

126th STATISTICAL MECHANICS CONFERENCE

Abstracts of Invited Talks

Michael Aizenman – Princeton University

[On entanglement in stoquastic states](#)

The entropy of the restriction of a pure quantum state of a lattice system to a subset is a measure of the entanglement between the system's two components. The talk will focus on conditions that imply an area-type bound on the entanglement at the ground states of positivity preserving Hamiltonians, and the criterion's application to the quantum Ising model. (Joint work with Simone Warzel)

Thomas Banks – University of California, Santa Cruz & Rutgers

[The Quantum Statistics of Causal Diamonds as "Derived" From Jacobson's Hydrodynamic Interpretation of Einstein's Equations, Following the Logic of Carlip and Solodukhin \(as Interpreted by T.Banks and K.Zurek\) \[with apologies to Peter Weiss\(Marat/Sade\)\]](#)

Jacobson argued that Einstein's gravitational equations are the hydrodynamic equations of a law equating entropy to one quarter of the maximal area in Planck units on the boundary of each causal diamond in space-time. By examining Einstein's equations near diamond boundaries, Carlip and Solodukhin argued that the hydrodynamic fluctuations satisfied the hydrodynamic equations of a 2 dimensional conformal field theory living on the "stretched horizon", with a central charge proportional to the area. One then postulates that the actual quantum density matrix of the diamond is given in terms of the cutoff thermal density matrix of this CFT. Ideas of Banks and Fischler about the description of the transverse geometry of the diamond in terms of its Dirac operator (following Connes) lead to a tentative identification of the precise CFT.

Roland Bauerschmidt – New York University

Probabilistic view on the Schwarzian Field Theory

I will discuss the probabilistic definition of the Schwarzian Field Theory and discuss some of its properties. The talk is based on joint work with Ilya Losev (Cambridge) and Peter Wildemann (Cambridge) as well as on work by Ilya Losev.

Gregory Bewley – Cornell University

How turbulence and intermittency relate to flight

We examine the problem of flying through turbulence with special attention to the ways in which turbulence may benefit flight. Theoretical arguments supported by computer models of flight in turbulence suggest bounds on the energetic advantages of turbulence available to a flight vehicle, as well as flight strategies that reduce energy consumption or flight time with only local knowledge of the flow velocity. The advantages are possible due to order in turbulence. We then examine the statistics of the accelerations of eagles in natural flight and find that extreme vertical accelerations are consistent with the selective amplification of small-scale turbulent updrafts. The finding appears to be the first observation of wildlife exploiting turbulent fluctuations, and extends what we know about how wildlife uses relatively stationary flows to stay aloft, such as thermal updrafts and wind shear, by showing how fully unsteady flows, or gusts, can also be beneficial. The evidence in favor of our interpretation includes the observation that the acceleration difference flatness blows up toward large values on timescales shorter than a few seconds in a way predicted by a simple nonlinear model of the eagles' interaction with turbulence. The model breaks up-down symmetry in favor of upward gusts, and is consistent with the eagles' interest in staying aloft while minimizing energy expenditure.

Sachin Bharadwaj – New York University

Can Quantum Computers Simulate Classical Flows?

The past couple of decades have alluded to a future, where quantum computers could potentially solve some specific problems, more efficiently than classical counterparts. This may be attributed to the advantage they offer in terms of memory and time. However, a question growing more pressing with time, is whether the advantage can be used to solve problems of practical interest, for instance, simulating classical, physical

systems. To attempt answering this, I will discuss the problem of solving the governing PDEs of classical fluid flows, with quantum computing -- the core theme of my work with Prof. Sreenivasan, during the past few years. In this talk, we will begin with a quick overview of progress made in this field thus far, while also highlighting some challenges such as -- noise, decoherence and statistical errors on current devices, apart from the fundamental challenge of simulating nonlinearity, using devices that are linear and unitary. I'll then present some results from specific state-of-the-art quantum algorithms, by simulating flow problems on an in-house, high performance simulator, as well as from experiments on an actual quantum device. Our results seem to suggest that, when appropriate measures are taken, the potential of simulating classical flows on near-term quantum devices is decent, while also retaining quantum advantage. I will finally outline a pragmatic summary, by listing the opportunities and bottlenecks that need to be addressed to make progress.

Camillo De Lellis – Institute for Advanced Study

On the uniqueness of the Cauchy problem for hyperbolic systems of conservation laws

Hyperbolic systems of conservation laws are widely studied as models for the formation and interaction of shock-waves in compressible fluid dynamics. In the scalar case existence and uniqueness of discontinuous solutions the Cauchy problem was achieved in the sixties and seventies. Local existence for systems in one space dimension when the data is suitably small, but nonetheless allows for the formation of shocks, is a celebrated result of Glimm. Powerful methods were developed starting in the nineties by Bressan and collaborators to handle the uniqueness of such solutions, delivering groundbreaking results: in a nutshell it was proved that there is a unique semigroup of solutions which is the limit of several approximations schemes, including vanishing viscosity. However, it has always been expected that uniqueness is essentially a matter of taking a single solution and inspect whether each shock in it is "admissible", and a rigorous proof of this was so far lacking for systems. It turns out that a satisfactory form of such a statement can in fact be rigorously proved combining the tools developed by Bressan and collaborators with a bit of classical geometric measure theory. I will illustrate this in my talk, which is based on a joint work with Alberto Bressan.

Diego Donzis - Texas A&M University

Degrees of freedom and the dynamics of fully developed turbulence

A classical challenge in high-Reynolds number turbulence is the extremely large number the degrees of freedom needed to represent accurately the dynamics of the flow. This leads to great difficulties in understanding, simulating and measuring turbulence at realistic conditions. Using well-resolved direct numerical simulations we show that one can capture essential physics with only a fraction of modes obeying the Navier-Stokes equations; the other modes can be modeled with very simple dynamics. This result suggests that the attractor for the dynamics of fully developed turbulence appears to be robust to modeling errors and the strongly nonlinear dynamics may reside on fewer degrees of freedom than traditionally thought. We present validation of the approach in terms of variables that play a key role in the dynamics of turbulence, namely, dissipation rate, skewness of velocity gradients, the energy and transfer spectrum, and structure functions. The resulting mixed-dynamics model presented may open different venues for turbulence modeling, and also be applicable to a broader set of physical phenomena governed by nonlinear complex dynamics with a wide range of scales.

Yuval Gefen - Weizmann Institute of Science

Quantum Steering with Frustrated and non-Frustrated Hamiltonians

Quantum measurements give rise to back-action on the measured system. Tuning the quantum measurement dynamics, and repeating the measurement protocol irrespective of the detectors' readouts, may be employed to engineer a stable target state. Such a scheme is referred to as a *passive quantum steering protocol*. The ground state of a given Hamiltonian may or may not be steerable, depending on whether the Hamiltonian is non-frustrated or frustrated. We will discuss and generalize this classification of Hamiltonians, and will derive a lower bound on how close to the ground state one can get in the presence of non-steerable frustrated Hamiltonians [1].

[1] Yixuan Wang and Yuval Gefen, unpublished.

Nigel Goldenfeld – University of California, San Diego
Stochasticity in Transitional and Fully-Developed Turbulence

There is growing evidence that turbulence in simple fluids is governed by two fixed points arising in the statistical mechanical description of flows. The first controls the behaviour near the laminar-turbulence transition, while the second controls the behaviour at asymptotically large Reynolds numbers. In the first part of the talk, I review the phenomena associated with the sub-critical transition to turbulence, primarily in quasi-one-dimensional flows such as pipe or high aspect-ratio Taylor-Couette, and show how theory and experiment are converging on a description based on a non-equilibrium phase transition. I present new experimental measurements on puff dynamics, which, when combined with renormalization group and simulation methods, unequivocally support the identification of laminar-turbulence transition of pipes in the directed percolation universality class. In the second part of the talk, I will discuss very briefly the widely unappreciated role of thermal fluctuations in the far dissipation range of turbulence, and using shell models, show how these are amplified and propagated to large scales by spontaneous stochasticity, reaching the integral scale eddies in just a few eddy turnover times. The signature of this mechanism is that the large-scale intermittency fluctuations exhibit universal probability distributions independent of the small-scale noise that seeds them, and vastly greater than the small-scale noise itself.

Both aspects of this work, like so much else in turbulence, rest on foundational early studies by K.R. Sreenivasan, whose contributions we celebrate at this meeting.

Work performed in collaboration with: Hong-Yan Shih (UIUC/Academia Sinica, Taiwan), Xueying Wang (University of Illinois at Urbana-Champaign), Tsung-Lin Shieh (UIUC/Princeton), Bjorn Hof (Institute of Science and Technology, Austria), Joachim Matheson (Niels Bohr Institute, Denmark), Gregoire Lemoult (University of Le-Havre, France), Vasudevan Mukund (Institute of Science and Technology, Austria), Gaute Linga (Niels Bohr Institute), Dmytro Bandak (University of Illinois at Urbana-Champaign), Gregory Eyink (Johns Hopkins University), Alexei Mailybaev (IMPA, Brazil).

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David A Huse - Princeton University

Quantum Kibble-Zurek plus coarsening after a ramp through a quantum critical point

We consider the out-of-equilibrium dynamics of a closed quantum many-body system driven across a quantum phase transition. While the quantum Kibble-Zurek mechanism elucidates part of these dynamics, the subsequent and significant coarsening processes lie beyond its scope. Here, we develop a description of such coarsening dynamics---and their interplay with the Kibble-Zurek mechanism---in terms of a scaling theory. This encompasses various coarsening scenarios involving both quantum and thermal fluctuations. Such coarsening dynamics are being experimentally studied in today's "synthetic" quantum many-body systems, including Rydberg atom arrays.

Reference: Rhine Samajdar and David A Huse, arXiv:2401.15144.

Alain Joye – Université Grenoble Alpes

Adiabatic Lindbladian Evolution with Small Dissipators

We consider a time-dependent small quantum system weakly coupled to an environment, whose effective dynamics we address by means of a Lindblad equation. We assume the Hamiltonian part of the Lindbladian is slowly varying in time and the dissipator part has small amplitude. We study the properties of the evolved state of the small system as the adiabatic parameter and coupling constant both go to zero, in various asymptotic regimes.

Aharon Kapitulnik – Stanford University

Anomalous metals: From “failed superconductor” to “failed insulator”

A ubiquitous observation of robust metallic ground states arising from “failed superconductors” has attracted much attention in recent years because it presents a fundamental challenge to the standard theory of electron fluids. Meanwhile, observations of analogous metallic phases arising from “failed insulators” are often overlooked in analysis of similar data. Aiming to reconcile observations of both regimes in strongly granular In/InOx two-dimensional films, we propose a unified understanding of these seemingly different anomalous metallic phases by drawing connections to resistive-capacitive-shunted Josephson junction arrays. Effects of quantum phase/charge fluctuations and macroscopic quantum tunneling are invoked to understand the anomalous metallic phase, thus advancing fundamental understandings of metals beyond the standard Fermi liquid theory.

Mehran Kardar – MIT

Boundaries, inclusions, and randomness in active matter

Active systems are driven out of equilibrium by exchanging energy and momentum with their environment. This endows them with anomalous mechanical properties which leads to rich phenomena when active fluids are in contact with boundaries, inclusions, or disordered potentials. Indeed, studies of the mechanical pressure of active fluids and of the dynamics of passive tracers have shown that active systems impact their environment in non-trivial ways, for example, by propelling and rotating anisotropic inclusions. Conversely, the long-ranged density and current modulations induced by localized obstacles show how the environment can have a far-reaching impact on active fluids. This is best exemplified by the propensity of bulk and boundary randomness to destroy bulk phase separation in active matter, showing active systems to be much more sensitive to their surroundings than passive ones.

Michael Kiessling – Rutgers University

Some rigorous results on T_c in the Eliashberg theory of superconductivity

Based on a recent reformulation of Eliashberg theory in terms of an infinite sequence of interacting Bloch spins, by Yuzbashyan and Altshuler, variational principles are presented that characterize the critical temperature T_c for two realizations of the theory (dispersionless Einstein phonons, resp. the so-called gamma-model). This is joint work with Emil Yuzbashyan (Rutgers U.) and Boris Altshuler (Columbia U.).

Steven Kivelson – Stanford University

New physics from strong electron-phonon coupling including deconfined phases and emergent “photons”

The electron-phonon problem has long been considered basically “solved” by a combination of Migdal-Eliashberg theory and Holstein small polaron theory in the weak and strong coupling limits respectively. However, we have recently realized that there are multiple regimes of parameter space in which intuitions based on these long-standing ideas are inapplicable, and in which a variety of new regimes, and even phases of matter can arise. I will discuss some of the progress along these lines, including a set of controlled solutions to model problems in which an exotic phase with deconfined fractionalized excitations and emergent photons arises in an electronically uninteresting “band insulator.”

Frederik Ravn Klausen – University of Copenhagen

Decoherence is an echo of Anderson localization in open quantum systems

We study the time evolution of single-particle quantum states described by a Lindblad master equation with local terms. By means of a geometric resolvent equation derived for Lindblad generators, we establish a finite-volume-type criterion for the decay of the off-diagonal matrix elements in the position basis of the time-evolved or steady states. This criterion is shown to yield exponential decay for systems where the non-hermitian evolution is either gapped or strongly disordered. The gap exists for example whenever any level of local dephasing is present in the system. The result in the disordered case can be viewed as an extension of Anderson localization to open quantum systems.

Joint work with Simone Warzel.

Jacek Miękisz – University of Warsaw

On stability of non-periodic Sturmian ground states in one-dimensional classical lattice-gas models

We will discuss one-dimensional classical lattice-gas models without periodic ground states. They are based on Sturmian systems derived by rotations on the circle [1]. Such systems are microscopic toy model of quasicrystals. It is important to investigate stability of non-periodic ground states of such models with respect to small perturbations of interactions.

We will explore connections between fast convergence to equilibrium of frequencies of patterns in non-periodic ground-state configurations and their stability [2].

Several examples (involving Thue-Morse and Fibonacci ground states) and open problems will be presented.

Bibliography

[1] A. van Enter, H. Koivusalo, and J. Miękisz, Sturmian ground states in classical lattice-gas models, J. Stat. Phys. 178: 832–844 (2020).

[2] J. Miękisz, Classical lattice-gas models of quasicrystals, J. Stat. Phys. 97: 835-850 (1999).

Alexander Migdal - NYU Abu Dhabi, IAS, Princeton

Quantum Solution of Classical Turbulence. \ Decaying Energy Spectrum

This paper summarizes and elaborates on recently found \cite{migdal2023exact} exact reduction of decaying turbulence in the Navier-Stokes equation in $3 + 1$ dimensions to a Number Theory problem of the statistical limit of the Euler ensemble. We reformulate the Euler ensemble as a Markov chain and show the equivalence of this formulation to the \textbf{quantum} statistical theory of N fermions on a ring, with an external field related to the random fractions of π . We find the solution of this system in the turbulent limit $N \rightarrow \infty$, $\nu \rightarrow 0$ in terms of a complex trajectory (instanton) providing a saddle point to the path integral over the density of these fermions. This results in an analytic formula for the observable correlation function of vorticity in wavevector space. This is a full solution of decaying turbulence from the first principle without approximations or fitted parameters. We compute resulting integrals in \texttt{Mathematica} and present effective index $\ln(t) = -t E'(t)/E(t)$ for the energy decay as a function of time Fig.\ref{fig::NPlot} and $s(k) = -k \partial_k \log E(k,t)$ for the energy spectrum Fig.\ref{fig::SPIndex}. The asymptotic values are $\ln(\infty) = \frac{5}{4}$, $s(\infty) = \frac{7}{2}$, but the universal functions $\ln(t)$, $s(t)$ are neither constant nor linear due to quantum effects. The theoretical value $\ln(\infty) = \frac{5}{4}$ matches the grid turbulence experiments \cite{GridTurbulence_1966} within experimental errors $\sim 2\%$.

Dhrubaditya Mitra - NORDITA

Fun with turbulence and polymers

Turbulence is a state of irregular, chaotic and unpredictable fluid motion at very high Reynolds numbers Re (ratio of typical inertial forces over typical viscous forces in a fluid). It remains one of the last unsolved problems in classical physics. Conceptually, the fundamental problem of turbulence shows up in the simplest setting of statistically stationary, homogeneous and isotropic turbulent (HIT) flows: What are the statistical properties of velocity fluctuations? Experiment and direct numerical simulations have now firmly established that the velocity fluctuations are intermittent/multifractal but we have no theory starting from first principles. Turbulent flows, both in nature and industry, are often multiphase, i.e. they are laden with particles, may comprise of fluid mixtures, or contain additives such as polymers. Of these, polymeric flows are probably the most curious: the addition of high molecular weight (about 100) polymers in 10–100 parts per million (ppm)

concentration to a turbulent pipe flow reduces the friction factor (or the drag) up to 5–6 times (depending on concentration). Evidently, this phenomena, called turbulent drag reduction (TDR), cannot be studied in homogeneous and isotropic turbulent flows; nevertheless, polymer laden homogeneous and isotropic turbulent (PHIT) flows have been extensively studied to understand how the presence of polymers modifies turbulence. Research in polymeric flows turned into a novel direction when it was realised that even otherwise laminar flows may become unstable due to the instabilities driven by the elasticity of polymers leading to the more dramatic phenomena of elastic turbulence (ET), where polymeric flows at low Reynolds but high Deborah numbers (ratio of characteristic timescale of relaxation of polymer over the characteristic time scale of the flow) are chaotic with mixing properties. In this talk I will report on newly discovered multifractal properties of both turbulence with polymers and elastic turbulence.

This talk is based on joint work with Marco Rosti (OIST), Prasad Perlekar (TIFR-H), Rahul K Singh (OIST)

Luca Moriconi - Instituto de Física: Universidade Federal do Rio de Janeiro

Contour Shape Dependency of Circulation Statistics in Homogenous and Isotropic Turbulence

Turbulence circulation moments, when numerically evaluated on planar rectangular contours which enclose identical areas, are noticed to have a more pronounced dependency on the contour aspect ratios, if at least one of the rectangle sides is sized around the smallest inertial range scales. Resorting to ideas addressed in the framework of a vortex gas model of circulation statistics, which integrates structural and the multifractal aspects of the turbulent velocity field, we are able to reproduce, with reasonable accuracy, the observed contour shape dependency of circulation moment ratios, up to high order statistics. A key phenomenological point in our discussion is the fact that the energy dissipation field, closely related to the local density of thin vortex tubes, is bounded from above at finite Reynolds numbers.

Bruno Nachtergaele - University of California, Davis

The gapped phases of $SO(n)$ quantum spin chains

The ground state phase diagram of the $SO(n)$ quantum spin chains with nearest neighbor interactions, for $n \geq 3$ or larger, shows two gapped phases separated by a critical point often referred to as the Reshetikhin point. One of the phases contains the $SU(n)$ invariant $-P^{(0)}$ model which has been analyzed using the Temperley-Lieb algebra and, more recently, by a random loop model. These works show the ground state to be dimerized. The other phase contains a special point with exact MPS ground states that generalize the AKLT state (corresponding to the case $n=3$). For even n , that point too is a phase with breaking of the translation invariance down to period 2. We show that it is not dimerized in the usual sense of the term and uncover other interesting new properties (joint work with Michael Ragone).

David Nelson – Harvard University

Active Antagonism: Reproducing Microorganisms and Fluid Flows

The growth and evolution of microbial populations is often subject to advection by fluid flows in spatially extended environments, with immediate consequences for spatial population genetics in marine ecology, planktonic diversity and fixation times. We review recent progress made in understanding this rich problem in the simplified setting of two competing genetic microbial strains subjected to fluid flows. We first review microbial range expansion experiments on liquid substrates and then move on to discuss antagonism, i.e., two killer microorganism strains, each secreting toxins that impede the growth of their competitors (competitive exclusion), both with and without stationary fluid flows. Recent experiments that reveal the presence of a genetic line tension are described. Coupled reaction-diffusion equations that include advection by simple steady cellular flows composed of characteristic flow motifs in two dimensions reveal how local flow shear and compressibility effects can interact with selective advantage to have a dramatic influence on genetic competition and fixation in spatially distributed populations. We analyze a variety of 1d and 2d flow geometries including sources, sinks, vortices and saddles, and show how simple analytical models of the dynamics of the genetic interface can be used to shed light on the nucleation, coexistence and flow-driven instabilities of genetic drops.

Joseph Niemela – International Center for Theoretical Physics

Ruminations on some turbulent themes

The talk will largely focus on the intersection of fluid turbulence and low temperature physics, which owes a tremendous amount to the collaboration and inspiration of K.R. Sreenivasan (Sreeni). There are many areas in which Sreeni was deeply involved, from turbulent superfluid flows to turbulent convection. The talk will mainly focus on aspects of the latter.

Ron Peled – Tel Aviv University

Mathematical study of disordered elastic media

Interfaces in disordered spin systems may be modeled by disordered elastic media (a.k.a. minimal surfaces in random environment) - surfaces minimizing the sum of internal elastic energy and environment potential energy. We present a mathematical study of d -dimensional surfaces in a $(d+n)$ -dimensional disordered medium, obtaining rigorous bounds on the geometric and energetic fluctuations of the surfaces as well as a proof for the scaling relation which ties these two types of fluctuations together. Our results show that the surfaces are delocalized in dimensions $d \leq 4$ and localized in dimensions $d \geq 5$, obtaining the Flory approximation of the physics literature as a rigorous lower bound on the geometric fluctuations. Many of our results are new even for one-dimensional surfaces ($d=1$), where the study relates to first-passage percolation and the KPZ universality class.

Based on joint works with Barbara Dembin, Dor Elboim and Daniel Hadas and with Michal Bassan and Shoni Gilboa.

Mira Shamir – Queen Mary University of London

On the abominable properties of the Almost Mathieu operator with Liouville frequencies

This talk is devoted to the study of some spectral properties of the Almost Mathieu Operator: that is one-dimensional discrete Schrödinger operator that acts on the space of square-summable sequences as a sum of the free discrete Laplacian and multiplication by a potential of the form $\lambda \cos(2\pi \alpha n + \theta)$. The parameter α , called the frequency, is some number between zero and one. It is well-known that the spectral properties of the Almost Mathieu operator depend sensitively on the arithmetic properties of the frequency. The case of poorly approximated frequencies that satisfy a certain Diophantine condition, is relatively well understood. In that case the spectral properties are as nice as one would expect. There is a completely different picture in the case of well approximated frequencies (Liouville numbers), in which case we show that several spectral characteristics of the Almost Mathieu operator can be as poor as at all possible in the class of all discrete Schrödinger operators. For example, the modulus of continuity of the integrated density of states (that is, of the averaged spectral measure) may be no better than logarithmic. The logarithmic modulus of continuity of the integrated density of states is known to be the optimal modulus of continuity in the class of all discrete Schrödinger operators. Other characteristics to be discussed are the Hausdorff measure of the spectrum for the so-called critical case when $\lambda = 1$, and non-homogeneity of the spectrum (as a set) for a range of λ -s. Based on joint work with A. Avila, Y. Last, and Q. Zhou

Jeffrey Schenker – Michigan State University

Disordered Quantum Trajectories under Random Generalized Measurements

A general framework to study the behavior of quantum trajectories obtained by repeated random measurements subject to not-necessarily-independent but stationary and ergodic noise will be discussed. Two results will be highlighted: 1) a large deviation principle for the results of random measurements and 2) a generalization to the disordered context of results of Kümmerer and Maassen on asymptotic purification to the ergodic, disordered setting.

Wolfgang Spitzer – FernUniversität in Hagen

Entanglement entropy of the ideal Fermi gas in magnetic fields

We consider fermionic ground states of the Landau Hamiltonian, H_B , in a constant magnetic field of strength $B > 0$ in $\mathbb{R}^d$, $d \in \{2, 3\}$, at some fixed Fermi energy $\mu > 0$. Such a ground state is described by the Fermi projection $P_B := 1(H_B \leq \mu)$. For some fixed bounded domain $\Lambda \subset \mathbb{R}^d$ with C^1 -smooth boundary set $\partial \Lambda$ and an $L > 1$ we restrict these ground

states spatially to the scaled domain $L \setminus \Lambda$ and denote the corresponding localized Fermi projection by $P_B(L \setminus \Lambda)$. Then we study the scaling of the entanglement entropy, $S(L \setminus \Lambda, B) := \mathrm{tr} \{-\ln(P_B(L \setminus \Lambda))\}$, of these localized ground states in the large scale limit $L \rightarrow \infty$, for fixed B and in the joint limit $L \rightarrow \infty, B \rightarrow 0$. Here, $h(t) := -t \ln(t) - (1-t) \ln(1-t)$ is the von-Neumann entropy function on the interval $(0,1)$. We determine the precise leading asymptotic behavior of $S(L \setminus \Lambda, B)$, which either obeys an area-law scaling of the order $L^{d-1} \partial \Lambda$ or a logarithmically enhanced area-law scaling of the order $L^{d-1} \ln(L) \partial \Lambda$. In the two-dimensional case, we see an interesting transition between the two scaling regimes if the magnetic field strength B tends to zero jointly with $L \rightarrow \infty$. I report from joint works with Hajo Leschke, Paul Pfeiffer and Alexander V. Sobolev.

Herbert Spohn – Technical University of Munich

Universality of coupled Burgers equations with degenerate flux Jacobian

Nonlinear fluctuating hydrodynamics covers the case of two peaks with different sound speeds. Currently of great interest is the case when the sound speeds coincide. We explore stationary measures and universality of the long time scaling behavior.

This is joint work with D. Roy, A. Dhar, K. Khanin, and M. Kulkarni.

Virginia Trimble – University of California, Irvine

HOW SCIENCE CHANGES ITS MIND: The Demise of Steady State Cosmology

Boxing matches can end with knock-outs or decisions; wars with Waterloos or just keeping the Continental Army together for seven years. Assuming that our In-group thinks that there is real progress in science, it still makes sense for us to ask which of those processes, both, or neither is characteristic for science. The answer, I think, has to be some of each, and perhaps also Planck's "one funeral at a time." It is also the case that the process can look different to those at the core of the issue from how it looks to the wider scientific community. The Steady State Universe (that things should look the same on large scales at all times as well as in all places) was a beautiful idea, coming in 1948 from Fred Hoyle (who was my boss for two years) and from Hermann Bondi and Thomas Gold (good friends). Allen Sandage said that it was "never taken very seriously in California" (by which he meant Pasadena), and the number of remaining supporters is now very small. But the question I would like to address is the extent to which, first, the core community (of which I was at least a fringe member) and second the ensemble of nearly all scientists, ignored or abandoned Steady State on the basis of accumulating statistical arguments. Or were we all waiting for that knock-out blow from the discovery of the isotropic, 3K, black body, microwave, relict, background radiation? A few of the other players I plan to mention are Peter A.G. Scheuer, Maarten Schmidt, Dennis Sciama, Martin Rees, and John Bahcall.

Maxime Van De Moortel – Rutgers University

Scattering of the Klein-Gordon equation on a black hole

The Klein-Gordon equation serves as the fundamental model for describing the relativistic dynamics of massive matter. While its scattering theory on Minkowski spacetime has been extensively studied, an equivalent framework for black hole spacetimes has been lacking. In this talk, we present our recent resolution of this long-standing issue on the Schwarzschild spacetime, the simplest model of a black hole. Time permitting, we will also explain how the proof uses, at a crucial step, results from analytic number theory related to the Riemann zeta function.

Joint work(s) with Federico Pasqualotto and Yakov Shlapentokh-Rothman.

Vlad Vicol – New York University

On anomalous diffusion

I will discuss a joint work with Scott Armstrong (NYU), in which we construct a class of incompressible vector fields that have many of the properties observed in a fully turbulent velocity field, and for which the associated scalar advection-diffusion equation generically displays anomalous diffusion. We also propose an analytical framework in which to study anomalous diffusion, via a joint forward cascade of energy and a backward cascade of renormalized eddy viscosities. Our proof is by "fractal" homogenization, that is, we perform a cascade of homogenizations across arbitrarily many length scales.