Chaos, Holography and Coadjoint Orbits

February 25-March 01, 2019 - Villa Batelle (UNIGE)

Colloquium Talks – invited Speakers

Alexander ALTLAND

Title :

Quantum Ergodicity of the Sachdev-Ye-Kitaev Model

Abstract :

The Sachdev-Ye-Kitaev (SYK) model is a system of a large number of randomly interacting Majorana fermions. It stands in the tradition of the random k-body interaction models pioneered in nuclear physics and later applied in condensed matter contexts. The SYK model can be looked at from three interrelated perspectives: a) a system showing many body chaos and random matrix correlations, b) a paradigm of strongly correlated (Majorana) quantum matter, and c) the holographic shadow of a two-dimensional AdS2 gravitational bulk. The interplay of these three has made it a focus of intensive current research. Previous analytic research has focused on the manifestations of quantum correlations at time scales short compared to the inverse of the many body level spacing. In this talk the focus will be on the complementary regime of large times. We will apply a replica field theory formalism to identify a set of collective modes in Fock space describing the relaxation of the system towards an ergodic long time limit. We will discuss universal signatures of these modes in spectral correlations, and compare our results to numerics. Finally, we will discuss the structure of the SYK many body wave functions and point out differences to the wave functions of chaotic single particle systems.

Jean-Michel BISMUT

Title :

Hypoelliptic Laplacian, probability and coadjoint orbits

Abstract :

The hypoelliptic Laplacian gives a natural interpolation between the Laplacian and the operator associated with the geodesic flow. This interpolation preserves important spectral quantities. From the point of view of dynamical systems, it provides a canonical interpolation between Brownian motion and geodesics. I will explain its properties as a consequence of a noncommutative version of the central limit theorem. Applications will be given in the context of reductive Lie groups: the hypoelliptic Laplacian is the analytic counterpart to localization in equivariant cohomology on the coadjoint orbits of loop groups. The construction for noncompact reductive groups ultimately gives a geometric formula for the semisimple orbital integrals, which are the key ingredient in Selberg's trace formula.

Frank FERRARI

TBA

Krzysztof GAWEDZKI

Title :

A simple class of non-equilibrium states in 1+1-dimensional CFT and characters of Diff(S^1)

Abstract :

I shall discuss a class of exactly soluble nonequilibrium states in (1+1)D CFT.
In particular, I shall present an exact expression for the Full Counting Statistics of heat transfers in such states that is based on a formula for the characters of positive energy representations of Diff(S^1) on general 1-parameter subgroups obtained using the conformal welding technique.

Razvan GURAU

Title :

On fixed points in tensor field theories

Abstract :

Tensor field theories at large N have been shown to have infrared attractive fixed points corresponding to a new class of conformal field theories. In this talk I will present an introduction to tensor field theories and their large N limit. Subsequently, I will discuss some recent rigorous results concerning the infrared fixed points of these theories.

Kristan JENSEN

Title :

De Sitter and SYK

Abstract :

Quantum gravity in two-dimensional nearly de Sitter spacetime has no propagating degrees of freedom. It has boundary degrees of freedom, whose dynamics are characterized by a Schwarzian-like effective action. I will focus on global de Sitter spacetime, where the role of the two boundaries has long been mysterious. I will present a two-replica modification of the SYK model which precisely resembles the gravitational physics of global nearly dS2 spacetime, and will discuss the lessons I think it teaches us for de Sitter holography more generally. If I have time, I will also discuss the boundary description of dS3 gravity.

Thomas MERTENS

Title :

Jackiw-Teitelboim gravity and the Schwarzian

Abstract :

We derive Schwarzian correlation functions using the BF formulation of Jackiw-Teitelboim gravity, where bilocal operators are interpreted as boundary-anchored Wilson lines in the bulk. Crossing Wilson lines are associated with OTO-correlators and give rise to 6j-symbols.
We discuss the semi-classical bulk JT physics contained within the correlation functions.
Extensions including bulk defects related to the other coadjoint orbits are discussed.

Pranjal NAYAK

Title :

Coadjoint orbit action of Virasoro group and two-dimensional quantum gravity dual to SYK/tensor models

Abstract :

The pseudo-Nambu-Goldstone (NG) bosons of the SYK model are described by a coset space Diff/$\mathbb{SL}(2,\mathbb{R})$, where Diff, or Virasoro group, is the group of diffeomorphisms of the time coordinate valued on the real line or a circle. It is known that the coadjoint orbit action of Diff naturally turns out to be the two-dimensional quantum gravity action of Polyakov without cosmological constant, in a certain gauge, in an asymptotically flat spacetime. Motivated by this observation, in this talk I will discuss Polyakov action with cosmological constant and boundary terms, and study the possibility of such a two-dimensional quantum gravity model being the AdS dual to the low energy (NG) sector of the SYK model, the Schwarzian theory.

Blagoje OBLAK

Title :

Virasoro Berry Phases in the KdV Equation

Abstract :

In this talk I consider Berry phases that appear when a primary state in a 2D CFT undergoes adiabatic conformal transformations. Despite the infinite-dimensional parameter space, these phases can be evaluated exactly and coincide with the symplectic fluxes on Virasoro orbits computed long ago by Alekseev and Shatashvili. In 3D gravity, such phases provide a gravitational extension of Thomas precession. They also appear in the Euler-Poincaré reconstruction of the KdV equation, which suggests that they may be observable, for instance, through the Stokes drift of fluid particles in a shallow water channel.

Samson SHATASHVILI

Title :

String Field Theory, Factorization and Gravitational Wess-Zumino

Abstract :

In this talk I will discuss the relation between group cocycles, coadjoint orbits and gravitational Wess-Zumino action. These topics are connected to the main subject of the conference as well as string field theory.

Manuel VIELMA

Title:

Eigenstate thermalization in the Sachdev-Ye-Kitaev model.

Abstract:

The eigenstate thermalization hypothesis (ETH) proposes an explanation as to how closed unitary quantum systems can exhibit thermal behavior in pure states. In this work we examine the Sachdev-Ye-Kitaev model as well its IR limit as described by an effective Schwarzian action. We show that, as expected from evidence found using exact diagonalization, the model satisfies ETH. In the Schwarzian limit, we study a specific class of states created by heavy operators and find that they only show a weak form of ETH.

Herman VERLINDE

TBA

Gideon VOS

Title:

Thermalization, the 2d identity block, and coadjoint orbits

Abstract:

It is by now well-established that the holographic dual of a black hole geometry is a thermal CFT state. A lot of the properties of AdS3 black holes are very robust under changes of the details of the gravitational theory that preserve low-energy effective action, this suggests that the process of thermalization should similarly be fixed by the universal properties of 2d CFTs with large central charge. In this talk we will find that whether a generic initial out-of-equilibrium heavy state acquires equilibrium and to what temperature it equilibriates is to is controlled by the coadjoint orbit in which the stress-tensor expectation value of the initial state is contained. Furthermore restricting to bounded Virasoro coadjoint orbits combined with some classical theorems of linear differential equation forces the identity block contribution to correlators on the initial heavy states to undergo a phase transition where the Virasoro charges act as coarse-grained equation of state variables. This transition nicely mirrors the transition from non-collapsing to collapsing scattering processes in the bulk.

Yilin WANG

Title :

The Loewner energy for simple loops

Abstract :

The one parameter family of random curves SLE_k introduced by Oded Schramm, has successfully described the scaling limits of interfaces in planar statistical mechanics models at critically, where conformal symmetries are present. The Loewner's energy defined for Jordan curves is naturally related to SLEs as their action functional, also as the large deviation rate function when k goes to 0.

In this talk, I will present the connection between Loewner energy and zeta-regularized determinants of Laplacians which is inspired by the coupling of SLE with 2D quantum gravity pioneered by Dubedat and Sheffield. As a consequence, it also equals to the universal Liouville action introduced by Takhtajan and Teo, which is a Kähler potential of the Weil-Petersson metric in the universal Teichmüller space arising from the unique homogeneous Kähler metric on the coadjoint orbit Diff(S^1)/PSL(2,R).

Claire ZUKOWSKI

Title :

Kinematic Space and the Orbit Method

Abstract :

Coadjoint orbits are symplectic manifolds that are the classical analogues of a Lie group's unitary irreducible representations. In this talk I will argue that the space of Ryu-Takayanagi surfaces in anti de Sitter spacetime, known as kinematic space, is a particular coadjoint orbit of the conformal group. In addition, I will show that the Crofton form on kinematic space, that was shown to compute the lengths of bulk curves, is equal to the standard Kirillov-Kostant symplectic form on the coadjoint orbit. Since kinematic space is K\"ahler in addition to symplectic, it can be quantized. The orbit method then translates geometrical properties of holographic auxiliary spaces like kinematic space into statements about the representation theory of the conformal group. This is a new application of the orbit method to holography that extends the kinematic space dictionary and suggests generalizations as well as obstructions for kinematic space.