MINI SYMPOSIUM

Holographic Tensors

October 31–November 2, 2018
OIST Conference Center/OIST Seaside House
Organizers: Reiko TORIUMI (OIST), Shinobu HIKAMI (OIST),
Vincent RIVASSEAU (University Paris-Sud XI)
This workshop is supported by OIST

Schedule

Wednesday, October 31 (at OIST Conference Center)

9:30–10:15 **Razvan Gurau (Centre de Physique Theorique, Ecole Polytechnique)**
Title: "Invitation to random tensors"

10:15–11:00 **Vincent Rivasseau (LPT Orsay, Univ. Paris-Sud 11)**
Title: "Classical Melonic Flows and the Spiked Tensor Model"

11:00-11:45 coffee break

11:45–12:30 **Dario Benedetti (LPT Orsay, Univ. Paris-Sud 11)**
Title: "Bilocal effective action for tensor models"

12:30-14:30 lunch

14:30–15:15 **Yuki Sato (Nagoya University)**

Title: "How to "cool down" Ising model on 2d dynamical triangulations"

15:15–16:00 **Junggi Yoon (Kias, South Korea)**
Title: TBA

16:00-16:45 coffee break

16:45–17:30 **Seiji Terashima (YITP, Kyoto University)**
Title: "AdS/CFT Correspondence in Operator Formalism"

17:30–18:15 **Astrid Eichhorn (University of Heidelberg)**
Title: " Tensor models from a functional Renormalization Group perspective "

18:30- dinner

Thursday, November 1 (at OIST Seaside House)

9:00–9:45 **Mikhail Vasilyev (Lebedev Physical Institute)**
Title: "From higher-spin gauge theory to strings and tensor models."

9:45–10:30 **Pablo Diaz (CTPU, Institute for Basic Science.)**
Title: "Spontaneous Symmetry Breaking in Tensor Theories"

10:30-11:15 coffee break

11:15–12:00 **Kiryl Pakrouski (Princeton University)** via skype
Title: TBA

12:00–12:45 **Joseph Ben Geloun (Laboratoire d'Informatique de Paris Nord, University Paris 13)**
Title: "Counting U(N) and O(N) invariants, and graph algebras of tensor models"

12:45–14:45 Lunch

14:45–15:15 **Sabine Harribey (CPHT Ecole Polytechnique)**
Title: "Adding bosons to an SYK-like model"

15:15–15:45 **Nicolas Delporte (LPT Orsay, Univ. Paris-Sud 11)**
Title: "Phase diagram of 3d Tensorial Gross-Neveu"

15:45–16:15 **K.V. Pavan Kumar (Indian Institute of Science)**
Title: TBA

16:15–16:45 coffee break

16:45–17:15 **Johannes Lumma (Heidelberg University)**
Title: "Universality classes for the continuum limit in rank-3 tensor models"

17:15–17:45 **Romain Pascalie (University of Bordeaux)**
Title: TBA

17:45–18:45 coffee break and discussion

18:45– dinner

Friday, November 2 (at OIST Seaside House)

9:00–9:45 **Sanjaye Ramgoolam (Queen Mary University)**
Title: "Tensor models, algebras and topological holography."

9:45–10:30 **Frank Ferrari (Université Libre de Bruxelles)**
Title: "Brief Review and New Results in Melonic Quantum Mechanics"

10:30-11:15 coffee break

11:15–12:00 **Dario Rosa (Korea Institute for Advanced Study)**
Title: "The Thouless time for mass-deformed SYK"

12:00–12:45 **Hiroshi Itoyama (Osaka City University)**
Title: "Cut and join operator in ring in tensor models"

12:45–14:45 Lunch

14:45–15:30 **Benoit Collins (University of Kyoto)**
Title: "norm estimate for polynomials in unitary random tensors."

15:30–16:15 **Oleg Evnin (Chulalongkorn University (Bangkok) & Solvay Institutes (Brussels))**
Title: "Quantum and classical resonant systems"

16:15-16:30 coffee break

16:30–17:30 **Luca Lionni (YITP, Kyoto University)**
Title: TBA

17:30–18:15 **Sylvain Carrozza (Perimeter Institute for Theoretical Physics)**
Title: "SYK-like tensor quantum mechanics with Sp(N) symmetry"

18:30- dinner

(Last modified: Nov. 1)

Titles and Abstracts

Razvan Gurau

Title: "Invitation to random tensors"

Abstract: TBA

Vincent Rivasseau

Title: Classical Melonic Flows and the Spiked Tensor Model

Abstract: I ll define the melonic approximation to classical random flows in the spirit of "Melonic Turbulence", arXiv:1810.01848, but in the simpler context of the spiked tensor model in data analysis. Then I'll give an introduction to the work of Ben Arous et al, arXiv1711.05424 which studies the landscape complexity of that model.

Dario Benedetti

Title: Bilocal effective action for tensor models

Abstract: Motivated by the central role that a bilocal action formulation has in the SYK model and its holographic interpretation, I will introduce the two-particle-irreducible (2PI) effective action for tensor models, and show that it plays a similar role. In particular, I will discuss the 1/N expansion of the Gurau-Witten model up to fourth order, and its interpretation as the one-loop approximation for an auxiliary bilocal theory.

Yuki Sato

Title: How to "cool down" Ising model on 2d dynamical triangulations

Abstract: The Ising model on 2d dynamical triangulations was originally introduced by Kazakov in 1986, which is a statistical system including gravitational degrees of freedom. This system is known to be critical at the finite temperature and the continuum theory defined around the critical point is the 2d gravity minimally coupled to fermion. We introduce a control parameter to the system, aiming at observing the quantum critical behavior. Tuning the parameter to a certain value the critical temperature reaches absolute zero and the resulting continuum theory at the zero temperature is NOT the 2d gravity minimally coupled to fermions. As it turns out, physics at the zero-temperature differs depending on the "cool down speed".

The talk will be based on the work with Tomo Tanaka (Phys.Rev. D98 (2018) no.2, 026026) and the work in progress with Jan Ambjorn.

Junggi Yoon

Title: TBA

Abstract: TBA

Seiji Terashima

Title: "AdS/CFT Correspondence in Operator Formalism"

Abstract: We study the AdS/CFT correspondence in the operator formalism without assuming the GKPW relation. We explicitly show that the low energy spectrum of the large N limit of CFT, which is realized by a strong coupling gauge theory, is identical to the spectrum of the free gravitational theory in the global AdS spacetime under some assumptions which are expected to be valid. Thus, two theories are equivalent for the low energy region under the assumptions. Using this quivalence, the bulk local field is constructed and the GKPW relation is derived.

Astrid Eichhorn

Title: Tensor models from a functional Renormalization Group perspective

Abstract: I will explain how Renormalization Group techniques can be applied to tensor models for quantum gravity. I will discuss the underlying concept of a form of coarse-graining adapted to a pregeometric setting, and highlight a notion of scaling dimension that arises naturally from a Renormalization Group equation in the large-N-limit. Finally, I will show first results for tentative universality classes in real and complex that might provide a continuum limit for quantum gravity.

Mikhail Vasilyev

title: From higher-spin gauge theory to strings and tensor models.

abstract: Higher-spin gauge theory is a theory exhibiting higher symmetries that can become manifest at ultra high (trans-Planckian) energies.

Hence, it is anticipated to be related to quantum gravity. Main properties of nonlinear higher-spin gauge theory and underlying structures such as unfolded formulation of dynamical equations and noncommutative higher-spin algebra in the twisor-like spinor space will be reviewed. The emphasize will be on the new class of models conjectured to form holographically dual to boundary tensor models, that are associated with Coxeter groups and Cherednik algebras.

Pablo Diaz

title: Spontaneous Symmetry Breaking in Tensor Theories

abstract: I will talk about spontaneous symmetry breaking patterns in tensor models. The choice of patterns (into diagonal subgroups) is motivated by a natural generalization of the chiral symmetry breaking. We find the explicit form of the Goldstone bosons which are organized as matrix multiplets transforming in the adjoint of U(N) in the effective theory. This provides a neat link between tensor and matrix theories. A fact that should add to the physical meaning of tensor theories in the context of holography and quantum gravity.

Kiryl Pakrouski

Title: TBA

Abstract: TBA

Joseph Ben Geloun

Title: Counting U(N) and O(N) invariants, and graph algebras of tensor models

Abstract: I will review the enumeration of unitary invariants, i.e. observables of complex tensor models (TMs), using symmetric group formulae. This counting reformulates in terms of a topological field theory which provides a geometrical interpretation of the counting as the number of branched covers of the sphere. The representation theory of symmetric groups allows one to enlighten other interesting features of the counting: the observables of a given complex TM span an algebra which support a matrix decomposition and possesses orthogonal bases. The dimension of this algebra, the number of unitary invariants, translates as a sum of squares of Kronecker coefficients, an object of major interest in Computational Complexity Theory.

I will then discuss how these results might be extended to observables of real TMs and will underline a few difficulties on the way to achieve the generalisation.

Sabine Harribey

Title: Adding bosons to an SYK-like model

Abstract: In this talk I will present an SYK-like tensor model with both bosons and fermions. The two-point functions and the conformal dimensions will be computed and compared to the results of Gurau-Witten and SYK models. (Work done under the supervision of Sylvain Carrozza).

Nicolas Delporte

title: Phase diagram of 3d Tensorial Gross-Neveu

abstract: TBA

Pavan Kumar Koutha

Title: TBA

Abstract: TBA

Johannes Lumma

title: Universality classes for the continuum limit in rank-3 tensor models

abstract: We explore the existence of universality classes in the large-N limit of real rank-3 tensor models using functional renormalization group methods. In particular, we discuss how to set up a functional renormalization group flow in a scale-free framework such as tensor models. Having established the set-up we search for fixed points, taking into account up to order-six interactions in the tensors. We discover several candidates for fixed points, and specifically explore the impact of a novel class of interactions allowed in the real rank 3 model.

Romain Pascalie

Title: TBA

Abstract: TBA

Sanjaye Ramgoolam

Title: Tensor models, algebras and topological holography.

Abstract: TBA

Frank Ferrari

Title: Brief Review and New Results in Melonic Quantum Mechanics

Abstract: After reviewing some of the basic ideas underlying the study of melonic quantum mechanics, in particular their relation to black hole physics with emphasis on the matrix point of view, I will briefly explain several new ideas and results:

i) a nice relation between the auxiliary field method and Tait graphs, which provides an approach to matrix/tensor models that does not use colored graph technology.

ii) new phenomena in the phase diagram of melonic quantum mechanics, like singular behaviour of Lyapunov exponents and quantum critical points.

iii) qualitatively new IR behaviour for melonic models, with a spontaneous breaking of conformal invariance without a mass gap

iv) a surprisingly rich structure of the space of solution of melonic Schwinger-Dyson equations with an interesting link with systems of coupled non-linear differential equations (if time allows).

Dario Rosa

Title: The Thouless time for mass-deformed SYK

Abstract: We analyze the onset of RMT dynamics in the mass-deformed SYK model (i.e. an SYK model deformed by a quadratic random interaction) in terms of the strength of the quadratic deformation. We use as chaos probes both the connected unfolded Spectral Form Factor (SFF) as well as the Gaussian-filtered SFF, which has been recently introduced in the literature. We show that they detect the chaotic/integrable transition of the mass-deformed SYK model at different values of the mass deformation: the Gaussian-filtered SFF sees the transition for large values of the mass deformation, while the connected unfolded SFF sees the transition at small values. The latter shows a closer agreement with the transition as seen by the OTOCs. We argue that the chaotic/integrable deformation affects the energy levels inhomogeneously: for small values of the mass deformation only the low-lying states are modified while for large values of the mass deformation also the states in the bulk of the spectrum move to the integrable behavior.

Hiroshi Itoyama

Title: Cut and join operator in ring in tensor models

Abstract: I will discuss the content of arXiv:1710.10027 = Nucl.Phys. B932 (2018) 52-118 and arxiv: 1808.07783.

Benoit Collins

Title: norm estimate for polynomials in unitary random tensors.

Abstract: Given any noncommutative polynomial in random Haar unitary matrices, its global spectral behavior in the large dimension limit is well understood thanks to free probability theory. However its exceptional spectrum (i.e. the existence of outliers) was not understood until recently. Together with Male, we described the asymptotic behavior of this exceptional spectrum — alternatively, the operator norm. It is also known that if one replaces HJaar unitary matrices by tensor copies thereof, the global spectral behavior des not change. However, nothing was known about the exceptional spectrum. I will present a joint work in preparation with Bordenave where we describe this behavior. The techniques required to achieve our result rely on uniform moment estimates and on non-backtracking operators, who were initially introduced in graph theory. We need to develop a non-commutative version of non-backtracking operators, which we will try to describe, as we hope it might be of interest to more problems related to the study of tensors in large dimension.

Oleg Evnin

Title: Quantum and classical resonant systems

Abstract: Resonant systems emerge as weakly nonlinear approximations to problems with highly resonant linearized perturbations. Examples include nonlinear Schroedinger equations in harmonic potentials and nonlinear dynamics in Anti-de Sitter spacetime. The classical dynamics within this class of systems can be very rich, ranging from fully integrable to chaotic as one changes the strength of mode couplings, while the quantized versions of the same systems can be seen as strikingly simple strongly interacting quantum field theories. I'll discuss two ways in which such considerations connect to the topics of the workshop. First, one can consider classical dynamics of resonant systems averaged over ensembles of random mode couplings. This results in a random tensor problem, which in particular shows melonic dominance in relevant computations representing turbulent energy transfer ("melonic turbulence"). Second, the quantum versions of resonant systems are closely related to the bosonic SYK model, and due to their simplicity they can be rather thoroughly analyzed.

Luca Lionni

Title: TBA

Abstract: TBA

Sylvain Carrozza

Title: SYK-like tensor quantum mechanics with Sp(N) symmetry

Abstract: I will introduce a family of tensor quantum-mechanical models based on irreducible rank-3 representations of Sp(N). In contrast to irreducible tensor models with O(N) symmetry, the fermionic tetrahedral interaction does not vanish and can therefore support a melonic large N limit. The strongly-coupled regime has a very analogous structure as in the complex SYK model, the main difference being that the states are now singlets under Sp(N). I will also present character formulas that enumerate such singlets, and conclude with some perspectives on explicit numerical diagonalizations of such systems for N small.