Two-hour review talks of the fifth and sixth week

Riccardo Argurio (ULB, Bruxelles)

Phases and dualities of 3d gauge theories and their brane constructions

We will review 3d gauge theories of Yang-Mills type, with a non-trivial Chern-Simons level and coupled to fermionic matter. We will focus on the different IR phases and the transitions among them as some parameters are varied. Dual, bosonic descriptions of the transitions will be discussed. Finally, a specific regime where only the rank of the gauge group is taken to be large will be discussed through a top-down brane construction.

Shiraz Minwalla (TIFR, Mumbai)

Chern-Simons-matter theories at large N

Seminars of the fifth and sixth week

Alexander Abanov (Stony Brook University)

Anomalous helicity non-conservation in Euler fluids

We argue that a close analog of an axial-current anomaly in quantum electrodynamics (QED) occurs in the classical Euler fluid. The current of fluid helicity plays the role of an axial current in an inviscid barotropic fluid. If the fluid is charged and placed in the background of an external electromagnetic field, the helicity is generated in a way identical to the generation of the axial charge in QED with the rate proportional to the dot product of electric and magnetic fields.

Jeremias Aguilera-Damia (Centro Atomico Bariloche, Argentina)

Non-Fermi Liquid Quantum Critical Points in 2+1 dimensions

The study of metallic Quantum Critical Points with dynamics falling beyond the Fermi Liquid paradigm is well motivated by experimental observations in Strange Metals. Even from a purely theoretical point of view, the description of these systems by means of a fully consistent QFT stands as a challenging task. In this talk, we describe a particular Quantum Critical Point displaying Non-Fermi Liquid dynamics, arising by coupling a Fermi Surface to a gapless boson. We extend the description to finite temperatures by proposing a mechanism to resolve the singular behavior associated with static bosons, thus leading to a consistent characterization of the Quantum Critical Region. If time permits, we will also comment on some important implications of quantum fluctuations on pairing instabilities, characterizing the onset of superconductivity near the critical region.

Pietro Benetti Genolini (DAMTP, Cambridge)

Instantons, symmetries and anomalies in five dimensions

Five-dimensional non-abelian gauge theories have a $U(1)$ global symmetry associated with instantonic particles. I will describe a mixed 't Hooft anomaly between this and other global symmetries of the theory, namely the one-form center symmetry or ordinary flavor symmetry for theories with fundamental matter. I will then apply these results to supersymmetric gauge theories, analysing the symmetry enhancement patterns occurring at their conjectured RG fixed points.

Matteo Bertolini (SISSA, Trieste)

The Octagon and the Non-Supersymmetric String Landscape

A long standing open question in the context of the gauge/gravity correspondence - more specifically in models of D-branes at Calabi-Yau singularities - regards the possibility of describing holographically supersymmetric gauge theories that dynamically break supersymmetry in stable vacua. In this talk I will present an orientifold of a Calabi-Yau singularity, the Octagon, which admits configurations of D-branes with this property. This model represents the first such instance within the gauge/gravity duality and may find interesting applications therein. I will also explain to what extent this result might be relevant for the string theory landscape and the swampland program.

Marco Bochicchio (INFN and Univ. of Rome, La Sapienza)

Nonperturbative renormalization in large-N QCD-like theories and topological strings

We demonstrate that the asymptotic freedom and renormalization group imply that the large-N 't Hooft expansion of the YM S matrix is ultraviolet (UV) finite nonperturbatively, while the large-N expansion of the QCD S matrix is only renormalizable, due to UV divergences starting from the order of N_f/N, with N_f the number of quark flavors.

We investigate the compatibility of the aforementioned renormalization properties with the existence of a supposed canonical string solution, matching the topology of 't Hooft large-N expansion, for the S matrix of large-N YM theory and QCD.

The UV finiteness of the large-N YM S matrix is compatible with the universally believed UV finiteness of closed string theories.

Yet, we demonstrate that the aforementioned renormalization properties of the large-N QCD S matrix to the order of N_f/N are incompatible with the open/closed string duality of the would-be canonical string solution, which therefore does not exist.

Similar results hold for n=1 SUSY YM theory and n=1 SUSY QCD.

We suggest a noncanonical way-out based on topological strings on noncommutative twistor space. We also discuss the corresponding spectral and UV properties.

Matthew Buican (Queen Mary University, London)

Some Galois Actions in Topological Quantum Field Theory

Galois theory features prominently in many areas of modern mathematics. Although somewhat less appreciated, interesting (and useful) Galois groups sometimes lurk beneath the surface in physics as well. One particularly fruitful area for studying physical Galois actions is in the context of TQFT and topological phases of matter. With this in mind, we will discuss some applications of Galois theory to the study of the symmetries and structures present in 2+1 dimensional TQFT.

Christian Copetti (SISSA, Trieste)

Condensing and factorizing in low dimensional gravity

We review the 2d-3d correspondence between chiral Seiberg-Moore data and full fledged physical RCFTs and recast it in terms of generalized gaugings (condensations). This allows us to precisely identify a rather natural prescription to restore factorization in some simple low dimensional gravitational theories by enhancing the gravitational path integral with a sort of "defect gas". We comment on different possible interpretations. Based on forthcoming work with F. Benini and L. di Pietro.

Lorenzo Di Pietro (University of Trieste)

Conformal boundary conditions for free fields

I will discuss the problem of classifying (interacting) conformal boundary conditions for the simplest bulk conformal field theories: free fields. I will mention concrete examples based on perturbation theory, and then describe results using the numerical conformal bootstrap approach, specifically in the case of a scalar field in four and three bulk dimensions.

Fabio Franchini (Ruder Boskovic Institute, Zagreb)

The frustration of being odd

A central tenant in the classification of phases is that boundary conditions cannot affect the bulk properties of a system. We present striking, yet puzzling, evidence of a clear violation of this assumption. We consider spin chains (with no external field) in a ring geometry with an odd number of sites (a setting we term Frustrated Boundary Conditions, FBC) and both ferromagnetic and antiferromagnetic interactions. In such a setting, even at finite sizes, we are able to calculate directly the order parameters (namely, the spontaneous magnetizations). When ferromagnetic interactions dominate, we recover the expected behavior, but when the system is governed by one AFM interaction, the magnetizations decay algebraically to zero with the system size (while not being staggered). With two competing AFM interactions a third, new type of order emerges, with a magnetization profile that varies in space with an incommensurate pattern. This modulation is the result of a ground state degeneracy which leads to a breaking of translational invariance. The transition between the two latter cases is a first order boundary QPT, which exists only with a suitable choice of boundary conditions (FBC). In other models, the order and disorder parameters across a second order QPT are destroyed and replaced by string order parameters, thus changing the nature of a QPT by boundary conditions. Finally, we consider a dynamical setting and show how the Loschmidt echo clearly distinguishes the parity in the number of sites of a spin chain for arbitrarily large systems.

Yasunori Lee (IPMU, Tokyo)

Matching higher symmetries across Intriligator-Seiberg duality

The $4d$ $so(2n_c)$ QCDs with $2n_f$ flavors possess 1-form symmetries in addition to ordinary (0-form) global symmetries. These two symmetries are in fact non-trivially related to each other, giving rise to a mixed 't Hooft anomaly or 2-group symmetry, depending on the global form of the gauge group, the parity of n_c and n_f, and the discrete theta angle. In this talk, I will explain these "mixing" of the symmetries and show that they indeed match across Intriligator-Seiberg duality in N=1 supersymmetric case.

Michael Mulligan (University of California, Riverside)

Disentangling Topological States with the Entanglement Negativity

I will discuss how the entanglement negativity, a bipartite measure of entanglement in mixed quantum states, can be used to study how multipartite entanglement constrains the real-space structure of the ground state wavefunctions of (2+1)-dimensional topological phases. Focusing on the (Abelian) Laughlin and (non-Abelian) Moore-Read states, I'll describe how a combination of entanglement negativities, calculated with respect to specific cylinder and torus geometries, determines a necessary condition for when a topological state can be disentangled, i.e., factorized into a tensor product of states defined on cylinder subregions. This condition, which requires the ground state to lie in a definite topological sector, is sufficient for the Laughlin state. On the other hand, I'll show that a general Moore-Read ground state cannot be disentangled even when the disentangling condition holds. Based on work with Pak Kau Lim, Hamed Asasi, and Jeffrey Teo in arXiv:2106.07668.

Takuya Okuda (University of Tokyo)

't Hooft line operators in N=2 supersymmetric gauge theories

In my talk I will present the supersymmetric localization calculation of the expectation values of half-BPS 't Hooft line operators in 4d $\mathcal{N} = 2 U(N), SO(N), USp(N)$ gauge theories on $S^1 \times R^3$ with an omega-deformation. We evaluate the non-perturbative contributions due to monopole screening/bubbling by calculating the supersymmetric indices of the corresponding supersymmetric quantum mechanics (SQM), which we obtain by realizing the gauge theories and the 't Hooft operators using branes and orientifolds in type II string theories. I will explain a relation between wall-crossing in SQM and the ordering of the operator product. I will also mention similar localization calculations for monopole operators in $3dN = 4$ gauge theories. Based on joint works (1905.11305, 1910.01802, 2012.12275) with Hayashi and Yoshida.

Srinivas Raghu (Stanford University)

Quantum Hall transitions with interactions and disorder: superuniversality and dynamical scaling

Quantum Hall transitions are archetypal quantum phase transitions. Many universal aspects of this problem still remain poorly understood. I motivate and study the formulation of quantum Hall transitions in a dual composite fermion representation. This formulation proves to be better for understanding 1) the finite and universal resistance at the critical point, 2) the dynamical scaling laws, and 3) the conditions under which integer and fractional quantum Hall transitions are in the same universality class (referred to as "superuniversality"). I end the talk with a brief description of open problems.

Paul Wiegmann (University of chicago)

Hydrodynamics of fractional Hall states as a representation of area-preserving diffeomorphisms

Since early days of superfluidity quantum liquids were central to understanding collective quantum matter. Apart from superconductors, two quantum liquids: superfluid Helium and (fractional) quantum Hall states are the most studied and measured. The aim of this talk is to emphasize an intimate relation between the two. In short, the theory of fast rotating superfluid is formally equivalent to that of FQHE under identifying the frequency of rotation of the superfluid with the Larmor frequency, vortices with electrons and the ratio between vortices and the number of atoms in superfluid with the filling fraction in FQHE.

This is basis of hydrodynamics of FQH states. As in the case of rotating superfluid it is completely determined by the area preserving diffeomorphisms SDiff and from this perspective is the physical realization of coadjoint orbits of SDiff. We will show how SDiff solely determines all what we know about FQH states.

Two-hour review talks of the third and forth week

Kantaro Ohmori

On non-invertible symmetries

In the review talk, I will try to summarize what is known about non-invertible symmetries in 2d and higher-dimensional QFTs. In 2d the tools about analyzing non-invertible symmetries/fusion categories are well-developed, while the higher-dimensional counter part is still in an infancy. The imminent task is to provide interesting examples in higher dimensions, on which I will try to say something.

Chenke Xu

Potential experimental platforms for fractons, type I and II

We discuss proposals of experimental realization of systems with subsystem symmetries and fracton excitations. We start with a recent proposal of realizing phases and phase transitions with fractal symmetry using the platform of arrays of Rydberg atoms. The system of Rydberg atom is highly tunable, with precision at the level of a single atom. We will also review previous works of realizing states of matter with type-I subsystem symmetries, including other cold atom platforms, and Majorana zero modes.

Dam Tan Son

Effective field theory of the fractional quantum Hall effect

We discuss the constraints placed by the symmetries of the microscopic theory on the low-energy effective field theory of the fractional quantum Hall effect. The symmetries that we will consider are particle-hole conjugations, volume-preserving diffeomorphism, and a noncommutative gauge symmetry. We will show how these symmetries can be implemented in effective field theory, and discuss their consequences.

Seminars of the third and forth week

Daniel Brennan

The Callan Rubakov Effect and Higher Charge Monopoles

In this talk we will discuss the interaction between magnetic monopoles and massless fermions. In the 1980's Callan and Rubakov showed that in the simplest example and that fermion-monopole interactions catalyze proton decay in GUT completions of the standard model. Here we will explain how fermions in general representations interact with general spherically symmetric monopoles and classify the types of symmetries that are broken: global symmetries with ABJ-type anomalies.

Diego Delmastro

Infrared phases of 2d QCD

Our main goal is to understand quantum chromodynamics in 1+1 spacetime dimensions. The motivation is two-fold: First, QCD is a strongly coupled QFT so it is of general interest to understand its dynamics. Low dimensional gauge theories share many features with the phenomenologically relevant 3+1 case, but they also show some new, fascinating properties. Second, some ingredients that are particular to 1+1 dimensions play an important role in the full story. For example, some well-known two-dimensional rational CFTs (such as minimal models) show up in the large distance limit of QCD, and therefore we can translate well-understood facts about CFTs to statements about QCD, and vice versa.

Jackson Fliss

Entanglement and dipolar quantum Hall physics of tensor Chern-Simons theory

Significant focus has been placed on finding ways to incorporate fractonic physics into quantum field theory. I will revisit a simple field theory of gapped fractonic order in (2+1) dimensions based upon conservation of dipole moment, examining several of its features: gapless Lifshitz-type edge theories, extended gauge-invariant operators with restricted deformability (a rephrasing of fractonic physics), and sub-leading "topological" entanglement entropy. Along the way I will comment on similarities to familiar quantum Hall physics.

Eduardo Fradkin

Duality in Condensed Matter and High Energy Physics

I will discuss the subject of duality transformations in condensed matter and in high energy physics both from a historical and modern perspectives. I will focus on the role of recently discovered dualities in 2+1 dimensions in the problem of the quantum Hall plateau transitions and in the theories of non-Abelian quantum Hall states.

Dimitra Karabali

Entanglement entropy for integer quantum Hall effect in two and higher dimensions

I will discuss the calculation of the entanglement entropy for integer QHE in arbitrary spatial even dimensions. In the case of the lowest Landau level, a semiclassical analysis shows that the entanglement entropy is proportional to the phase-space area with a universal overall constant, same for any dimension and Abelian or non-Abelian background magnetic fields. This is modified at higher Landau levels.

Joseph Maciejko

Hyperbolic band theory

The notions of Bloch wave, crystal momentum, and energy bands are commonly regarded as unique features of crystalline materials with commutative translation symmetries. Motivated by the recent realization of hyperbolic lattices in circuit QED, I will present a hyperbolic generalization of Bloch theory, based on ideas from Riemann surface theory and algebraic geometry. The theory is formulated despite the non-Euclidean nature of the problem and concomitant absence of commutative translation symmetries. The general theory will be illustrated by examples of explicit computations of hyperbolic Bloch wavefunctions and bandstructures, and comparison with exact numerical diagonalization of tight-binding models.

Parameswaran Nair

Topological terms and diffeomorphism anomalies in fluid dynamics

The requirement of diffeomorphism symmetry for the target space can lead to anomalous commutators for the energy-momentum tensor for sigma models and for fluid dynamics, if certain topological terms are added to the action. We analyze some examples. A topological term is shown to lead to the known effective hydrodynamics of a dense collection of vortices, i.e., the vortex fluid theory in 2+1 dimensions. This will be related to Wiegmanns work on the vortex fluid in Hall effect and superfluids. The possibility of a similar vortex fluid in 3+1 dimensions, as well as a fluid of knots and links, with possible extended diffeomorphism algebras will also be discussed.

Pavel Putrov

Spin-cobordisms, surgeries and fermionic modular bootstrap

In my talk I will describe a general method of explicitly calculating the modular transformation matrices of the partition function of a 1+1d fermionic CFT with a given anomaly of a global dicrete symmetry group G. I will also describe how to determine the map from the group classifying free fermionic anomalies (the real representation ring of G) to the group classifying the anomalies in interacting theories (the spin-cobordism group of BG, the classifying space of G). As an example I will consider the case $G = Z_2$, where as an application one can use the known modular transformations to bootstrap the spectrum of the theories with a given anomaly.

Titus Neupert

Emergent Black Hole Dynamics in Critical Floquet Systems

While driven interacting quantum matter is generically subject to heating and scrambling, certain classes of systems evade this paradigm. I will discuss such an exceptional class in periodically driven critical $(1 + 1)$-dimensional systems with a spatially modulated, but disorder-free time evolution operator. Instead of complete scrambling, the excitations of the system remain well-defined. Their propagation is analogous to the evolution along light cones in a curved space-time obtained by two Schwarzschild black holes. The Hawking temperature serves as an order parameter which distinguishes between heating and non-heating phases. Beyond a time scale determined by the inverse Hawking temperature, excitations are absorbed by the black holes resulting in a singular concentration of energy at their center. I will discuss how these results can be obtained analytically within conformal field theory and complementary by means of numerical calculations for an interacting XXZ spin-1/2 chain. The latter demonstrate that our findings are surprisingly robust and survive lattice regularization.

John Sous

Fracton conservation laws in hole-doped antiferromagnets

Fractons are exotic quasiparticles that emerge in certain tensor-gauge theories and obey both charge and dipole conservation. I will describe a physical implementation of dipole conservation laws in quantum magnets. First, I will demonstrate a broad parametric regime of fracton behavior characterized by immobile single excitations (fractons) and dipolar two-particle excitations (dipoles) in hole-doped two-dimensional square antiferromagnets. I will then consider the case of holes confined to one dimension in an otherwise two-dimensional antiferromagnetic background, which can be realized via the application of external fields, and prove ideal fracton behavior. Finally, I will briefly discuss implementation of extra mobility restrictions on fracton and dipole quasiparticles in hole-doped collinearhoneycomb antiferromagnets. These results suggest that manifestations of fracton behavior may be accessible in current experiments.

Two-hour review talks of the first two weeks

Shinsei Ryu

Topological phases of matter and quantum entanglement

We will overview topological phases of matter, with emphasis on quantum entanglement and related quantities.

Alex Turzillo

SPT phases and beyond

This talk will review invertible topological phases of matter, including symmetry-protected topological phases.

Seminars of the first two weeks

Fiona Burnell

Higher rank chirality in semi-metallic systems

Michele Burrello

Discrete Abelian lattice gauge theory on a ladder geometry

Thanks to the development of quantum technologies and simulations, in the last years a considerable attention has been devoted to the investigation of gauge theories based on techniques inspired by quantum information and condensed matter. A key aspect in this approach is to reduce the degrees of freedom to discrete sets, amenable for numerical and quantum simulations. In this talk I will investigate the behavior of Z_N gauge theories on a ladder geometry. This geometry is the simplest to allow for the introduction of the plaquette interactions, and it is relevant for ultracold atom setups. I will present, in particular, a model that includes both gauge boson and Higgs matter degrees of freedom. I will study its phase diagram based on bosonization and DMRG. For $N > 5$ the model is characterized by the emergence of a gapless Coulomb phase and BKT phase transitions.

Domenico Giuliano

Violation of the Wiedemann-Franz law and multi-particle scattering in the Topological Kondo model

We study the thermal transport through a Majorana island connected to multiple external quantum wires in the presence of a large charging energy. We analyze the charge and thermal transport of the system close to equilibrium. Within the framework of Tomonaga-Luttinger liquids, we compute the thermal conductance and find that that the Wiedemann-Franz law is nontrivially violated at low temperature as a consequence of the onset of the topological Kondo effect, contrarily to what happens for the overscreened Kondo effect and for nontopological junctions. For three wires, we find that the Lorenz ratio is rescaled by a universal factor 2/3 and we show that this behavior is due to the presence of localized Majorana modes on the island.

Carlos Hoyos

Effective action for anisotropic quantum Hall states

Fermions at a quantum critical point of semi-Dirac metals may have anisotropic dispersion relations leading to exotic quantum Hall transport properties. Using an effective action approach, I discuss possible anisotropic contributions to Hall transport coefficients.

Sergej Moroz

Two-dimensional Z_2 gauge theory coupled to single-component fermion matter: from topological order to confinement and fractons

I will present our investigations of the rich quantum phase diagram of Wegner's theory of discrete Ising gauge fields interacting with U(1) symmetric single-component fermion matter hopping on a two-dimensional square lattice. In particular limits the model reduces to (i) pure Z_2 even and odd gauge theories, (ii) free fermions in a static background of deconfined Z_2 gauge fields, (iii) the kinetic Rokhsar-Kivelson quantum dimer model at a generic dimer filling. I will introduce a local transformation that maps the lattice gauge theory onto a model of Z_2 gauge-invariant spin 1/2 degrees of freedom. In the absence of the magnetic plaquette term, I will present evidence of topologically ordered Dirac semimetal and staggered Mott insulator phases at half-filling. I will discuss the nature of the phase transition between these phases. At strong coupling, the lattice gauge theory displays fracton phenomenology with isolated fermions being completely frozen and dimers exhibiting restricted mobility. In that limit, I will argue that in the ground state dimers form compact clusters, whose hopping is suppressed exponentially in their size. I will present our numerical investigations of the band structure of the smallest clusters using exact diagonalization.

Christopher Mudry

Lieb-Schultz-Mattis type theorems for Majorana models with discrete symmetries

The Lieb-Schultz-Mattis theorem was established for a spin-1/2 quantum spin chain and made use of the global continuous SU(2) spin symmetry. However, the existence of a continuous symmetry is not necessary to generalize the Lieb-Schultz-Mattis theorem to interacting Majorana degrees of freedom, as I will explain.

Giandomenico Palumbo

Non-Abelian Higgs fields in the momentum space of multi-band topological phases

I will present a general construction to identify momentum-space Higgs fields, i.e. non-Abelian complex scalar fields that emerge from the degenerate band structure of Hermitian and pseudo-Hermitian topological phases, which are protected by suitable (crystalline) symmetries. Firstly, I will show that topological invariants of two-dimensional (Hermitian) topological insulators and three-dimensional Dirac semimetals can be derived from the winding number associated with the Higgs fields. Secondly, through these non-Abelian complex scalar fields, I will construct non-Abelian tensor Berry connections and the corresponding higher-dimensional Berry-Zak phases to show their role in the topological characterisation of novel gapped and gapless systems in three and four dimensions. Finally, I will provide some examples of pseudo-Hermitian systems (i.e. non-Hermitian phases with real spectra) that can be topologically characterised through the momentum-space Higgs fields.

Djordje Radicevic

Lattice precursors of Chern-Simons theories

There are two fundamentally different ways in which an Abelian Chern-Simons theory can arise from a finite, nonperturbatively defined lattice system. First, Chern-Simons terms may need to be included as contact terms in generating functionals of theories of massive lattice fermions; such terms are often called "induced." Second, Chern-Simons actions can arise from pure lattice gauge theories with flux attachment. Using new insights on the lattice-continuum correspondence in quantum field theory, I will give a detailed description and comparison of these two lattice descriptions of Chern-Simons theory.

Ady Stern (Weizmann Institute, Israel)

Topology vs. interaction: the strong, the weak and the fragile

Topological systems of non-interacting electrons may be forced by their topological nature to have a gapless spectrum. As two examples, Integer quantum Hall states and topological insulators must carry gapless edge states, which allow them to carry current. Whether interaction between the electrons may turn a gapless conductor into a fully gapped insulator depends on the case at hand, with a negative answer for the first example and a positive for the second. In this talk I will review these two examples, and then discuss bands of fragile topology. I will explain what fragile topology is as well as how and when it forbids a gapped spectrum at the non-interacting level. Then, I will show that in this case interactions may be powerful enough to overcome the decree issued by topology, and explain how they do that. Finally, I will discuss relevance to twisted bi-layers of graphene.

Glenn Wagner (Oxford University)

Kekule spiral order in twisted bilayer graphene

Twisted bilayer graphene has attracted a lot of attention due to the presence of correlated insulators proximate to superconductivity. In this talk I will present a new proposal for the nature of the correlated insulators. This order, which we dub the 'incommensurate Kekule spiral' (IKS) order, spontaneously breaks both the emergent valley-charge conservation and moire translation symmetries. The IKS state emerges as the ground state in detailed self-consistent Hartree-Fock calculations at any non-zero integer filling of the moire unit cell. I will discuss the phenomenological and microscopic properties of this order and argue that our findings are consistent with all experimental observations reported so far, suggesting a unified explanation of the global phase diagram of twisted bilayer graphene in terms of the IKS order.

Yizhi You

Plaquette-dimer liquid beyond renormalization

We consider close-packed tiling models of geometric objects – a mixture of hardcore dimers and plaquettes – as a generalisation of the familiar dimer models. Specifically, on an anisotropic cubic lattice, we demand that each site be covered by either a dimer on a z-link or a plaquette in the x-y plane. The space of such fully packed tilings has an extensive degeneracy. This maps onto a fracton-type 'higher-rank electrostatics', which can exhibit a plaquette-dimer liquid and an ordered phase. We analyse this theory in detail, using height representations and T-duality to demonstrate that the concomitant phase transition occurs due to the proliferation of dipoles formed by defect pairs. The resultant critical theory can be considered as a fracton version of the Kosterlitz-Thouless transition. A significant new element is its UV-IR mixing, where the low energy behavior of the liquid phase and the transition out of it is dominated by local (short-wavelength) fluctuations, rendering the critical phenomenon beyond the renormalization group paradigm.