New advancements on defects and their applications

Report of Contributions

https://indico.yukawa.kyoto-u.ac.jp/e/63

Contribution ID: **2** Type: **not specified**

Tzu-Chieh Wei: Kennedy-Tasaki transformation and non-invertible symmetry in lattice models beyond one dimension

Monday, July 14, 2025 10:00 AM (1 hour)

Symmetry-protected topological phases are dual to spontaneous symmetry-breaking phases, recognized by Kennedy and Tasaki using a non-local transformation (i.e., KT transformation). On the symmetry-breaking side, Kramers-Wannier duality transformation was long known to map between ordered phase (i.e., symmetry-breaking phase) and symmetry-preserving phase (i.e., disordered phase). There has been progress in KT and KW duality, especially for one spatial quantum systems. Here, we give an explicit operator representation, via a sequential circuit and projection to symmetry subspaces (hence noninvertible operations), of Kramers-Wannier duality transformation in higher-dimensional subsystem symmetric models, generalizing the construction in the 1D transverse-field Ising model. Combining such a Kramers-Wannier duality operator, we also construct the Kennedy-Tasaki transformation that maps subsystem symmetry-protected topological phases to spontaneous subsystem symmetry-breaking phases, where the symmetry for the former is either Z_2 or Z_2xZ_2. This also generalizes the recently proposed picture of the one-dimensional Kennedy-Tasaki transformation as a composition of manipulations involving gauging and stacking symmetry-protected topological phases to higher dimensions. Additionally, there has been progress in characterizing certain non-invertible symmetry protected phases in (1+1)d and we also present some results of high-order topological phases protected by a combination of non-invertible and subsystem symmetry. For example, there can be gapless modes residing on the corners of the boundary between two distinct non-invertible symmetry-protected phases, instead of the entire boundary. What combinations of non-invertible and invertible symmetries are anomalous (and hence what non-invertible symmetry-protected phases are not allowed) can be understood using fusion of symmetry defects.

Contribution ID: **4** Type: **not specified**

Sungjay Lee: Gauge theory with gauge group G versus G/\Gamma

Monday, July 14, 2025 11:30 AM (1 hour)

In this talk, I will explore the one-form center symmetries in four-dimensional gauge theories through the lens of Symmetry Topological Field Theory (SymTFT). Along the way, I will discuss potential new phases in certain classes of pure Yang–Mills theories in four dimensions.

Contribution ID: **5** Type: **not specified**

Kenta Suzuki: Time-like Janus Solution - Holographic Global Quench and Thermalization

Monday, July 14, 2025 2:00 PM (30 minutes)

The usual space-like Janus solution is an AdS_d slicing of AdS_{d+1} with mediated by a massless dilaton field depending on the slicing coordinate. In this talk, we construct a time-like Janus solution, which is a dS_d slicing of AdS_{d+1} with mediated by a time-dependent massless dilaton field. Even though this solution breaks the null energy condition, we argue that the solution is nevertheless useful in the context of AdS/ICFT or AdS/BCFT to discuss holographic global quench and thermalization.

Contribution ID: **6** Type: **not specified**

Taishi Kawamoto: AdS3 wormhole via non-local TT bar deformation or imaginary Janus deformation

Monday, July 14, 2025 2:30 PM (30 minutes)

Wormholes are important objects in quantum gravity. Especially traversable wormhole in AdS is important since they casually relate the distinguished boundary theories and allows information transfer among them. So far the constructing wormhole is typically done in low dimensional gravity related to SYK model or the level of gravitational perturbation. In this talk, we introduce two novel deformations in two dimensional CFTs and their gravity duals which include wormholes. The first one is non-local TT bar and the other is a kind of Janus defrormation with imaginary coupling. This talk is based on J. High Energ. Phys. 2025, 86 (2025)(arXiv:2502. 03531).

Contribution ID: **7** Type: **not specified**

Yuefeng Liu: Non-conformal line defects and ETH in AdS3/CFT2

Monday, July 14, 2025 3:30 PM (30 minutes)

Defects in QFT can touch non-local correlations which are usually blank to local operators. In CFT, topological defects and conformal defects are under active research due to large symmetries they have. For non-conformal defects it is generally hard to have analytic control. However, inspired by recent works on wormholes and chaotic statistics of high energy sector of AdS/CFT system, a special kind of non-local non-conformal line defects (some literature call it thin-shell operator) are found to have analytic results. The techinique that make this hard problem possible is special to holographic CFT_2, which is vacuum Virasoro block approximation and monodromy method. From point of these field methods, this special kind of non-conformal line defects are simpler (in some respects) than local operators. Interestingly, the whole story of this defect have relations with ETH of non-local operator and non-trivially backreacted gravity. In this talk, we want to report this developments and our recent work in May, 2025 that generalize this story to include higher point correlators with multiple defect insertions and spinning defect that have unequal holomorphic/ anti-holomorphic weight of defect operators. We expect our works would provide interests in both defect community and (chaotic nature part) AdS/CFT community.

Contribution ID: **8** Type: **not specified**

Giuseppe Policastro

Tuesday, July 15, 2025 10:00 AM (1 hour)

Contribution ID: **9** Type: **not specified**

Yuya Kusuki: New Crosscap States from Non-invertible Symmetries

Tuesday, July 15, 2025 11:30 AM (1 hour)

We investigate crosscap states in two-dimensional rational conformal field theories (RCFTs), with a particular emphasis on the role of symmetries, including non-invertible ones. In this work, we develop a systematic bootstrap framework that incorporates both crosscaps and topological interfaces, leading to explicit solutions that reveal new classes of crosscap states beyond previously known constructions. Furthermore, we elucidate how these crosscap states transform under symmetry actions, and establish their connection to anomalies.

Contribution ID: **10** Type: **not specified**

Jesper Jacobsen

Tuesday, July 15, 2025 2:00 PM (1 hour)

Contribution ID: **11** Type: **not specified**

Charlotte Kristjansen: Quantum Quenches from Quantum Fields

Wednesday, July 16, 2025 10:00 AM (1 hour)

An integrable spin chain underlies the celebrated AdS/CFT duality. Overlaps between matrix product states and Bethe eigenstates of the chain contain information both about correlation functions of the quantum field theory entering the duality and about the behavior of the spin chain after a quantum quench. I will explain how such overlaps can be calculated exactly.

Contribution ID: **12** Type: **not specified**

Bowen Shi: Homogeneity versus defect: an entanglement bootstrap view

Wednesday, July 16, 2025 11:30 AM (1 hour)

Defects break homogeneity by definition. To talk about defects, a sense of homogeneity should be established first. We introduce the entanglement bootstrap view of this problem, which takes a many-body vacuum state as the input instead of a Hamiltonian or Lagrangian. In a nutshell, the entanglement bootstrap imposes a set of local axioms on the wave function to guarantee the space is "uniform and smooth" without defects. A sense of homogeneity is established by the isomorphism theorem of convex sets of information, or alternatively, flexible algebras of operators, which indicates the emergence of TQFTs on lattice many-body systems. The axioms are based on entanglement properties of a time slice rather than translations, Lorentz, or other symmetries. Topological defects can be bootstrapped in various ways, including the novel transportation properties detected by immersed regions and the pinching of gapped domain wall partons. We further discuss related thoughts in chiral systems, instantaneous modular flows, gapless setups, and under decoherence.

Contribution ID: **13** Type: **not specified**

Yu Nakayama: (Non-) Factorizing Defect

Wednesday, July 16, 2025 2:00 PM (1 hour)

I discuss (non-) factorizing defect or interface in Kyoto and in the (long-range) Ising model. The scientific part of my talk is based on a collaboration with Dongsheng Ge.

Contribution ID: **14** Type: **not specified**

Janet Hung: A 2D-CFT Factory: Critical Lattice Models from Competing Anyon Condensation in SymTO/SymTFT

Thursday, July 17, 2025 10:00 AM (1 hour)

In this talk, we introduce a CFT factory" : a novel algorithm of methodically generating 2D lattice models that would flow to 2D conformal fixed points in the infrared. These 2D models are realised by giving critical boundary conditions to 3D topological orders (symTOs/symTFTs) described by string-net models, often called the strange correlators. We engineer these critical boundary conditions by introducing a commensurate amount of non-commuting anyon condensates. The non-invertible symmetries preserved at the critical point can be controlled by studying a novelrefined condensation tree". Our structured method generates an infinite family of critical lattice models, including the A-series minimal models, and uncovers previously unknown critical points. Notably, we find at least three novel critical points (c ≈1.3, 1.8, and 2.5 respectively) preserving the Haagerup symmetries, in addition to recovering previously reported ones. The condensation tree, together with a generalised Kramers-Wannier duality, predicts precisely large swathes of phase boundaries, fixes almost completely the global phase diagram, and sieves out second order phase transitions. This is not only illustrated in well-known examples (such as the 8-vertex model related to the A5 category) but also further verified with precision numerics, using our improved (non-invertible) symmetry-preserving tensor-network RG, in novel examples involving the Haagerup symmetries. We show that critical couplings can be precisely encoded in the categorical data (Frobenius algebras and quantum dimensions in unitary fusion categories), thus establishing a powerful, systematic route to discovering and potentially classifying new conformal field theories.

Contribution ID: **15** Type: **not specified**

John Estes: (Super)Conformal defects and boundaries in holography

Thursday, July 17, 2025 11:30 AM (1 hour)

I will give an overview of the geometric features arising in the holographic description of CFTs with conformal defects or boundaries. Weyl anomalies arising in such theories have a rich structure, as they are less restricted by Lorentz invariance. Entanglement entropy arises naturally as a way to characterize the defects and boundaries, and provides an effective tool for determining certain central charges appearing in the Weyl anomaly. I will discuss recent work on the holographic description of 4-dimensional BPS defects in 6-dimensional SCFTs arising from M5 branes.

Contribution ID: **16** Type: **not specified**

Mitchell Weaver:Reading between the Special Kähler Structures of Coulomb branch geometries: N=4 sYM

Thursday, July 17, 2025 2:00 PM (30 minutes)

Quantum field theories (QFTs) possess both local data, e.g. the spectrum and OPEs of local operators, and global data. Global data determines the topologically non-trivial manifolds the theory can be placed on, and the distinct sets of such data define the global variants of the QFT, all of which contain the same local data. For gauge theories, global variants are described by the (maximal) spectra of genuine Wilson-'t Hooft line operators, but it is natural to ask: what other field theory data can characterize the global variants of the theory? For example, is there a correspondence between the geometry of a theory's moduli space of vacua and its global variant? Four-dimensional N=2 supersymmetric quantum field theories always possess a moduli space of vacua with a Coulomb branch (CB) component (conjecturally) that is known to encode some local data, e.g. the OPEs of chiral BPS operators. Since 4d N=4 super Yang-Mills (sYM) theories are conformal gauge theories whose global variants are known, we can readily test the ability of their moduli space geometry to capture its global variants. To this end, we classify certain moduli spaces of putative 4d N=4 superconformal field theories (SCFTs). For a generic N=2 SCFT, the geometry of the CB component is described by a special Kähler structure (SKS), and when equipped with N=4 supersymmetry, part of this structure is determined by a (compact) semi-simple Lie algebra. For simple Lie algebras, we classify the inequivalent SKSs and compare these results with the inequivalent global variants of the corresponding 4d N=4 sYM theory under S-duality. Generically, the SKS distinguishes between all inequivalent global variants, but it can fail to do so for BCn (n > 2) and Dn theories where it represents slightly coarser global data that fails to capture either the size of an S-duality orbit or the self-duality group of an orbit. Our results suggest that the global variants of 4d N=2 SCFTs, which often don't admit a weakly coupled/Lagrangian description, can be determined and/or defined by the inequivalent SKSs of their CB geometries. This gives a powerful tool to explore the global variants of strongly interacting QFTs.

Contribution ID: **17** Type: **not specified**

Valentina Forini: Conformal field theories from line defects, holography and the analytic bootstrap

Friday, July 18, 2025 10:00 AM (1 hour)

Wilson lines are a prototypical example of defect in quantum field theory. After reviewing the superconformal case - in which the one-dimensional defect CFT that they define is particularly interesting - I will discuss some analytic tools that may prove useful in this context, but are developed for generic 1d CFTs. Among them, a representation of the four-point correlator as a Mellin amplitude and via a dispersion relation.

Contribution ID: **18** Type: **not specified**

Xi Yin: The unreasonable effectiveness of D-instantons

Friday, July 18, 2025 11:30 AM (1 hour)

I will review a first-principle approach to D-instanton effects based on string field theory, and discuss a new result on the non-perturbative effective action of D3-branes that hints at unexplained structures in the non-BPS sector. The latter is based on upcoming work with Jaroslav Scheinpflug and Yuchen Wang.

Contribution ID: **19** Type: **not specified**

Ma-Ke Yuan: Rényi Entropy with Surface Defects in Six Dimensions

Thursday, July 17, 2025 3:30 PM (20 minutes)

Defect operators in quantum field theory have attracted significant attention in recent years. Meanwhile, quantum information measures—such as Rényi entropy—provide powerful tools to probe quantum field theories. In this talk, I will focus on surface defects in 6d (2,0) theories and their contributions to the Rényi entropy and supersymmetric Rényi entropy. Remarkably, the contribution to supersymmetric Rényi entropy can be compactly expressed in terms of the Weyl anomaly coefficients of the defects. I will begin by reviewing related concepts, including defects, entanglement entropy, replica trick, and (supersymmetric) Rényi entropy. After motivating this work, I will present explicit calculations in free field theory and holography. The talk will conclude with discussions on future directions, including possible connections with monodromy defects.

Contribution ID: **20** Type: **not specified**

Kenya Tasuki: Multi-entropy at Ising Criticality

Thursday, July 17, 2025 3:50 PM (20 minutes)

Multi-entropy, a recently introduced generalization of bipartite entanglement entropy, has been proposed as a powerful probe of multipartite correlations; however, it has been little explored in explicit calculations for many-body systems so far. We investigate its scaling behavior in the one-dimensional transverse-field Ising model near the critical point. Numerical results from tensor network calculations quantitatively reproduce conformal field theory predictions at criticality and match exact solutions for the infinite chain derived via the Jordan-Wigner transformation. Finite-size scaling analysis further enables precise extraction of the critical field and central charge. This is based on a paper in preparation with Jonathan Harper, Ali Mollabashi, and Tadashi Takayanagi.

Contribution ID: **21** Type: **not specified**

Arpit Das: Anomalies and Entanglement: Twist Field Approach to Non-Invertible Symmetries in RCFTs

Monday, July 14, 2025 4:00 PM (30 minutes)

In this talk, I will present an approach to Symmetry Resolved Entanglement Entropy based on the twist field formalism. I will construct twist fields corresponding to non-invertible symmetries in two-dimensional Rational Conformal Field Theories (RCFTs) and demonstrate their connection to 't Hooft anomalies. These anomalies, manifesting as the absence of scalar primaries in twisted symmetry sectors, pose a fundamental obstruction to the construction of the twist fields – and hence to the resolution of entanglement entropy by symmetry sectors. I will then compare the symmetry resolved entanglement entropy computed via the twist field approach with results obtained through the boundary CFT framework, for both conventional and non-invertible symmetries.

Contribution ID: **22** Type: **not specified**

Mahesh Balasubramanian: Topological surface defects in 2+1d, and gauging of non-invertible symmetries

Tuesday, July 15, 2025 3:30 PM (20 minutes)

We describe non-invertible symmetries of 2+1d TQFTs and their twisted sectors in terms of connected fusion 2-categories. We rephrase these objects in the familiar language of QFT whenever possible, and for 2+1d Z_{2} gauge theory, we describe gauging of these non-invertible symmetries and their inversion using Anyon condensation.

Contribution ID: **23** Type: **not specified**

Yongchao Lu: On Exact solutions in Superconformal Indices for N=2 Super Yang mills theories

Thursday, July 17, 2025 2:30 PM (30 minutes)

The superconformal index (SCI) provides a powerful non-perturbative tool for investigating supersymmetric quantum field theories, particularly in the presence of BPS defects. In this talk, I will present exact closed-form solutions of the SCI for 4d N=2 super Yang–Mills theories with all simple gauge groups (types A, B, C, D, E, F, and G). These solutions exhibit a unified mathematical structure that reveals intricate dependencies on the gauge group data and modular properties. The method also extends to defect indices, enabling exact results in the presence of line and surface defects.

Contribution ID: **24** Type: **not specified**

Zi-Xiao Huang: From Weyl Anomaly to Universal Surface Defect Entropy and Casimir Energy

Tuesday, July 15, 2025 3:50 PM (20 minutes)

Defects serve as a key tool for understanding the non-perturbative properties of the quantum field theory. In general, defect insertions lead to nontrivial contributions to observables including entanglement measure and the ground state energy. We establish a universal relation between surface defect Weyl anomalies and the entanglement measure in higher-dimensional quantum field theories. In particular, we focus on surface defects in 6d (2,0) theories and show that the defect contribution to twisted R\'enyi entropy is governed by the defect Weyl anomalies. We also derive a closed-form expression for the defect contribution to the twisted Casimir energy, establishing a direct connection between defect anomalies and the ground state energy in higher-dimensional CFTs. The comprehensive method we develop combines supersymmetric localization, anomaly polynomials and holography, with potential applications to broader conformal field theories with defects. [Based on arXiv:2501.09498]

Contribution ID: **25** Type: **not specified**

Kazuki Doi: Entanglement Suppression Due to Black Hole Scattering

Tuesday, July 15, 2025 4:10 PM (20 minutes)

We consider the evolution of entanglement entropy in a two-dimensional conformal field theory with a holographic dual. Specifically, we are interested in a class of excited states produced by a combination of pure-state and mixed-state local operator quenches. While we expect a logarithmic time dependence of entanglement entropy relative to the vacuum in the case of the insertion of a single pure-state local operator, the presence of a mixed-state quench nearby appears to heavily suppress its contribution, reducing it to a time-independent constant bump. The degree of suppression depends on the relative position of the quenches as well as the ratio of regularization parameters associated with the quenches; in varying them we observe oscillatory behavior in the degree of suppression, but it also comes with a discrete set of values of the parameter ratio at which the suppression becomes singular and the quench's contribution to entanglement entropy is seemingly infinite. This work sheds light on the interesting properties of gravitational scattering involving black holes.