as the temperature approaches to the Hagedorn temperature. It is natural to think that the open string vacuum becomes the global minimum near the Hagedorn temperature.

7.

"Geometric Approach to Quantum Statistical Mechanics and Minimal Area Principle"

Shoichi Ichinose (University of Shizuoka)

A geometric approach to some quantum statistical systems (including the harmonic oscillator) is presented. We regard the $(N+1)$-dimensional Euclidean coordinate system (X^i, τ) as the quantum statistical system of N quantum (statistical) variables (X^i) and one Euclidean time variable (τ). Introducing a path (line or hyper-surface) in this space (X^i, τ), we adopt the path-integral method to quantize the mechanical system. This is a new view of (statistical) quantization of the mechanical system. It is inspired by the extra dimensional model, appearing in the unified theory of forces including gravity, using the bulk-boundary configuration. The system Hamiltonian appears as the area. We show quantization is realized by the minimal area principle in the present geometric approach. When we take a line as the path, the path-integral expressions of the free energy are shown to be the ordinary ones (such as N harmonic oscillators) or their simple variation. When we take a hyper-surface as the path, the system Hamiltonian is given by the area of the hyper-surface which is defined as a closed-string configuration in the bulk space. In this case, the system becomes a $O(N)$ non-linear model. The two choices, (1) the line element in the bulk (X^i, τ) and (2) the Hamiltonian (defined as the damping functional in the path-integral) specify the system dynamics. After explaining this new approach, we apply it to a topic in the 5 dimensional quantum gravity. We present a new standpoint about the quantum gravity: (a) The metric (gravitational) field is treated as the background (fixed) one; (b) The space-time coordinates are not merely position-labels but are quantum (statistical) variables by themselves. We show the recently-proposed 5 dimensional Casimir energy (ArXiv:0801.3064,0812.1263) is valid.

8.

"Landscape of Minimal String Theory"

Hirotaka Irie (YITP)

String theory is a candidate for the ultimate theory of our universe and people have been wishing to explain how the standard model is realized as a vacuum of the string theory. Despite of this anticipation, our current understanding is based on perturbative description, and there has not been known any quantitative understanding on relative stability of perturbative string-theory vacua, relation to non-perturbative vacua and its true vacuum. On the other hand, minimal string theory is a low-dimensional string theory which is a solvable toy model of string theory. Importantly, we now has a control over non-perturbative completion of this string theory. In this poster, we discuss how meta-stability, decay rates and its true vacuum are obtained with this completion program, and show several explicit solutions to non-perturbatively completion of minimal string theory.

9.

"Holographic Wilsonian renormalisation group and emergent fermions in extremal charged black holes"

Hiroshi Isono (Tata Institute of Fundamental Research)

I talk about our recent works on the holographic Wilsonian renormalisation group. First, I present a brief review of the holographic Wilsonian renormalisation group. Second, I present an application of this technique to some holographic model of non-Fermi liquids and derive its low-energy effective action with some emergent fermions, which has the same forms as one proposed by Faulkner-Polchinski.

10.

"Signature of the Schwinger pair creation rate via radiation generated in graphene by a strong electric current"

Hsien-Chung Kao (National Taiwan Normal University)

Electron - hole pairs are copuously created by an applied electric field near the Dirac point in graphene or similar 2D electronic systems. It was shown recently that for sufficiently large electric fields E and ballistic times the I-V characteristics become strongly nonlinear due to Schwinger's pair creation rate, proportional to $E^{3/2}$. Since there is no energy gap the radiation from the pairs' annihilation is enhanced. The spectrum of radiation is calculated and exhibits a maximum at $\omega = \sqrt{eEv_g/\hbar}$. The angular and polarization dependence of the emitted photons with respect to the graphene sheet is quite distinctive. For very large currents the recombination rate becomes so large that it leads to the second Ohmic regime due to radiation friction.

11.

"New relations among high-energy bosonic string scattering amplitudes"

Shoichi Kawamoto (Tunghai University)

As various scattering amplitudes and higher spin theories are discussed in the context of recent AdS/CFT development, we revisited the analysis of bosonic string scattering amplitudes in the high-energy regime. We consider four-point amplitudes in the flat background with the external particles being various higher spin states. The leading order amplitudes have been known to obey nontrivial relations. By use of the basis constructed through Del Giudice-Di Vecchia-Fibini (DDF) operators, which form spectrum generating algebra, they are concisely classified by its leading energy dependence and the scattering angle dependence of the center-of-momentum frame. We

find that in this basis there appear further nontrivial relations among the amplitudes, such as inheritance of the angle dependence from a higher order amplitudes, and linear relations among the subleading order amplitudes. We present a detailed spectroscopy of multi spin state scattering amplitudes up to total spin four, as well as the leading order calculations for some amplitudes with higher spin.

12.

"Three- (and four-) point functions of classical Liouville field theory from integrability"

Shota Komatsu (Univercity of Tokyo)

We compute classical three-point functions of Liouville field theory. Such computation usually requires solving the classical Liouville equation, which, in the case of three point functions, reduces to a hypergeometric differential equation. Applying integrability-based methods developed recently for holographic calculation of correlation functions in AdS/CFT, we show that the computation can be done without solving a classical Liouville equation or a hypergeometric equation. We also discuss some preliminary results on the generalization to four-point functions (conformal blocks), for which the solution to the Liouville equation is not known.

13.

"Supersymmetry for string solutions corresponding to correlators of a Wilson loop and a local operator"

Akitsugu Miwa (Nihon University)

We study supersymmetry preserved by string solutions which correspond to correlation functions between a 1/4 BPS Wilson loop and a 1/2 BPS local operator. Since the solution is given in an Euclidean AdS space, we consider "analytic continuation" for fermionic parameters as well as bosonic string coordinates. The existence of the preserved supersymmetry suggests that non-trivial check of the AdS/CFT correspondence is possible for this system (see the poster by T.Enari).

14.

"New States of Gauge Theories on a Circle"

Takashi Morita (KEK)

We find a new class of saddle point solutions in $U(N)$ and $SU(N)$ gauge theories on a circle. In the case of finite temperature pure Yang-Mills theory, these states appear above the deconfinement transition temperature, and they are characterized by the expectation values of the Polyakov loop operators, which wind the temporal circle different times. In the case of the spatial circle, these solutions appear as intermediate states in certain real-time dynamical processes. We also study the role of these solutions in the gauge/gravity correspondence. Especially they play an important role in the Gregory-Laflamme transition.

15.

"Exact Results on the ABJM Matrix Model"

Sanefumi Moriyama (Nagoya University)

It was known that the worldvolume theory of M2 branes is described by the supersymmetric Chern-Simons theory. Due to the localization technique, the partition function is reduced to a finite-dimensional matrix model and gives the famous degrees of freedom $N^{3/2}$. We would like to discuss some exact results of this system.

16.

"Nonequilibrium Phase Transitions and a Nonequilibrium Critical Point from AdS/CFT"

Shin Nakamura (Kyoto University)

The AdS/CFT correspondence brought a discovery of new phase transitions in nonequilibrium states. We find novel phase transitions and critical phenomena that occur only outside the linear-response regime of current-driven nonequilibrium states by using AdS/CFT. We consider strongly-interacting $(3+1)$-dimensional $N=4$ large-Nc $SU(Nc)$ supersymmetric Yang-Mills theory with a single flavor of fundamental $N=2$ hypermultiplet as a microscopic theory. We compute its non-linear non-ballistic quark-charge conductivity. We find that the system exhibits a novel nonequilibrium first-order phase transition where the conductivity jumps and the sign of the differential conductivity flips at finite current density. A nonequilibrium critical point is discovered at the end point of the first-order regime. We propose a nonequilibrium-steady-state analogue of thermodynamic potential in terms of the gravity-dual theory in order to define the transition point. Nonequilibrium analogues of critical exponents are proposed as well. Critical behaviors of the conductivity are numerically confirmed based on these proposals. The present work provides a new example of nonequilibrium phase transitions and nonequilibrium critical points. The reference is Phys. Rev. Lett. 109 (2012) 120602 [arXiv:1204.1971].

17.

"Refined Holographic Entanglement Entropy for the AdS Solitons and AdS black Holes"

Bo Ning (National Taiwan University)

We consider the refinement of the holographic entanglement entropy on a disk region for the holographic dual theories to the AdS solitons and AdS black holes, including the corrected ones by the Gauss-Bonnet term. The refinement is obtained by extracting the UV cutoff-independent piece of the holographic entanglement entropy. We find that the refined entanglement entropy of the AdS_{d+1} soliton decreases monotonically for $d=3$, however for $d=4,5$ violation of the C-theorem occurs around the deconfinement/confinement phase transition. We also check that there is no topological entanglement entropy for AdS_5 soliton even with Gauss-Bonnet correction. For the AdS black holes, the renormalized entanglement entropy obeys an expected volume law at IR regime, and the transition between UV and IR regimes is a smooth crossover even with Gauss-Bonnet correction. Based on AdS/MERA conjecture, we postulate that the IR fixed-point state for the non-extremal AdS soliton is a trivial product state.

18.

"Holographic Entanglement Entropy in Topologically Massive Gravity"

Noriaki Ogawa (KIAS)

We investigate the holographic calculation of entanglement entropy in $2d$ left-right asymmetric conformal field theories, using topologically massive gravity (TMG). We find that the naive prescription gives some small numerical disagreements with the expectation on the gauge side, although it is rather good qualitatively. We also discuss the origin and the resolution of it. (This poster is based on my ongoing work with Tomonori Ugajin (IPMU & YITP).)

19.

"Charged Black Holes in String Theory with Gauss-Bonnet Correction in Various Dimensions"

Takashi Torii (Osaka Institute of Technology)

We study charged black hole solutions in Einstein-Gauss-Bonnet gravity with the dilaton. We derive the field equations for the static spherically symmetric spacetime with the $(D-2)$-dimensional hypersurface of curvature signature k in general D dimensions. The system has some scaling symmetries which are used in our analysis of the solutions. We find numerical solutions, i.e., regular asymptotically flat solutions for $k = 1$. For spherically symmetric solutions, there is the minimum horizon radius below which no solution exists in $D = 4 - 6$.

20.

"The tetrahedron Zamolodchikov algebra and the $AdS_5 \times S^5$ S-matrix"

Zengo Tsuboi (Humboldt-Universität zu Berlin)

The S-matrix of the $AdS_5 \times S^5$ string theory is a tensor product of two centrally extended $su(2|2) \ltimes \mathbb{R}^2$ S-matrices, each of which is related to the R matrix of the Hubbard model. The R-matrix of the Hubbard model was first found by Shastry, who ingeniously exploited the fact that, for zero coupling, the Hubbard model can be decomposed into two XX models. In this poster, we review and clarify this construction from the AdS/CFT perspective and investigate the implications this has for the $AdS_5 \times S^5$ S-matrix. This is a joint work with Vladimir Mitev, Matthias Staudacher.

21. 22.

"Phase Structure in a Holographic QCD model"

Shang-Yu Wu (National Chiao Tung University)
Yi Yang (National Chiao Tung University)

We construct a holographic QCD model at finite temperature and finite chemical potential by AdS/CFT duality. We solve the equations of motion analytically by using the potential restruction methods. We calculate the free energy of our system to explore the phase structure. We also study the equation of states and compare our model to the QCD phenomemology.

23.

"3-dimensional N=2 SUSY theories with boundary"

Satochi Yamaguchi (Osaka University)

We consider 3-dimensional $N = 2$ SUSY field theories with boundaries. There are two distinct classes of 1/2 BPS boundary conditions: A-type and B-type. Boundary conditions of $N = 2$ Landau-Ginzburg model is classified. In the $N = 2$ free Maxwell theory, we identify the correspondence of the boundary conditions in the abelian duality. The boundary conditions and the mirror symmetry in the $N = 2$ QED is also discussed.

24.

"Holography and anomaly matching for resonances"

Naoki Yamamoto (YITP)

We derive a universal relation for the transverse part of triangle anomalies in a class of holographic models of QCD which may be regarded as the "anomaly matching" for resonances. We argue its consequences and possible realization in real QCD.