

130th STATISTICAL MECHANICS CONFERENCE

Abstracts of Invited Talks

Natan Andrei, Rutgers University

Title: Thermodynamics in a split Hilbert Space: Quantum Impurity in interacting environments

Abstract: I will show that rich phase diagram arises when a quantum spin is placed in an interacting superconducting system with the different phases being due to the competition of the various interactions. Particularly surprising is the appearance of multichannel physics in a gapped superconducting phase.

I will show further that in each phase the Hilbert space splits into several towers of excitations. Computing explicitly the impurity entropy in each phase I'll show that the excitation towers induce interesting nonmonotonic behavior which is experimentally accessible.

G rard Ben Arous, NYU

Title: Recent progress on the Replica Symmetry Breaking phase for the Elastic Manifold

Abstract: I will report on recent progress in joint works with Pax Kivim e (University of Colorado) on the Elastic Manifold, a model of disorder coupled with elastic interactions, introduced by Marc Mezard and Giorgio Parisi in the 90's, and abundantly studied since then, in particular in recent works by Fyodorov, Le Doussal, Texier and Rosso in the context of the study of depinning.

I will start by a zero-temperature question, i.e. the study of the topological complexity defined by this model, as given in the work with Benjamin Mc Kenna and Paul Bourgade (CPAM 2024) before proceeding to a new Mezard-Parisi type formula at positive temperature and our (still partial) understanding of the Replica Symmetry Breaking phase for this model.

Bill Bialek, Princeton University

Title: Ensembles of near-optimal organisms

Abstract: On a dark night our visual systems can count single photons, and there many other examples where living systems perform close to the relevant physical limits—a kind of optimality. Many groups have suggested that these observations can be promoted to optimization principles, from which we could derive the behavior and mechanisms of these complex systems, and this approach has had a number of significant successes. But there have always been worries: Does optimization require fine tuning of the underlying parameters? Can evolutionary dynamics navigate the landscape in this high dimensional parameter space? We have analyzed the landscape close to the optimum for several biologically relevant problems, from generating rhythms in small neural circuits to reading out information encoded in the expression levels of genes, and more. In each case we find that there is a branch of “soft modes” in parameter space, similar to the ideas of sloppy models proposed by Sethna and colleagues; there are also important connections to observations on learning in deep networks. If we

construct a maximum entropy ensemble of organisms that achieve some mean performance, we find that the soft modes allow the entropy in parameter space to be extensive while the deviation from optimality becomes arbitrarily small as the number of parameters grows. These observations remove major obstacles to the use of optimization principles in thinking about the physics of life.

Pietro Bonetti, Max Planck Institute for Solid State Research

Title: Photoinduced Charge Condensation in a Driven Quantum Spin Liquid

Abstract: Optical driving can trigger emergent symmetry breaking and offers a route to superconducting-like states far from equilibrium. In correlated quantum materials, superconductivity often emerges from strongly fluctuating regimes proximate to quantum spin-liquid phases. Yet it remains unclear whether light can drive a quantum spin liquid into a genuine condensate, rather than a transient enhancement of conductivity. Here we use light to directly control the organic quantum spin-liquid candidate κ -(BEDT-TTF) $_2$ Cu $_2$ (CN) $_3$. Starting from an insulating ground state, intense midinfrared pulses induce a transient divergent imaginary conductivity, which we identify as a signature of incipient condensation of fractionalized bosonic charge excitations. Our results establish the observation of coherent, inductive charge dynamics in a quantum spin liquid and provide a key step toward understanding driven superconductivity and other nonequilibrium phases in correlated materials.

Federico Bonetto, Georgia Institute of Technology

Title: A Kac system interacting with two heat reservoirs.

Abstract: We consider a Kac system (a toy model for a dilute gas in 3 dimensions) containing M particles and interacting with two heat reservoirs with $N \gg M$ particles at different initial temperatures and average velocities (shear). We show that the system can well be approximated, for a time comparable with $\sqrt{N}$, by replacing the reservoirs with dynamic thermostats. If the initial temperatures and shears of the reservoirs are equal, the approximation is uniform in time.

Almut Burchard, University of Toronto

Title: Symmetry-breaking in geometric capacitor problems

Abstract: How does the shape of a body determine its capacity? Classical results say that balls minimize the Newton capacity among bodies of given volume, but maximize it among bodies of given diameter. While the lower bound on capacity in terms of volume is a cornerstone of potential theory, the upper bound in terms of diameter (proved by Szego in 1930) was largely relegated to a footnote.

Recently isodiametric shape optimization for Riesz capacities has become interesting in the context of aggregation problems with pair interactions of attractive-repulsive type. In this talk I will discuss situations where the capacity-maximizer is not a ball. When does symmetry-breaking occur, and what are good candidates for non-radial maximizers.

Debanjan Chowdhury, Cornell University

Title: Frozen Dynamics in Floquet Quantum Matter

Abstract: Periodic driving offers a versatile tool for engineering novel regimes of quantum many-body dynamics. However, interacting Floquet systems are generally expected to absorb energy and rapidly thermalize to an infinite-temperature state. In this talk I will show that this fate can be dramatically delayed through the phenomenon of dynamical freezing, where special drive conditions suppress the growth of chaos and generate emergent conservation laws. In this regime the system retains memory of its initial state for parametrically long times. I will then discuss how the slow thermalization ultimately resumes through non-perturbative processes that puncture the frozen dynamics and restore ergodicity. These results reveal a unified picture of Floquet dynamics in which periodic driving can both arrest and eventually revive quantum chaos in interacting quantum matter.

Maine Christos, CalTech

Title: Non-Abelian Quantum Low-Density Parity Check Codes and Non-Clifford Operations from Gauging Logical Gates via Measurements

Abstract: In this work, we introduce constructions for non-Abelian qLDPC codes obtained by gauging transversal Clifford gates using measurement and feedback. In particular, we identify two qualitatively different approaches to gauging qLDPC codes to obtain their non-Abelian counterparts. The first approach applies to codes that exhibit a generalized form of Poincaré duality and leads to a qLDPC non-Abelian Clifford stabilizer code, whose stabilizers are reminiscent of the action of a Type-III twisted quantum double. Our second approach applies to general qLDPC codes, and uses a graph of ancilla qubits which may be tailored to properties of the input codes to gauge a single transversal gate. For both constructions, the resulting gauged codes are shown to have properties analogous to 2D non-Abelian topological order—e.g. the analog of a single anyon on a torus. We conclude by demonstrating that our gauging procedures enable magic state preparation via the measurement of logical Clifford gates. Consequently, our gauging constructions offer a protocol for performing non-Clifford operations on any qLDPC code.

Piers Coleman, Rutgers

Title: Kitaev meets Kondo: New insights into Many Body Physics from a merger of two models

Abstract: I will discuss how the merger of two classes of models - the Kondo lattice model and the Kitaev spin liquid model has opened up a new vein of solvable Many Body physics models which, like BCS theory or the Peierls instability, are solvable to logarithmic accuracy[1,2].

Kitaev's spin liquid technology has led to the discovery of solvable two and three dimensional spin liquids - in which the Heisenberg spins fractionalize into spinons, in some cases, with Fermi surfaces of gapless spin excitations. Remarkably, when these fractionalized spin fluids interact with electrons new forms of metal and superconductor are formed. I will give a short overview of these theoretical developments.

[1] Solvable 3D Kondo Lattice Exhibiting Pair Density Wave, Odd-Frequency Pairing, and Order Fractionalization, Piers Coleman, Aaditya Panigrahi and Alexei Tsvelik, Phys. Rev. Lett. 129, 177601 (2022).

[2] Tractable model for a fractionalized Fermi liquid on a square lattice, Piers Coleman, Elio Koenig, Aaditya Panigrahi and Alexei Tsvelik, arXiv April 2026.

Ovidiu Costin, Ohio State University

Title: Resurgence and boundary crossing in Ramanujan's Mock Theta functions

Abstract: We present a unified approach to Ramanujan's Mock Theta functions (Mfs), a special class of q -series, that extends them from the known orders $Mf_{\{3-10\}}$ to Mf_n , $n \in \mathbb{N}$. We also show that a wider class of q -series, including the Mfs, have unique continuation through their natural boundary $|q|=1$. This continuation is crucial for understanding phase transitions in applications such as statistical mechanics and complex Chern-Simons theory.

Oriana Diessel, Harvard

Title: Steady-states and response functions of the periodically driven $O(N)$ scalar field theory

Abstract: In this talk, I will discuss the phase diagram of a relativistic, parametrically driven $O(N)$ -symmetric field theory coupled to a Markovian thermal bath. The interplay of coherent driving and dissipation gives rise to a rich set of non-equilibrium phases, including both uniform and spatially modulated symmetry-broken states. In particular, there are regimes where the order parameter oscillates at half the drive frequency, realizing period-doubled steady states. When coupled to a background electromagnetic potential, these phases exhibit a Meissner effect, in the sense that the photon acquires a mass term. However, if the order parameter oscillates around a sufficiently small value, a fraction of an externally applied magnetic field can penetrate the sample in the form of a standing wave. This hybrid collective excitation can be understood as a Meissner polariton, arising from the hybridization of light with order parameter oscillations. I will further show that strong fluctuations near the onset of symmetry breaking can generate a superconducting-like optical response even in the absence of a Meissner effect or a Meissner polariton. These results are relevant to experiments on light-induced orders, particularly superconductivity.

Amit Einav, Durham University

Title: Can we have a little order in all this chaos?

Abstract: A revolutionary idea that birthed a new way to investigate systems of many elements was formalised in the work of Mark Kac in 1956. Kac suggested to find how an average particle in dilute gas behaves by considering a “probabilistic model” of the gas, expressed via a PDE for the probability to find the system in various configurations, together with the idea that as the number of particles in the gas increases, they become more and more independent. The latter is often known as molecular chaos, or chaos.

Combining these two ingredients, Kac was able to find an equation that describes how a “limiting average particle” evolves in his settings – which ended up being a one-dimensional variant of the celebrated Boltzmann equation.

These ideas are far more general and powerful than their application in Kac's model, and they have formed the framework of what we now call the mean field limit approach. At its heart, the mean field limit approach has two ingredients:

1. An average model for the system, expressed via a PDE for its probability measure.
2. An asymptotic correlation relation that expresses the emerging phenomena we expect to get as the number of elements goes to infinity.

In recent decades the use of the mean field limit approach has expanded beyond physical models into the realm of biology, economy, and societal studies. Yet in almost all cases considered so far, the sole correlation relation used was chaos. This seems to be inappropriate in settings that have a tendency for adherence such as biological swarming.

In our talk we will briefly discuss the background to the mean field limit approach as well as Kac's model and its limiting equation. We will then jump to 2013 and consider the Choose the Leader model, or CL model, which is a Kac-like animal swarming model introduced by Carlen, Degond, and Wennberg where chaoticity breaks. Motivated by the desire to understand this model better, we will introduce two new asymptotic correlation relations, order and partial order, and see how they arise naturally in the CL model.

David Gamarnik, MIT

Title: The free energy of the Sachdev-Ye-Kitaev model at high temperature

Abstract: Sachdev-Ye-Kitaev (SYK) model is a quantum mean field spin glass model, which arises in studies of condensed matter physics and holographic theory of black holes. Structural properties of this model can be deduced heuristically using a combination of replica method and path integration techniques. Analyzing it mathematically rigorously, however, turned out to be notoriously difficult, even for basic questions such as computing the annealed free energy.

In this paper we rigorously compute the free energy limit (annealed and quenched) for this model at high enough but constant temperature. Our results are in agreements with the results derived by physics methods. Remarkably though, our method of proof is novel and is different from the physics approach. It is based on (a) a variant of the cavity method, which was used widely in prior rigorous and heuristic treatment of classical spin glasses, and (b) the theory of component structure of sparse random graphs.

Joint work with Francisco Pernice (MIT), Alexander Schmidhuber (MIT) and Alexander Zlokapa (MIT)

Yin-Chen He, Perimeter Institute

Title: A Fuzzy Sphere Journey into Conformal Gauge Theories

Abstract: Conformal Field Theory (CFT) represents a class of quantum field theories that have profound applications across various physics domains, from critical phenomena in condensed matter to high energy physics. In this talk, I will talk about our recently progress on applying fuzzy (non-commutative) sphere approach to 3D CFTs, including deconfined phase transition,

SU(2) QCD3 and Chern-Simons-matter theory, which are relevant to the gapless spin liquid, phase transitions in magnets and fractional quantum Hall states.

David Huse, Princeton

Title: Thermal first-order phase transitions and the eigenstate thermalization hypothesis

Abstract: A many-body system with a thermal first-order phase transition exhibits an extensive discontinuity in the energy and entropy (the latent heat) at the phase transition, within the canonical ensemble. There are states within the energy range that is “skipped over” by this canonical ensemble first-order phase transition, and these states may be studied in the microcanonical ensemble and, in particular, in the limit of the microcanonical “ensemble” for a closed quantum many-body system that is a single energy eigenstate. To make this a tractable semi-classical calculation we study a class of infinite-range models exhibiting this physics. Such models can have a microcanonical first-order phase transition (that occurs “within” the canonical first-order transition) where the energy and entropy are both continuous, but the temperature is a discontinuous function of the energy. At this microcanonical transition, the eigenstates of an otherwise quantum-chaotic system may either be “localized” within one of the two coexisting phases, or they may contain Schrodinger-cat-like phase coexistence within a single eigenstate. Ref: Serbyn, Avdoshkin, Diessel and Huse, arXiv:2601.08347 .

Ian Jauslin, Rutgers

Title: A framework to study twisted bilayer graphene in a tight binding model

Abstract: The study of the electronic properties of twisted bilayer graphene (TBG) has garnered much attention from the condensed matter community recently. TBG is obtained by stacking two graphene monolayers on top of each other, and rotating one of them with respect to the other. Theoretical and experimental analyses have found that the electronic properties of TBG depend very strongly on the angle between the layers. In fact, a handful of "magic" angles have been predicted at which TBG becomes a superconductor, and this has even been verified experimentally. The model commonly used to study TBG is an effective one, and was derived by Bistritzer and MacDonald. In this talk, I will present recent results on developing a framework to study TBG from first principles. To be more exact, we consider a tight-binding model for the electrons, but make no further approximations. Using a renormalization group technique, we construct a perturbative expansion to study TBG that is convergent when the twisting angle satisfies certain diophantine conditions. This is joint work with V. Mastropietro.

Mathieu Lewin, CNRS & Université Paris-Dauphine (Sunday or Monday only)

Title: The gnocchi phase in nuclear pasta

Abstract: We provide the first rigorous justification for the so-called "gnocchi phase" in the liquid drop model at low density. Joint work with Rupert L. Frank and Robert Seiringer.

Vieri Mastropietro, Universita' di Roma La Sapienza

Title: Quasi-periodicity in statistical physics: Ising models and Hall insulators

Abstract: Small divisor problems appeared first in celestial mechanics at the end of XIX century but they play now a very important role in statistical physics, as they appear in several problems ranging from quasi-crystals to graphene. We present two results obtained generalizing methods introduced for the convergence of the Lindstedt series and assuming suitable Diophantine conditions: a) the proof of the validity of the Harris-Luck criterion for the 2d Ising model with quasi-periodic potential; b) the proof of the quantization of the conductance in Haldane-like topological insulators on the cylinder with weak quasi-periodic disorder.

Jedediah Pixley, Rutgers

Title: Kondo lattice emulators in stacked transition metal dichalcogenides

Abstract: Two-dimensional transition metal dichalcogenides (TMDs) have emerged as an exciting platform to stack and twist bilayers to engineer novel strongly correlated states that include continuous Mott transitions, heavy fermi liquids, fractional anomalous Hall states, and (putative) topological superconductivity. We argue that these highly tunable experimental platforms are ideal settings to try and tackle long-standing questions in the field while uncovering some new phenomena in the process. We present a theory to describe the recent realization of a Kondo lattice and a heavy fermion state in stacked MoTe₂/WSe₂ bilayers that dope the Mott insulator to a filling of $n=1+x$. We will discuss the limit of filling $n=2$ in detail where we predict a 2D topological Kondo insulator, which has just recently been observed in experiment. Open directions and the route to quantum criticality will be discussed.

Leo Radzihovsky, University of Colorado at Boulder

Title: "Boundary" superfluids

Abstract: I will discuss two striking examples of "boundary superfluids" -- novel 1D states of bosons coupled to correlated 2D bulk -- instantiated by an edge dislocation in a He-4 crystal and in correlated bosons hopping on a "comb" lattice. I will describe corresponding boundary anomalous superfluid phases -- a new class of 1D phases of bosons qualitatively distinct from a Luttinger liquid -- their stability to instanton deconfinement under a superflow and the associated quantum phase transitions.

Rhine Samajdar, Princeton

Title: Quench spectroscopy of amplitude modes in a one-dimensional critical phase

Abstract: We investigate the emergence of an amplitude (Higgs-like) mode in the gapless phase of the (1+1)D XXZ spin chain. Unlike conventional settings where amplitude modes arise from spontaneous symmetry breaking, here, we identify a symmetry-preserving underdamped excitation on top of a Luttinger-liquid ground state. Using nonequilibrium quench spectroscopy, we demonstrate that this mode manifests as oscillations of U(1)-symmetric observables following a sudden quench. By combining numerical simulations with Bethe-ansatz analyses, we trace its microscopic origin to specific families of string excitations. We further discuss experimental pathways to detect this mode in easy-plane quantum magnets and programmable quantum simulators. Our results showcase the utility of quantum quenches as a powerful tool to probe collective excitations, beyond the scope of linear response.

Anders Sandvik, Boston University

Title: Defects at the deconfined quantum critical point

Abstract: The transition between antiferromagnetic and spontaneously dimerized ground states in two dimensional $S=1/2$ spin systems is the prime example of a deconfined quantum critical point (DQCP). Lattice simulations have determined the critical exponents of this transition to rather high precision [1], with good agreement also with numerical conformal field theory (CFT) calculations for a critical point with $SO(5)$ symmetry (of the combined antiferromagnetic and dimer order parameters in the lattice model). Here I will discuss critical scaling associated with defects (vacancies) at the DQCP, using the same model as in [1]. Scaling analysis of the spin and energy texture around the defects produce exponents that should correspond to an emergent boundary CFT related to the DQCP [2]. The defect exponents are also fully compatible with the previously determined scaling dimension of the $SO(5)$ order parameter [1].

[1] J. Takahashi, H. Shao, B. Zhao, W. Guo, and A. W Sandvik, arxiv:2405.06607.

[2] A. W. Sandvik and S. Sachdev (work in progress).

Jeff Schenker, Michigan State University**Title: Disordered Matrix Product States for 1D Spin Chains**

Abstract: In 1991, Fannes, Nachtergaele, and Werner introduced the notion of a "finitely correlated state" for a translation invariant 1D spin chain, generalizing the structure of the AKLT state. In this talk, we will discuss a recent extension of the FNW theory to states with homogeneous disorder. In the disordered context, a new phenomenon arises: there are states with exponential clustering that are inherently gapless, in the sense that they have no gapped finite-range parent Hamiltonian. A disordered generalization of the AKLT state with this property will be presented. This state has a gapless nearest neighbor parent Hamiltonian and exponential clustering. We call such a state "quasi-gapped." Time permitting, several open questions about quasi-gapped states will be presented.

Leyna Shackleton, MIT**Title: Twisted quantum doubles are sign problem-free**

Abstract: The sign problem is one of the central obstacles to efficiently simulating quantum many-body systems. It is commonly believed that some phases of matter, such as the double semion model, have an intrinsic sign problem and can never be realized in a local sign problem-free Hamiltonian due to the non-positivity of the wavefunction. We show that this is not the case. Despite not being stoquastic, the standard criteria for the existence of a sign problem, the double semion model, and all twisted quantum double phases of matter for finite groups G can be realized in local Hamiltonians $\{\textcolor{red}{\text{that are sign problem-free within a stochastic series expansion}}\}$. The lack of a sign problem is not fine-tuned and does not require the Hamiltonian to be exactly solvable, with sign problem-free perturbations allowing access to a variety of topological phase transitions.

Herbert Spohn, Technische Universitaet Muenchen**Title: Diffusion of a tagged Toda fluid quasiparticle**

Abstract: The Toda chain is an integrable classical many-body system. Its conservation laws are determined through the eigenvalues of a Lax matrix, while the positions of quasiparticles are

linked to time-dependent eigenvectors. In thermal equilibrium the Lax matrix is random and thus eigenvectors are well localized. This allows one to follow numerically the random motion of a single quasiparticle, which is predicted to be diffusive with a coefficient computed from TBA. Such simulations serve as a novel stringent test of generalized hydrodynamics.

This is joint work with A. Brollo, A. Dhar, A. Kundu, I. Mukherjee, and S. Subhash. On April 15, 2026, A. Aggarwal and M. Nicoletti posted their probabilistic study “Fluctuations for the Toda lattice” on arXiv:2604.14346.

Alexei Tsvelik, Brookhaven National Laboratory

Title: Fractional order in Kondo lattice models

Abstract: I will discuss the concept of fractional order and provide examples of tractable models of condensed matter physics where existence of such order can be established.

Yuhai Tu, Flatiron Institute

Title: Statistical Physics for Deep Learning: Towards a Theoretical Foundation

Abstract: Artificial Neural Network (ANN) and Machine Learning (ML) have received a huge amount of attention among physicists triggered by the 2024 Nobel Physics Prize to John Hopfield and Geoff Hinton. Historically, ANN-based ML was developed based on ideas from neuroscience and statistical physics. However, the recent successes of deep learning neural networks (DLNN) are mainly driven by large amount of data and exponentially growing computing capability. As a result, despite its successes in many different disciplines, DLNN remains largely a black box – it is unclear how it learns and whether what it learns is generalizable. In the past several years, we have been trying to develop a theoretical framework based on statistical physics and stochastic dynamical systems theory to study DLNN. In this talk, we will first give a broad introduction of the ANN-based ML emphasizing on the role of physics in its development followed by describing some of our recent progress in understanding DLNN in two related areas – learning dynamics and generalization.

Chong Wang, Perimeter Institute

Title: Self-dual Higgs transitions: Toric code and beyond

Abstract: The toric code, when deformed in a way that preserves the self-duality Z_2 symmetry exchanging the electric and magnetic excitations, admits a transition to a topologically trivial state that spontaneously breaks the Z_2 symmetry. Numerically, this transition was found to be continuous, which makes it particularly enigmatic given the longstanding absence of a continuum field-theoretic description. We propose an $SO(4)$ Chern-Simons-Higgs (CSH) theory at level $k=2$ and argue that it serves as a natural field theory description of the self-dual transition. Moreover, it can be generalized to an entire series of theories labeled by an integer k . For each $k>2$, the theory describes an analogous transition involving different non-Abelian topological orders, such as the double Fibonacci order ($k=3$) and the S_3 quantum double ($k=4$). For $k=1$, we conjecture that the corresponding CSH transition is in fact infrared-dual to the 3d Ising transition, in close analogy with the particle-vortex duality of a complex scalar.

Lenka Zdeborova, École Polytechnique Fédérale de Lausanne

Title: The Rules-and-Facts Model for Simultaneous Generalization and Memorization in Neural Networks

Abstract: A key capability of modern neural networks is their capacity to simultaneously learn underlying rules and memorize specific facts or exceptions. Yet, theoretical understanding of this dual capability remains limited. We introduce the Rules-and-Facts (RAF) model, a minimal solvable setting that enables precise characterization of this phenomenon by bridging two classical lines of work in the statistical physics of learning: the teacher–student framework for generalization and Gardner-style capacity analysis for memorization. In the RAF model, a fraction $1 - \epsilon$ of training labels is generated by a structured teacher rule, while a fraction ϵ consists of unstructured facts with random labels. We analyze when the learner can simultaneously recover the underlying rule—allowing generalization to new data—and memorize the unstructured examples. Our results quantify how overparameterization enables the simultaneous realization of these two objectives: sufficient excess capacity allows memorization without degrading generalization, while regularization and the choice of kernel or nonlinearity control how capacity is allocated between rules and facts. The RAF model provides a theoretical foundation for understanding how modern neural networks can infer structure while storing rare or non-compressible information.

YaHu Zhang, Johns Hopkins University

Title: Pseudogap metal and non-fermi-liquid criticality in a bilayer model

Abstract: Continuous phase transition is one of the central topics in statistical mechanics. Normally the phase transition belongs to a universality class characterized by the symmetry breaking order in the Ginzburg-Landau framework. In this talk I will present an example of phase transition between two metallic phases in a bilayer model, but without any symmetry breaking (and no fractionalization) in either side. The transition is driven by tuning an inter-layer spin-spin coupling and is between the conventional Fermi liquid and a pseudogap metal which has small Fermi surface. Interestingly in this bilayer model the pseudogap metal is still a Fermi liquid, but is at a strongly interacting fixed point. I will show numerical results of a non-Fermi-liquid fixed point for such a transition from single-site dynamical mean field theory (DMFT), which is known to be exact in infinite dimension. Within the pseudogap phase, I will provide a model wavefunction based on ancilla framework.