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Álvaro Álvarez-Domínguez #69

Abstract submission

Title: Cosmological vacuum ambiguities and the quantum kinetic approach

Short abstract: When quantizing matter fields in a flat FLRW spacetime, ambiguities in the choice of vacuum appear due to the expansion of the universe, and particle creation might occur. We analyze how the time evolution of the number of created particles depends on these ambiguities. Moreover, after providing a generalization of the standard quantum Vlasov equation for general vacua, we focus on the family of quantizations that allow for unitary dynamics, and we propose a new criterion to further reduce the family of physically acceptable vacua.

Lautaro Amadei #85

Abstract submission

Title: The landscape of polymer quantum cosmology

Short abstract: We show that the quantization ambiguities of loop quantum cosmology, when considered in wider generality, can be used to produce discretionary dynamical behavior. There is an infinite dimensional space of ambiguities which parallels the infinite list of higher curvature corrections in perturbative quantum gravity. There is however an ensemble of qualitative consequences which are generic in the sense that they are independent of these ambiguities. Among these, one has well defined fundamental dynamics across the big bang, and the existence of extra microscopic quantum degrees of freedom that might be relevant in discussions about unitarity in quantum gravity. We show that (in addition to the well known bouncing solutions of the effective equations) there are other generic type of solutions for sufficiently soft initial conditions in the matter sector (tunneling solutions) where the scale factor goes through zero and the spacetime orientation is inverted. We also show that generically, a contracting semiclassical universe branches off at the big bang into a quantum superposition of universes with different quantum numbers. Despite their lack of quantitative predictive power these models offer a fertile playground for the discussion of qualitative and conceptual issues in quantum gravity.

Seth Asante #58

Abstract submission

Title: Gravity dynamics from effective spin foam models.

Short abstract: Effective spin foam models are geometrical path integrals for quantum gravity based on discrete area variables. These models have simple amplitudes while maintaining the universal features of quantum geometry and thus allow for fast computations, they are the fastest to date. This allows to study spin foam dynamics on configurations providing a test of quantum equations of motion. This study reveals a very rich semi classical regime as an interplay between parameters of the model and in addition addresses the 'flatness problem' appearing in spin foam models. These results are very promising as a hope for emergence of general relativity from spin foam models. The nature of the semi classical regime is a generic feature of the path integral quantization of systems with second class constraints.

Mehdi Assanioussi #51

Abstract submission

Title: The loop representation and r-Fock measures

Short abstract: The subject of the talk concerns the r-Fock representations and their relation to the standard loop representations, in light of the recent generalization of the construction of r-Fock measures for SU(N) gauge theories. The presentation will focus on the technical aspects of the construction of r-Fock measures, and the role that r-Fock representations could play in bridging the gap between quantum field theory on Minkowski spacetime and the background independent framework of loop quantum gravity.

Sepideh Bakhoda #68

Abstract submission

Title: The U(1)^3 model of Euclidean Quantum Gravity

Short abstract: In order to construct a consistent quantisation of the Hamiltonian constraint of general relativity, one only needs to survey and control the Euclidean quantum constraint operator. On the other hand, the quantisation is required to be anomaly-free, i.e. the classical constraint algebra is represented by its quantum counterpart. It is possible to solve both the Hamiltonian and spatial diffeomorphism constraint simultaneously, however, the precise structure functions of the classical formulation are not recovered. To improve the formulation, it is constructive to study toy models to gain more insight about the dynamics. It is intriguing to focus on a model whose constraint algebra has structure functions similar to the gravitational case. A theory with this property is the □(1)^3 model of Euclidean gravity. In this talk, we will speak about the reduced phase space approach to this model and also its Lagrangian formalism will be discussed.

Jesus Fernando Barbero Gonzalez #63

Abstract submission

Title: Consistent and non-consistent deformations of gravitational theories

Short abstract: I will discuss the internally abelianized version of several gravitational theories, written in connection tetrad form, and study the possible interaction terms that can be added to them in a consistent way. I will do this for 2+1 dimensional and 3+1 dimensional models. In the latter case I will show that the Cartan-Palatini and Holst actions are not consistent deformations of their abelianized versions and also that the Husain-Kuchař and Euclidean self-dual actions are consistent deformations of their abelianized counterparts. This suggests that if these can be quantized, it could be possible to devise a perturbative scheme leading to the quantization of Euclidean general relativity along the lines put forward by Smolin in the early nineties.

Aurélien Barrau

#110

Abstract submission

Title: Some aspects of LQG phenomenology

Short abstract: I will review some recent results on the cosmological dynamics with generalized holonomy corrections and on quasinormal modes of quantum black holes.

Jibril Ben Achour

#111

Abstract submission

Title: Exploring black holes in modified gravity

Short abstract: Modified gravity theories aiming at providing infrared modifications of gravity, while restoring General Relativity on local scales, have been extensively developed as an alternative path to explain the dark sector. Among the different theories, the ones based on an additional scalar mode have been explored in depth. In this talk, I will review the main motivations for considering these theories, and I will discuss the construction of the Degenerate Higher Order Scalar Tensor (DHOST) theories, the most general theories constructed so far. I will also review the role of disformal transformations in exploring the solution space of these theories, and I will present several examples of exact hairy black hole solutions obtained recently in that framework among which rotating black hole and radiative solutions and discuss their properties.

Källan Berglund #97

Abstract submission

Title: Quasinormal mode predictions methods for modified black hole spacetimes

Short abstract: Applying novel quasinormal mode calculations to a modified black hole spacetime, we can predict the effects of a quantum correction on metric components represented by an additional scalar field. If one can make this calculation method applicable to a broader range of spacetimes, it will be possible to predict the nuances of gravitational wave signals produced by mergers of other such modified black holes. These predictions should be distinguishable from other models with the LISA detector.

Michał Bobula

#100

Abstract submission

Title: Radiation in Quantum Gravitational Collapse

Short abstract: Non-singular dust ball collapse can be realised by a quantum treatment of the classical Oppenheimer-Snyder scenario. Tools from LQC applied to the interior of the ball replace the classical singularity with a quantum bounce. As a result, the black hole evolves into a white hole. In this modified scenario, I will discuss revised and improved treatment of rainbow metric [1] accounting for quantum geometry modifications in the exterior of the collapsing matter. Using it, I will present how to extract the exterior geometry from the effective interior geometry, also including the geometry backreaction from the scalar field. I will show how ingoing and outgoing null geodesics are globally related. Ultimately, it delivers a framework to calculate covariantly regularized entanglement entropy [2], more specifically radiation entropy.

Tobias Bommer #61

Abstract submission

Title: Timelike faces and lightlike vectors within the CH- extended EPRL model asymptotics

Short abstract: Asymptotic expansions in terms of coherent states provide a potent tool to explore the semi-classical limit of spin foam models. The particular model we consider here is the CH-extended EPRL model, which allows triangulations that may feature timelike tetrahedra and triangles. Earlier studies of the CH-extended EPRL model have revealed that each timelike triangle is not only associated with its expected spacelike normal vector, but also with a particular lightlike vector. However, the role of these lightlike vectors for the asymptotics of the model remained unclear. We show that the vertex amplitude has stationary points featuring non-vanishing lightlike vectors and provide a geometric interpretation of such configurations. In particular, we show that even for non-vanishing lightlike vectors one can obtain geometric 4- simplices and extract the Regge action from the vertex amplitude.

Johanna Borissova #39

Abstract submission

Title: Towards a continuum effective action for spin foams

Short abstract: Spin foams arise from a quantization of classical gravity expressed via the Plebanski action. Key open questions related to their continuum limit are: Is general relativity reproduced and what type of corrections can emerge? Recent studies analyzed the continuum limit of the Area Regge action as a central component for spin foam dynamics. Inspired by these results, starting from the Plebanski action we construct a family of candidate effective actions. These actions are expected to describe the continuum limit of spin foams and provide a starting point to explore phenomenological aspects of the large-scale dynamics of spin foams.

Ian Bornhoeft

#103

Abstract submission

Title: Residual Diffeomorphisms in Kantowksi-Sachs Spacetime

Short abstract: We extend the Kantowski-Sachs canonical framework, modeling the interior of a black hole, to include a Maxwell field. The group of residual diffeomorphisms --- both discrete and continuous --- in this framework is carefully derived. The action of these diffeomorphisms on the phase space are almost all non-canonical. Nevertheless, we show how the flow under these diffeomorphisms in the phase space can be caste in the form of a differential equation consisting of terms with immediate quantum analogues, thereby paving a way to define the action of such diffeomorphisms in quantum theory.

Andrea Calcinari #56

Abstract submission

Title: Towards anisotropic cosmology in group field theory

Short abstract: In cosmological group field theory models for quantum gravity coupled to a massless scalar field, the total volume - seen as a function of the scalar field - follows the classical Friedmann dynamics of a flat Friedmann–Lemaître –Robertson–Walker (FLRW) Universe at low energies, while resolving the Big Bang singularity at high energies. An open question is how to generalise these results to other homogeneous cosmologies. Here we take the first steps towards studying anisotropic Bianchi models in group field theory, based on the introduction of a new anisotropy observable analogous to the β variables in Misner’s parametrisation. In a classical Bianchi I spacetime, β behaves as a massless scalar field and can be used as a (gravitational) relational clock. In a model based on coupling three Peter–Weyl modes, we find that in an expanding Universe β initially behaves like its classical analogue before “decaying” showing a previously studied “isotropisation”. One possible outcome of our work is a definition of relational dynamics in group field theory that does not require matter.

Hank Chen

#106

Abstract submission

Title: Categorified Phase Space and Spinning Geometries

Short abstract: Categorification is a procedure by which one coherently introduces a new layer of structure on top of existing structures. In various areas of physics, the central application of this is to “raise the dimension” of various models. Following this notion, we perform this categorification procedure to the symplectic structure and obtain a notion of a categorified, or “2-graded”, phase space. We show then that spinning geometries introduced by Freidel and Ziprick provide a natural example of such a categorified phase space.

Qian Chen

#107

Abstract submission

Title: Coarse-graining: holonomy operators and spin network entanglement.

Short abstract: We set coarse-graining in the framework of bulk-boundary relation, building the transformation rule for holonomy operators based on finer graph and coarser graph. We investigate the spin network entanglement, showing that the coarse-graining preserves the spin network entanglement under the dynamics of holonomy operators. This leads to a holographic perspective for the entanglement issue in loop quantum gravity.

Marios Christodoulou #30

Abstract submission

Title: The search for a table-top signature of quantum gravity

Short abstract: The past years have seen an intense search for `table-top' quantum gravity signatures, mainly inspired by technological and conceptual advances coming from the quantum information community. What are possible protocols?? How close are we to see such experiments actually done? What is the pertinence and opportunities for clarifying quantum gravity theory in this low energy and weak field regime where such experiments are typically imagined to operate? This brief talk is a status report on these questions.

Eugenia Colafranceschi #77

Abstract submission

Title: Modelling black hole horizons via random spin networks

Short abstract: In recent years, the import of languages and techniques from quantum information theory to quantum gravity has significantly enhanced our capability to investigate quantum spacetime. In this vein, we consider spin network states composed of random vertices entangled to each other and make use of random tensor network techniques to study how the entanglement entropy of the boundary is affected by the bulk. We recover a bulk area law for the boundary entropy with corrections due to the bulk entanglement and show that a horizon-like surface arises as the entanglement content of the bulk exceeds a certain threshold.

Alejandro Corichi

#113

Abstract submission

Title: Phase spaces for black hole horizons

Short abstract: We consider isolated horizons from the canonical point of view, and show that the well studied self dual case possesses different descriptions for the horizon phase space variables, depending on different choices for the canonical action. We show that only for certain choices one recovers the well knowns horizon description, while other perfectly consistent choices exist. We discuss the possible implications for black hole entropy.

Grzegorz Czelusta #95

Abstract submission

Title: Quantum simulations of loop quantum gravity

Short abstract: One of the possible applications of quantum computers in the near future is a simulation of quantum physics. In particular, quantum gravitational systems associated with the Planck scale physics can be considered. Such systems are expected to be of the many-body type, which justifies the utility of quantum computations in analyzing their complex quantum behavior. This talk considers the simulation of loop quantum gravity on a quantum computer. A construction of quantum circuits that generate states of spin networks will be presented. Furthermore, quantum algorithms that enable the projection of states on a physical subspace of Hilbert space and determination of amplitudes of transitions between different spin network states are proposed. The implementation of the approach on IBM superconducting quantum computers will be presented. Obtained results provide building blocks for quantum simulations of complex spin networks, which can give insight into the Planck scale physics in the near future.

Roukaya Dekhil #67

Abstract submission

Title: A new spin-foam model based on edge vectors

Short abstract: We present a construction of a new spin foam model for 4d lorentzian quantum gravity based on the quantization of edge vectors and bivectors on 2-simplices. We propose a new prescription for building a quantum tetrahedron based on edge vectors and identify it as the quantum state of the new model. We find in this case that the Hilbert space of the discrete geometry can be precisely defined in terms of functions on the group of translation on Minkowski space. Based on this construction, we prove that the new spin foam amplitude for a time-like tetrahedron reduces to the one proposed by Barrett and Crane once we restrict the space of quantum states to the skew-symmetric part. Finally, we argue that this new SF model encodes the complete information on the full geometry of time-like tetrahedra, including the sector of degrees of freedom that carries the information of space-like normal vectors.

Maïté Dupuis #38

Abstract submission

Title: q-deformed Loop Quantum Gravity - an overview

Short abstract: I will present a quick overview of the q-deformed Loop Quantum Gravity (LQG) model which describes 3-dimensional quantum gravity with a cosmological constant. I will start from the BF action and shows how after a canonical transformation, we have a well-understood discretization process that leads to a model for discrete homogeneously curved geometries. The associated quantum model, q-deformed LQG, is characterized in terms of quantum group structures and the quantum Hamiltonian constraints define the Wheeler-DeWitt equations in this framework and generate the Turaev-Viro model (with real q, q being the deformation parameter).

Konstantin Eder #35

Abstract submission

Title: Towards black hole entropy in chiral loop quantum supergravity

Short abstract: Recently, many geometric aspects of N-extended AdS supergravity in chiral variables have been encountered and clarified. In particular, if the theory is supposed to be invariant under SUSY transformations also on boundaries, the boundary term has to be the action of a OSp(N|2) super Chern-Simons theory, and particular boundary conditions must be met. Based on this, we propose a way to calculate an entropy S for surfaces, presumably including black hole horizons, in the supersymmetric version of loop quantum gravity for the minimal case N=1. It proceeds in analogy to the non-supersymmetric theory, by calculating dimensions of quantum state spaces of the super Chern-Simons theory with punctures, for fixed quantum area of the surface. We find S = a_H/4 for large areas and determine the subleading correction. Due to the non-compactness of the gauge group and the corresponding difficulties with the Chern-Simons quantum theory, we use analytic continuation from the Verlinde formula for a compact real form, UOSp{1|2), in analogy to work by Noui et al. This also entails studying some properties of OSp{1|2) representations that we have not found elsewhere in the literature.

Rodrigo Eyheralde #88

Abstract submission

Title: Hawking radiation from a sandwich evaporating Black Hole: Bogoliubov transformations applied slightly beyond its framework.

Short abstract: We study Hawking radiation on a toy model Vaidya space-time that feautures gravitational collapse and evaporation. From the method of Bogoliubov transformations we describe the spectrum and compute an increasing effective temperature characterizing the dominating thermal contribution. This is in numerical agreement with other techniques. As a consistency check, we re-derive the results from the zero mass limit of a remnant BH scenario and compare them with Hawking radiation from regular Black Hole metrics.

Max Joseph Fahn #47

Abstract submission

Title: A master equation for gravitationally induced decoherence of a scalar field using Ashtekar variables

Short abstract: In the talk, we present the derivation of a decoherence model containing a scalar field coupled to a gravitational environment. With such models the influence of the quantum gravitational environment on the scalar field’s dynamics can be analysed. Starting with full general relativity in Ashtekar's connection formulation, we focus on weak gravitational interactions in an asymptotically flat universe and the scalar field as matter component. We apply a reduced phase space quantisation of the model by means of choosing suitable Dirac observables and apply a Fock quantisation to the reduced phase space. The quantised system is then treated as an open quantum system with gravity as the environment. With the help of the projection operator technique, we derive a second order time-convolutionless master equation. This equation is an effective evolution equation which encodes the temporal evolution of the scalar field in terms of certain operators, whose form is a result of the model under consideration and several physical assumptions. These operators arise when taking the trace over the gravitational environment and lead to physical effects like dissipation or decoherence of the matter field induced by gravity. Finally, we briefly discuss possible applications of the model's master equation.

Pietropaolo Frisoni #78

Abstract submission

Title: Recent advances in numerical loop quantum gravity

Short abstract: The application of numerical techniques in covariant LQG may able to provide answers to many of the current open questions in theory. In this talk, I first present one of the main formalisms currently used to implement numerical computations in this framework. Then I illustrate recent applications of numerical techniques concerning the study of infrared divergences, with references to work in progress on primordial fluctuations of the early universe and black hole lifetime.

Iñaki Garay #44

Abstract submission

Title: Classical dynamics for a simple model in Loop Quantum Gravity

Short abstract: The spinorial techniques for Loop Quantum Gravity offer a new way to study the main open problems of the theory; in particular, the implementation of the dynamics. Moreover, this formalism provides a clear interpretation of spin networks in terms of discrete twisted geometries, with the quantum 3d space made of superpositions of polyhedra glued together by faces of equal area. Within this framework, we study the dynamics of a simple model based on a graph with 2 vertices linked by an arbitrary number of edges. The evolution of a symmetry reduced sector of the model (the homogeneous and isotropic sector) was studied in the past, where interesting cosmological insights were found. In this talk, we will use the spinorial formalism to study the classical evolution of this model in the general case, out of the homogeneous and isotropic sector, for arbitrary number of edges with random initial configurations. Remarkably, oscillatory and divergent regimes are found with a universal dependence on the coupling constants of the Hamiltonian and independent of the initial spinors or the number of edges. Furthermore, we explore the evolution of the associated polyhedra as well as their volumes and areas.

Steffen Gielen #45

Abstract submission

Title: Dirac quantisation and deparametrisation in group field theory

Short abstract: Group field theories (GFT) have traditionally been formulated in path integral language, where their Feynman expansion generates a sum over Feynman amplitudes, but recently a lot of attention has also focused on their canonical quantisation, in particular in models coupled to a massless scalar field that can serve as relational clock. Here we give an overview over different approaches to such a canonical formalism, which closely mimic different approaches in canonical LQG: namely, one can employ an algebraic Dirac-like approach based on abstract spin-network states on which dynamical equations are imposed afterwards, or one can alternatively deparametrise using the matter clock and directly work with physical states. In simple examples where the GFT "constraint" can be imposed exactly, the two approaches can be shown to be equivalent using a "frozen formalism". I will also comment on some implications for the resulting effective cosmology derived from GFT.

Florian Girelli #99

Abstract submission

Title: “When category theory enters your field, it is time to leave it”

Short abstract: This title was a graffiti in some bathroom of the old building of the Perimeter Institute. I will discuss how it is especially wrong in the context of quantum gravity. In particular I will discuss how categorifying can be seen as gauging and how higher gauge theory could be potentially useful to build more refined spinfoam models.

Christophe Goeller #87

Abstract submission

Title: Dynamical reference frames: gauge invariant observables, general covariance and locality

Short abstract: I will discuss a general formalism for the construction of dynamical reference frames in gravitational theory and I will show how they can be used to construct physical, i.e. gauge-invariant, observables. This formalism has the advantages of providing us with a physically meaningful (relational) definition of both general covariance and locality, on top of unifying the relational and dressed approaches to the construction of physical observables.

Vesselin Gueorguiev #31

Abstract submission

Title: Reparametrization Invariance and Some of the Key Properties of Physical Systems

Short abstract: We consider first-order homogeneous Lagrangians in the velocities. The relevant form of these Lagrangians is justified physically and geometrically. Such Lagrangian systems possess reparametrization invariance - as such, they exhibit the Hamiltonian constraint H≡0. The extended Hamiltonian formulation is generally covariant and applicable to reparametrization-invariant systems will be demonstrated. Within such quantization, Schrödinger’s equation and the principle of superposition of quantum states emerge naturally.

Rafael Guolo Dias #48

Abstract submission

Title: Diffeomorphism Covariant Dynamics in Quantum Kantowski-Sachs

Short abstract: We introduce a notion of residual diffeomorphism covariance in a quantum Kantowski-Sachs framework (KS) --- a canonical minisuperspace framework describing the interior of a black hole. We solve for the family of Hamiltonian constraint operators satisfying this covariance condition, as well as parity invariance, possession of a single length scale, preservation of the Bohr Hilbert space of loop quantum KS and the correct classical limit. We further explore imposing minimality of the number of terms, and compare the solution with other Hamiltonian constraints proposed for Loop Quantum KS in the literature.

Hal Haggard #37

Abstract submission

Title: Quantization of the Volume of a Grain of Space and Tunneling Between Euclidean and Lorentzian Tetrahedra

Short abstract: Quantization of the geometrical observables of spacetime is a key feature of quantum gravity. However, the area spectrum stands alone as having a complete analytic treatment. Even for the simplest, tetrahedral grain of space, research on other observables, like the volume, usually proceeds either completely numerically or via strong approximations. We present analytic expressions that relate perturbative and non-perturbative aspects of the quantization of the volume of a tetrahedron. These results are achieved through complexification of the underlying dynamical system and provide an accessible introduction to Picard-Fuchs equations and to new methods in non-perturbative quantization. In particular, this application provides a method for computing the tunneling between Euclidean and Lorentzian Tetrahedra beyond the lowest order in hbar.

Alexander Jercher #60

Abstract submission

Title: Causal Structure in the complete Barrett-Crane Model

Short abstract: Causal structure is a quintessential element of continuum spacetime physics that needs to be properly encoded in a theory of Lorentzian quantum gravity. Established spin foam and tensorial group field theory (TGFT) models mostly consider only a special class of discrete spacetime building blocks in the form of spacelike tetrahedra. The main objective of this article is to construct a full-fledged model for Lorentzian quantum geometry by completing the Barrett-Crane TGFT and spin foam model to include spacelike, lightlike and timelike tetrahedra. Following an explicit characterization of the amplitudes via methods of integral geometry, we analyze the model with respect to its time orientation properties and provide for the first time a more detailed comparison with causal dynamical triangulations (CDT). As a result, we obtain a TGFT and spin foam model that encodes the microscopic quantum seeds of bare causality and which is invariant under space, time and spacetime reversal symmetries. This paves the way to define timelike and null boundary states which is important to give a quantum geometric description of Anti-de Sitter space, cosmological and black hole horizons, as well physical propagation of inhomogeneities.

Michael Kobler #71

Abstract submission

Title: A decoherence model in polymerised open quantum mechanics

Short abstract: Open quantum systems pose an excellent testing ground for decoherence phenomena and the quantum-to-classical transition. The dynamical equation is often presented in terms of a master equation that dictates the effective behaviour of the system of interest under the influence of an environment. In the course of the derivation of said master equations, there are oftentimes a multitude of assumptions and/or approximations involved in order to achieve a tractable form of the dissipator. Starting from a minimal polymerised quantum mechanical model, we investigate in detail at which instances these assumptions hold, need to be dropped or modified and consequently arrive at a master equation for a polymerised open quantum system. This equation exhibits some features that are usually not found in Schrödinger-type master equations, which consequently alter the physical interpretation of the individual terms in the equation. Furthermore, we discuss some aspects of the limit of a vanishing fundamental length scale and how these results compare to the standard formalism.

Athanasios Kogios #40

Abstract submission

Title: On the continuum limit of spin foams: graviton dynamics and area metric induced corrections

Short abstract: The semi-classical limit of spin foams leads to the Area Regge action. It was long thought that this action leads to flatness and does, in particular, not allow for propagating gravitons. I will present the first systematic studies of the continuum limit of the Area Regge action, using different versions of regular hypercubic lattices. These studies have shown that the Area Regge action does in its continuum limit, lead to leading order to general relativity, and thus to propagating gravitons. The higher order corrections depend on the choice of triangulation for the hypercubic lattice. However, there seems to be a preferred choice, for which the Area Regge action is not singular. In this case the correction term approximates the square of the Weyl curvature tensor, and can be interpreted to arise from an area metric dynamics. We therefore conjecture that the continuum limit of spin foams is described by an area metric theory.

Maciej Kowalczyk

#101

Abstract submission

Title: Prescriptions and analytic control over quantum dynamics in loop quantum cosmology

Short abstract: Ambiguities of the so-called Thiemann regularization in Loop Quantum Cosmology lead to freedom in how to construct a particular quantization prescription, which in turn may significantly affect the mathematical structure of the quantum model and its dynamical predictions. Out of several prescriptions presented in the literature I will focus on one showing somewhat counterintuitive properties, often referred as mLQC-II. Its mathematical structure will be discussed in detail. It will be further used as an example for testing a variant of a semiclassical treatment that allows to analytically probe the dynamics of LQC systems with high order quantum corrections and with good control of the approximations for a wide variety of LQC/geometrodynamics models. This method will be in particular used to find (in the approximation of macroscopic universe) the quantum trajectory of the volume as analytic function of the internal clock and the so called central moments of the constants of motion.

Dimitrios Kranas #90

Abstract submission

Title: Quantum Aspects of Stimulated Hawking Radiation in an Optical Analog White-Black Hole Pair

Short abstract: Serious experimental investigations into analog gravity systems have been underway for more than a decade by creating causal horizons in different setups, including Bose-Einstein condensates, non-linear optical materials, or even flowing water. Stimulated and spontaneously generated Hawking radiation has recently been observed in several platforms, but measuring entanglement has proven to be elusive, due to its faint and fragile character. In this talk, I will discuss the main results of my work. We have shown that, by illuminating the horizon with appropriately chosen quantum states, one can amplify the production of entanglement in the Hawking process in a tunable manner. We apply our ideas to the concrete case of an analog white-black hole pair sharing an interior and produced within a non-linear optical material. These results open a novel and promising avenue for confirming the quantum origin of the Hawking effect in the lab.

Simon Langenscheidt #75

Abstract submission

Title: Boundary-to-boundary isometry in superposed random spin tensor networks

Short abstract: Building on work by Colafranceschi, Oriti, Chirco et al, we study a class of superpositions of spin network states in the form of PEPS. We ask when a region of the boundary is mapped isometrically onto its complement by computing the purity of the reduced boundary state. Using techniques from random tensor networks, we map this computation to a random Ising model on the spin network's graph and find a necessary and sufficient criterion for this type of 'transport' holography to hold on average. This crucially extends existing results to spin network states without fixed edge spins.

Jerzy Lewandowski #96

Abstract submission

Title: Equations of isolated horizons

Short abstract: One additional result of quantum gravity research is the purely classical quasilocal black hole theory associated with the hashtag "isolated horizons". Einstein's equations leave every isolated horizon with a set of local degres of friedom. However additional geometric assumptions impose equations that considerably restrict the isolated horizon degrees of friedom to the extend that the cosmic censorship, rigidity and no-hair theorem apply. Inthis talk the results on the horizon equation that is implied either by the Petrov type D in the case of non-extremal horizons or by the extremity itself will be reviewed. They are still relevant for the uniqueness theorems.

Hongguang Liu #89

Abstract submission

Title: Lefschetz thimbles, complex critical points and curved geometries in Lorentzian spinfoam model

Short abstract: I will present details on recent results of Lorentzian spinfoam model in integral formulation. I will in particular discuss the numerical methods on Lefschetz thimbles, as well as finding complex critical points and curved geometries which resolves the flatness problem.

Seth Major #36

Abstract submission

Title: On energy and statistical models for constantly accelerating observers in black hole spacetimes

Short abstract: The (quasi-local) energy observed by constantly accelerating observers in the exterior of black holes spacetimes is discussed. Expressed in terms of quantities measurable by the observers such as acceleration, cosmological constant, and area, the energy is introduced in Schwarzschild spacetime and extended to Schwarzschild-de Sitter (Kottler) spacetimes. Quasi-local thermodynamics for these observers is briefly explored. Using the quantization of area in loop quantum gravity, statistical models based on this energy are formulated.

Ilkka Mäkinen #94

Abstract submission

Title: Scalar curvature operator for loop quantum gravity on a cubical graph

Short abstract: We introduce a new operator representing the three-dimensional scalar curvature in loop quantum gravity. The classical starting point of our construction is to express the Ricci scalar directly as a function of the Ashtekar variables. The construction does not apply to the entire Hilbert space of loop quantum gravity; instead, the operator is defined on the Hilbert space of a fixed cubical graph. As such, the operator is relevant to approaches such as algebraic quantum gravity, quantum-reduced loop gravity and models of effective dynamics.

Luca Marchetti #65

Abstract submission

Title: Cosmological inhomogeneities and relational perturbations of quantum gravity condensates

Short abstract: I discuss the effective dynamics of small relational inhomogeneities of group field theory (GFT) condensates, obtained from the mean field hydrodynamic regime of the fundamental theory. At the same level of approximation, I define relational observables in terms of a physical frame composed of four (minimally coupled, massless) scalar fields. I then discuss the compatibility of the volume and matter dynamics in an appropriate (continuum) limit with the ones of scalar cosmological perturbations from general relativity, emphasizing what may be the next needed steps in order to achieve the ambitious goal of recovering cosmological perturbations from full quantum gravity.

Juan Margalef #26

Abstract submission

Title: On the on-shell equivalence of general relativity and Holst theory

Short abstract: In this talk, I will introduce a natural generalization of Holst's action both in metric and tetrad variables. I will then prove that they define the same space of solutions as Palatini which, in turn, can be put into correspondence with GR. I will also prove the equivalence of their symplectic structures and charges despite their cohomological inequivalence.

Pierre Martin-Dussaud #33

Abstract submission

Title: Causal structure in spin-foams

Short abstract: The metric field of general relativity is almost fully determined by its causal structure. Yet, in spin-foam models for quantum gravity, the role played by the causal structure is still largely unexplored. The goal of this paper is to clarify how causality is encoded in such models. The quest unveils the physical meaning of the orientation of the two-complex and its role as a dynamical variable. We propose a causal version of the EPRL spin-foam model and discuss the role of the causal structure in the reconstruction of a semiclassical spacetime geometry.

Vinicius Medeiros Gomes da Silveira #98

Abstract submission

Title: Holonomy observables for the Turaev–Viro model

Short abstract: The intriguing connection between quantum gravity with a cosmological constant and quantum groups is yet to be fully explained. This work attempts to tackle that question within the spinfoam approach (rather than the canonical approach employed in other investigations) by defining and computing holonomy observables for the Turaev–Viro model. To make this possible, the duality between the quantum groups SLq(2,C) and slq(2,C) when q is a root of unity is examined in detail. When q is of odd order, the process is relatively straightforward, but the case of even order raises technical questions.

Fabio M. Mele #84

Abstract submission

Title: Quantum frame relativity of subsystem correlations and (thermo)dynamics

Short abstract: The absence of external relata, as it is often the case for instance in Page-Wootters dynamics, gauge theories, and quantum gravity, requires us to describe physical phenomena relative to internal subsystems. The latter play the role of internal reference frames and, as any other system, are subject to quantum dynamical laws. In such a relational scenario, the (gauge-invariant) partitioning of the remaining DoFs into subsystems as well as their instantaneous and dynamical descriptions are contingent on the internal frame choices. In this talk, I will elaborate on such a relativity of quantum subsystems within the framework of the perspective-neutral approach to quantum reference frame (QRF) covariance. First, exploiting the fact that the physical Hilbert space does not admit any preferred tensor product structure (TPS), I'll show how subsystems relativity originates from the inequivalence of the physical TPSs induced by the relational observables associated with the local subalgebras in the different frame-perspectives, and provide the explicit TPS-change map. The latter allows to characterise subalgebras of QRF invariant local and non-local operators, and provide conditions under which the structure of interactions and correlations will or will not change. This in turn will play a key role for the dynamical description (closed/open evolution) and the thermodynamical description (heat and work exchanges) of subsystems to be QRF invariant or relative.

Lucía Menéndez-Pidal #70

Abstract submission

Title: Unitarity and clock dependence in quantum cosmology

Short abstract: The problem of time has been an ongoing question in quantum cosmology: the universe has no background time, only interacting dynamical degrees of freedom within it. The relational view is to use one degree of freedom as clock for the others. In this talk I will exemplify this by discussing a flat FLRW universe filled with a massless scalar field and a perfect fluid. My talk is based in two papers [arXiv:2005.05357] and [arXiv:2109.02660]. In these works we studied three different choices of dynamical clocks and showed that, if we require dynamics to be unitary, all three make drastically different predictions. We also showed that the issue of non equivalent dynamics is not only limited to relational quantisation, but also appears in other supposedly clock neutral frameworks as Dirac quantisation. I will present the construction of the theories, compare relational quantisation to Dirac quantisation and outline how unitarity plays a main rôle in the dynamics of each theory.

Lisa Mickel #76

Abstract submission

Title: Scalar perturbations in cosmological scenarios with a modified Friedmann equation

Short abstract: When applying quantum gravity theories to cosmology, one often obtains an effective Friedman equation that captures dominant quantum gravity corrections, such as the replacement of the Big Bang singularity by a bounce. We study what statements can be made for the evolution of cosmological perturbations from a modified Friedmann equation alone, using the separate universe framework. In particular, we focus on the curvature perturbation on uniform density hypersurfaces and the comoving curvature perturbation, which are commonly used to characterise scalar perturbations in cosmology. We ask whether general relativistic conservation laws of these quantities hold also for a modified Friedmann equation, and show that while they remain valid for LQC-like modifications, this is generally not the case. As an example for the latter we consider an effective Friedmann equation obtained from group field theory.

Jakub Mielczarek #73

Abstract submission

Title: Tying the loops on quantum simulators

Short abstract: Future, large-scale quantum simulations of gravitational degrees of freedom may provide a unique opportunity to study many-body phenomena in the Planck scale physics. In particular, such issues as the quantum phases of gravity, the semi-classical limit, and the gravitational entropy will be possible to examine. This talk will summarize our first results concerning the quantum simulations of loop quantum gravity. First, I will present a systematic method of constructing quantum circuits for arbitrary Ising spin networks (with two-dimensional intertwiner spaces). Outcomes of simulations of such networks with up to 10 nodes (both on emulators and superconducting quantum computers) and analyzing quantum entanglement properties will be presented. Second, solving the quantum Hamiltonian constraint (Wheeler-DeWitt equation) using the Variational Quantum Eigensolver algorithm will be discussed. As an exemplary application, extraction of the physical states for the de Sitter model in loop quantum cosmology will be shown.

Johannes Münch #80

Abstract submission

Title: The Physical Relevance of the Fiducial Cell in Loop Quantum Cosmology

Short abstract: A common way to avoid divergent integrals in homogeneous spatially non-compact gravitational systems, as e.g. cosmology, is to introduce a fiducial cell by cutting-off the spatial slice at a finite region Vo. This is usually considered as an auxiliary integral regulator to be removed after performing computations by sending it to infinity. This talk discusses the dependence of the classical and quantum theory of homogeneous, isotropic and spatially flat cosmology on this fiducial cell. It is argued that for each choice of the fiducial cell the theories are canonically independent. While classically the on-shell dynamics is not affected by this, the sitation in the quantum theory is more subtle as each Vo leads to a different quantum theory. It is discussed that the choice of the phyical volume of the fiducial cell directly influences quantum fluctuations and thus playing a physical role.

Elliot Nash #52

Abstract submission

Title: A chiral pure connection approach to quantum cosmology

Short abstract: By making use of the duality of 2-forms in 4D and a similar notion of duality on the complexified Lorentz Lie algebra, J.Plebanski was able to write down GR as a constrained BF theory. Recently, K.Krasnov (Nottingham) and collaborators discovered a reduction of Plebanski's theory to a theory of SO(3,C) connections in 4D with equivalent classical dynamics. I will discuss some of my research using theories of this kind to examine homogeneous models with certain global symmetries, specifically FLRW and Bianchi I, IX type space-times.These are theories of complex variables and need to be treated with reality conditions in order to select classical solutions which resemble real Lorentzian gravity. Applying these reality conditions is very difficult in the general case. For example, the case of Bianchi IX is already quite non-trivial. Another point of interest, we find that the pure connection action in the vacuum FLRW case (with cosmological constant) is a pure boundary term. I propose an approach for computing a covariant path integral for a theory of this kind using certain boundary conditions. The result is a closed form for a 2-point function between connection states. This begs comparison to similar 2-point functions in the metric language which often require a saddle-point approximation.

Rita Neves #93

Abstract submission

Title: States of Low Energy and Alleviation of Anomalies in Loop Quantum Cosmology

Short abstract: It has been shown that Loop Quantum Cosmology (LQC) has the potential to alleviate anomalies related to large scale power suppression and the lensing amplitude present in observations of the CMB. As a consequence of the pre-inflationary dynamics, some modes reach the onset of inflation in an excited state with respect to the Bunch-Davies vacuum, resulting in a scale dependence of the primordial power spectrum for large scales. However, the choice of vacuum state in the pre-inflationary regime and free parameters of the theory impact the concrete predictions. In this work we investigate the consequences of choosing States of Low Energy as the vacuum of cosmological perturbations. We perform an MCMC analysis of the hybrid LQC model, contrasting with observations from the CMB, so that we can obtain constraints on free parameters and find whether the alleviation of some anomalies is prevalent.

Gloria Odak #66

Abstract submission

Title: Brown-York charges with mixed boundary conditions

Short abstract: We compute the Hamiltonian surface charges of gravity for a family of conservative boundary conditions, that include Dirichlet, Neumann, and York's mixed boundary conditions defined by holding fixed the conformal induced metric and the trace of the extrinsic curvature. We show that for all boundary conditions considered, canonical methods give the same answer as covariant phase space methods improved by a boundary Lagrangian, a prescription recently developed in the literature and thus supported by our results. The procedure also suggests a new integrable charge for the Einstein-Hilbert Lagrangian, different from the Komar charge for non-Killing and non-tangential diffeomorphisms. We study how the energy depends on the choice of boundary conditions, showing that both the quasi-local and the asymptotic expressions are affected. The procedure also suggests a new integrable charge for the Einstein-Hilbert Lagrangian, different from the Komar charge for non-Killing and non-tangential diffeomorphisms.

José Padua-Argüelles #41

Abstract submission

Title: Challenges for Lorentzian path integrals in quantum gravity/cosmology

Short abstract: Many results indicate that quantum gravity path integrals should be taken over Lorentzian geometries and not e.g. Euclidean. Inspired by this, we will discuss general features that Lorentzian path integrals face in quantum gravity, such as which geometries can contribute to the sum (domain), and how to deal with oscillatory integrals (convergence); and propose resolutions to some of these. We will exemplify the way these features show up in mini-superspace quantum cosmology, (effective) spin-foams; and more generally Regge calculus-inspired lattice approaches.

Qiaoyin Pan #32

Abstract submission

Title: q-deformed LQG with a cosmological constant

Short abstract: In this talk, I will present a recent work on the q-deformed loop quantum gravity (LQG) model, which describes 3-dimensional quantum gravity with a cosmological constant. The classical phase space is described by the Heisenberg double, whose quantization naturally leads to the emergence of quantum groups. I will discuss how the spinorial approach is generalized to such a deformed case and allow to construct a complete set of observables. I will show in particular how the notion of parallel transport can be encoded in terms of a quantum R-matrix.

Xiankai Pang #64

Abstract submission

Title: Late time cosmological acceleration from group field theory

Short abstract: In this talk, we will analyse the emergent cosmological accelerating expansion from the group field theory formalism, a candidate theory of quantum gravity. Using mean-field approximation, the cosmological evolution can be extracted from the condensate states, in the form of modified FLRW equations. By introducing an effective equation of state w, we can reveal the relevant features of the evolution, and show that with the proper choice of parameters, w will approach -1, leading to an accelerating phase dominated by the cosmological constant effectively.

Tomasz Pawłowski

#102

Abstract submission

Title: Semiclassical states, high order quantum corrections and cosmology

Short abstract: Determining the dynamics of quantum systems beyond simplest 'textbook' ones on the genuine quantum level is usually very computationally expansive to the level of impractical. In cases, when the point of focus is the evolution of the semiclassical states, an alternative approach based on the so called Hamburger decomposition can be taken. There, one encodes the information about the state in the countable set of (expectation values of the) observables -- the moments, which essentially are the polynomial decomposition coefficients of the Wigner quasi-probability distribution. The set of the equations of motion for these moments is equivalent to a genuine quantum evolution, however a convenient cutoff (on the order of the moments) can be introduced, leaving just a couple of most relevant degrees of freedom. The accuracy of the resulting effective dynamics depends on the order of cutoff and the properties of particular system. In this presentation I will discuss the techniques dedicated to constructing and applying such formalism to cosmological models, considering in particular the intricacies following from polymer representation and the applications to inhomogeneous models. Further, I will discuss an example of a simple geometrodynamical quantum cosmological models, focussing in particular on the issue of accuracy of the description and effect of high order quantum corrections on Universe dynamics. I will present the case, where the high order effects significantly change the conclusions drawn from models including just the 2nd order moments (variances), in many situations significant corrections may actually compensate the effects of variances making the evolution more classical.

Javier Peraza #55

Abstract submission

Title: Phase space extensions at Null infinity for Gravity and Gauge theories.

Short abstract: In this talk we will describe extensions of phase spaces at null infinity for gravity and gauge theories, such that the charges are consistent with tree-level soft (graviton, gluon or photon) theorems. We will show that the action of the Diff(S^2)-generalized BMS in gravity at null infinity can be defined by constructing a covariant derivative in non-Bondi frames, presenting an extended phase space where Diff(S^2) acts canonically. A similar approach can be done in Yang Mills, by extending the phase space with a "Goldstone mode" that transforms inhomogeneously under linearized O(r) symmetries. In the Abelian case, we show that the phase space can be extended to allow well-defined charges associated to O(r^n) symmetries for any n.

Alejandro Perez #54

Abstract submission

Title: Seeds for cosmic structure from Planckian discreteness

Short abstract: I will present a model proposing a paradigm shift where inhomogeneities in the CMB are relics of the fundamental discreteness in the sense that they are actively produced by a quantum gravity mechanism instead of emerging from quantum fluctuations of the homogeneous vacuum state of the inflation. The model generates a (approximately) scale invariant spectrum of (adiabatic) primordial perturbations with the correct amplitudes and red tilt without an inflaton. In the construction we assume the validity of the standard model up to close to the Planck scale. The process admits a semiclassical interpretation and avoids the trans-Planckian problem of standard inflationary scenarios based on the role of vacuum fluctuations. The deviations from scale invariance observed in the CMB are controlled by the self coupling constant of the Higgs scalar. The thermal production of primordial black holes can produce the amount of cold dark matter required by observations. For natural initial conditions set at the Planck scale the amplitude and tilt of the power spectrum produced by the model fit the observations at the CMB and predict subleading corrections to the violation of scale invariance possibly measurable in the future.

Andreas Pithis #92

Abstract submission

Title: Towards the phase structure of the complete Lorentzian Barrett-Crane model

Short abstract: In the tensorial group field theory approach to quantum gravity, the basic quanta of the theory correspond to discrete building blocks of geometry. It is conjectured that their collective dynamics gives rise to continuum spacetime at criticality via phase transition. In this work we demonstrate for the first time how phase transitions for more realistic TGFT models can be realized using Landau-Ginzburg mean-field theory. More precisely, we consider models of rank-4 where the non-local group degrees of freedom live on the Lorentz group and are subject to gauge and simplicity constraints such that their Feynman diagrams are dual to triangulations of Lorentzian manifolds solely formed by spacelike tetrahedra. To render the models even more compelling, we include local degrees of freedom which may be interpreted as discretized scalar fields typically employed in quantum gravity to furnish a matter reference frame. This work represents a crucial advance to understand how phase transitions to continuum spacetime can be achieved in even more compelling TGFT models for quantum gravity and paves the way for the analysis of their phase structure via functional renormalization group techniques in the future.

Antoine Rignon-Bret #74

Abstract submission

Title: Analogy to second law of thermodynamics from the Noether current associated to the symmetries of open systems

Short abstract: There has recently been new developments in the theory of surface charges with the inclusion of anomalies, which are terms not transforming covariantly because of the presence of background structures. I will show that this construction allows a unified description of Noether's theorem for both global and local symmetries. From the conservation law associated to some of these symmetries, I will discuss generalizations of Wald's Noether entropy formula and generalizations of the second law of thermodynamics based on the null energy conditions.

Hanno Sahlmann #86

Abstract submission

Title: Fun with fermions

Short abstract: I will briefly review the quantization of Fermions coupled to loop quantum gravity. I will then comment on some specific aspects, in particular on statistics and the diffeomorphism constraint, spin and spin addition, and the entanglement of fermions with the gravitational fields and with each other.

Francesco Sartini

#108

Abstract submission

Title: Hidden symmetries in black holes

Short abstract: The black hole minisuperspace can be described by a homogeneous line element, for which the Einstein–Hilbert action reduces to a one-dimensional mechanical model. We have shown that this model exhibits a symmetry under the (2+1)-dimensional Poincaré group. The existence of this symmetry unravels new aspects of symmetry for black holes and opens the way toward a rigorous group quantization of the interior, which in turn provides a powerful tool to discriminate between different regularization schemes. Remarkably, the physical ISO(2,1) symmetry can be seen as a broken infinite-dimensional symmetry. This is done by reinterpreting the action for the model as a geometric action for the BMS3 group, where the configuration space variables are elements of the algebra bms3 and the equations of motion transform as coadjoint vectors.

Michele Schiavina #82

Abstract submission

Title: "Algebroid" structures for constraint sets and the B(F)V formalism: disambiguation for general relativity

Short abstract: Lately, the language of Lie algebroids - generalising the concept of Lie algebra actions - has gained traction and provided some insight into the subtleties of the (canonical) structure general relativity. The devil is in the details though, and while one can indeed construct a Lie algebroid for Einstein--Hilbert theory on the space of paths of Riemannian metrics on a (spacelike) surface (after Blohmann, Fernandes and Weinstein), restriction to initial value data fails to preserve the Lie algebroid structure off shell. What one gets satisfies instead the axioms of a more general "L_\infty algebroid", which is the natural object one generically obtains when cohomologically treating coisotropic sumbanifolds (e.g. constraint sets), and can be thought of a Lie algebroid "up to homotopy". In this talk I will present the L_\infty algebroid structure for general relativity, compare it to the hypersurface deformation algebroid, and how all this naturally fits within a general approach to constraint sets for Lagrangian field theories. The structural disambiguation I will present may have consequences for (quantum) deformations of the hypersurface deformation algebra discussed within LQG. Based on joint work with A.S. Cattaneo, and with C. Blohmann and A. Weinstein.

Gabriel Schmid #46

Abstract submission

Title: Transition Amplitudes and Holography in the Coloured Boulatov-Ooguri Model

Short abstract: We consider transition amplitudes in the coloured simplicial Boulatov model. The starting point of this discussion is the construction of suitable boundary observables from spin-network states living on the dual 1-skeleton of some fixed boundary topology. The transition amplitudes defined using these observables are then given by a sum over all possible bulk topologies with our fixed boundary, each weighted by their corresponding Ponzano-Regge spin foam amplitude. Afterwards, we discuss the transition amplitudes for two explicit choices of boundary topologies, namely the 2-sphere and 2-torus, and show that they factorize into a sum entirely given by the combinatorics of the boundary spin-network state. This can be seen as the first step towards a more detailed study of quasi-local holographic dualities in the context of coloured Boulatov-Ooguri type GFT models.

Robert Seeger #81

Abstract submission

Title: Revisiting loop quantum gravity with selfdual variables

Short abstract: We review quantisation of gravity as an SL(2,C) gauge theory in terms of Ashtekar's selfdual variables and reality conditions for the spatial metric (RCI) and its evolution (RCII), and we add some new observations and results. The selfdual part of the complexified Palatini action in Ashtekar variables requires a holomorphic phase space description in order to obtain a non-degenerate symplectic structure. This does not allow to implement the reality conditions as additional constraints, so they have to be added by hand during the quantisation. We observe that the reality conditions allow two types of embeddings of real gravity into the selfdual theory, both compatible with the real ADM formalism. We explore the extension of the holomorphic character to the quantum theory by working with SL(2,C) holonomies, holomorphic derivatives, and a notion of holomorphic spin networks. This seems to be a natural choice, as anticipated by Ashtekar and others in early works on the selfdual theory. We discuss the implementation of RCI and RCII as adjointness relations via the choice of an appropriate measure. This leads to a new class of cylindrically consistent measures that implement RCI. In a model of the holomorphic quantum theory in which SL(2,C) is replaced by the complexification of U(1), we demonstrate the implementation of both reality conditions and show a connection to cosmology.

Jose Diogo Simao #57

Abstract submission

Title: Towards a hybrid algorithm for spin-foam amplitudes

Short abstract: This talk reports on a recent proposal that aims to improve computational viability in spin-foam models by making use of both the full amplitude at the quantum regime and its asymptotic expansion at semiclassical scales - an hybrid algorithm. As as a first step towards the proposal, I will show how the spin-foam amplitude associated to a general triangulation can be modeled on the amplitude of a single simplex, to be glued to every other one through what we define to be "gluing constraints" - analogous objects to their namesakes in the context of effective spin-foams. The asymptotic behavior of the full amplitude would then in principle be obtained by considering the asymtpotics of both the individual vertices and the gluing constraints, thus disentangling the complicated critical configurations of the full complex. Finally, since there has been strong numerical evidence for almost-critical configurations that still contribute substantially to the amplitude, I will show that an asymptotic approximation of the gluing constraints can be obtained arbitrarily away from the critical points, matching the full constraints remarkably well (a result which we hope can be generalized to the vertex amplitude itself).

Farshid Soltani #62

Abstract submission

Title: Black to White Hole Transition

Short abstract: Black holes formation and evolution have been extensively studied at the classical level. However, little is known about the end of their lives and about the true nature of the spacetime singularity in their interior, the description of which requires to consider the quantum nature of the gravitational field. Recent theoretical evidence suggests a scenario in which the black hole horizon undergoes a quantum transition into a white hole horizon and the classical singularity is replaced by a smooth transition of the interior trapped region into an anti-trapped region. After an overview of this scenario I study the quantum transition of the horizon using the EPRL-KKL spin foam model, explicitly computing the resulting transition amplitude.

Simone Speziale #29

Abstract submission

Title: Simplicity without simplicity constraints

Short abstract: The EPRL is based on the use of minimal weights for the unitary irreps of the Lorentz group. I will show how the notion of simple bivectors emerges in the semiclassical limit even for arbitrary weights. The results are relevant to the understanding of the booster functions.

Sebastian Steinhaus #59

Abstract submission

Title: Towards "matter matters" in spin foam quantum gravity

Short abstract: Any approach to pure quantum gravity must eventually face the question of coupling quantum matter to the theory. In this talk, I present a model, in which I couple massive, free scalar lattice field theory to a simplified 4D spin foam model, called quantum cuboids, which can be understood as a superposition of flat irregular lattices. To this end, I briefly introduce spin foam models, generalize scalar lattice field theory to irregular discretizations via discrete exterior calculus and explain the idea of how to couple both theories. I explore the coupled system using Monte Carlo techniques and present results for geometrical and matter observables. In particular, there exists an extended regime in parameter space of the model, where the spin foam is sharply peaked around a regular lattice. This lattice spacing is a function e.g. of the mass of the scalar field. Furthermore, I measure the 2-point correlation function of the scalar field and its correlation length, which matches well the 2-point correlation function of a scalar field of the same mass defined on the average spin foam. Thus, effectively the coupled system can be described as a scalar lattice field theory defined on regular lattice.

Deepak Vaid #24

Abstract submission

Title: Coherent States and Particle Scattering in Loop Quantum Gravity

Short abstract: Quantum field theory provides us with the means to calculate scattering amplitudes. In recent years a dramatic new development has lead to great simplification of such calculations. This is based on the discovery of the“amplituhedron” in the context of scattering of massless gauge bosons in Yang-Mills theory. One of the main challenges facing Loop Quantum Gravity is the lack of a clear description of particle scattering processes and a connection to flat space QFT. Here we show a correspondence between the space of kinematic data of the scattering N massless particles and U(N) coherent states in LQG. We provide (qualitative) evidence for this correspondence by invoking the Complexity=Action/Momentum conjecture. This correspondence allows us to provide the outlines of a theory of quantum gravity based upon the dynamics of excitations living on the the positive Grassmannian.

Francesca Vidotto

#104

Abstract submission

Title: Computing the primordial quantum fluctuations with the full covariant theory

Short abstract: One of the major challenges of a quantum theory of gravity is to be able to predict the amplitude of the fluctuations of the primordial quantum geometry, that provides a seed for the formation of structures in the late universe. I discuss a proposal to concretely compute such fluctuations in Loop Quantum Gravity using the spinfoam formalism. The spinfoam transition amplitudes provide a natural notion of state as a superposition of Lorentzian geometries, compatible with a given spatial boundary. It is possible to compute correlations between spatially separated regions and the corresponding entanglement entropy, with the advantage of doing so for a state defined by the dynamics of the full theory. The computation of observable quantities relies on the recent development of numerical techniques to compute the transition amplitudes. The results obtained so far open new interesting questions regarding the properties of the vacuum state and the relation with the inflationary framework in cosmology.

Sami Viollet #79

Abstract submission

Title: Ambiguities in polymer quantum black hole

Short abstract: It is known that by applying techniques inspired by Loop Quantum Cosmology to static black holes, the singularity is replaced by a black to white hole transition. The technique, known as the polymerization procedure, corresponds to modifying the dynamics at an effective level. This amounts to replacing certain phase space variables with periodic functions of these variables. Until now, the most often used polymerization functions have been the sinus functions. While this is a well justified construction, we explored the influence on the dynamics of other choices. We were able to show that the metric solution of the dynamics can be explictly obtained for arbitrary polymerization functions, and we studied its generic features. There is always at least one black to white hole transition. The number of such transiions, as well as the number of horizons, can be easily determined. We conclude discussing some physical arguments to constrain the choice of these polymerization functions.

Marko Vojinovic #72

Abstract submission

Title: Coupling matter to spinfoam models using higher gauge theory

Short abstract: Higher category theory can be employed to generalize the BF action to the so-called nBF action, by passing from the notion of a gauge group to the notion of a gauge n-group. The novel algebraic structures called n-groups are designed to generalize notions of connection, parallel transport and holonomy from curves to manifolds of dimension higher than one. Thus they generalize the concept of gauge symmetry, giving rise to a class of topological actions called nBF actions. Similarly as for the Plebanski action, one can add appropriate simplicity constraints to topological nBF actions, in order to describe the correct dynamics of Yang-Mills, Klein-Gordon, Dirac, Weyl and Majorana fields coupled to Einstein-Cartan gravity. Specifically, one can rewrite the whole Standard Model coupled to gravity as a constrained 3BF or 4BF action. The split of the full action into a topological sector and simplicity constraints sector is adapted to the spinfoam quantization technique, with the aim to construct a full model of quantum gravity with matter. In addition, the properties of the gauge n-group structures open up a possibility of a nontrivial unification of all fields. An n-group naturally contains additional novel gauge groups which specify the spectrum of matter fields present in the theory, just like the ordinary gauge group specifies the spectrum of gauge bosons in the Yang-Mills theory. The presence and the properties of these new gauge groups has the potential to explain fermion families, and other structure in the matter spectrum of the theory. Based on [1,2,3,4,5,6].

Anzhong Wang #23

Abstract submission

Title: Analytical Studies of Power Spectra and Non-Gaussianity of Loop Quantum Cosmological perturbations

Short abstract: In the past couple of years, we have developed the uniform asymptotic approximation method to calculate analytically the mode function of cosmological perturbations after quantum gravitational effects are taken into account. To the third-order of the approximations, the upper bound of errors is no larger than 0.15%, which is accurate enough for the current and forthcoming CMB observations. With such obtained analytical mode functions, we further study the power spectra of scalar and tensor perturbations, as well as the corresponding non-Gaussianities in different approaches, such as the dressed metric, hybrid and deformed algebra. Combining them with numerical analyses, such analytical investigations will provide valuable insight and understanding of loop quantum cosmology. In particular, they will provide a systematic exploration of the roles played by the initial conditions, inhomogeneities and anisotropies before and near the quantum bounce. In this talk, I would like to summarize such studies that we carry out so far and outline our future directions.

Jinzhao Wang #27

Abstract submission

Title: Demystifying the replica trick calculation of the entropy of Hawking radiation

Short abstract: The Page curve describing the radiation entropy of a unitarily evaporating black hole has recently been obtained by new calculations based on the replica trick. We analyse the discrepancy between these and Hawking's original conclusions from a quantum information theory viewpoint, using in particular the quantum de Finetti theorem. The theorem implies the existence of extra information, W, which is neither part of the black hole nor the radiation, but plays the role of a reference. The entropy obtained via the replica trick can then be identified to be the entropy S(R|W) of the radiation conditioned on the reference W, whereas Hawking's original result corresponds to the non-conditional entropy S(R). The entropy S(R|W), which mathematically is an ensemble average, gains an operational meaning in an experiment with N independently prepared black holes: for large N, it equals the regularized entropy of their joint radiation, S(R_1…R_N)/N. The discrepancy between this entropy and S(R) implies that the black holes are correlated, that is geometrically captured by the replica wormholes. In total, I will give three different interpretations of the radiation entropy calculated via the replica trick, that are distinguishes from Hawking’s S(R). (Based on the joint work (https://arxiv.org/abs/2110.14653) with Renato Renner.)

Yili Wang #43

Abstract submission

Title: Spherically-symmetric geometries in a matter reference frame as quantum gravity condensates

Short abstract: Candidate microstates of a spherically symmetric geometry are constructed in the group field theory formalism for quantum gravity, for models including both quantum geometric and scalar matter degrees of freedom. The latter are used as a material reference frame to define the spacetime localization of the various elements of quantum geometry. By computing quantum geometric observables, we then match the quantum states with a spherically symmetric classical geometry, written in a suitable matter reference frame.

Stefan Weigl #49

Abstract submission

Title: On consistent gauge-fixing conditions in polymerized gravi- tational systems

Short abstract: Gauge fixing is a standard method for deriving the physical sector of a gauge theory. In the context of symmetry reduced models of loop quantum gravity a polymerisation has been applied to gauge fixed models to obtain so called effective theories that mimic the underlying quantum theory to some extend. Motivated from the question whether gauge fixing and polymerization commute, in this talk we will discuss the subtleties of implementing dynamical consistent gauge fixings in the effective theory and present a procedure to determine in a given model the effective lapse and shift. Although we can proof for a range of models that gauge fixing and polymerization does indeed commute and discuss consequences, for most models in the literature this is not the case. We further discuss how for a given choice of effective lapse and/or shift one can obtain a corresponding gauge fixing condition and show that in general this requires non-standard polymerisations or gauge fixing conditions with different classical limits. Based on these results we will then conclude with a discussion of some models from the literature.

Wolfgang Wieland

#109

Abstract submission

Title: Metriplectic geometry for local gravitational subsystems

Short abstract: A self-gravitating system, confined by its own gravity to a bounded region, radiates some of the charges away into the environment. On the covariant phase space, the existence of dissipation implies that some diffeomorphisms are not Hamiltonian. There is no Hamiltonian on phase space that would move the region relative to the fields. Recently, an extension of the covariant phase space has been introduced by Leigh and Ciambelli and Freidel to resolve the issue. On the extended phase space, the Komar charges are Hamiltonian generators of dressed diffeomorphisms. In my talk, I will provide an overview of the construction before developing a geometric approach that takes into account dissipation in a novel way. The approach is based on metriplectic geometry, a framework used in the description of dissipative systems. Instead of the Poisson bracket, we introduce a Leibniz bracket -- which is the sum of a skew-symmetric and a symmetric bracket. The symmetric term accounts for the loss of charge due to radiation. On the metriplectic space, the charges are Hamiltonian, yet they are not conserved under their own flow. The talk is based on recent results with Viktoria Kabel [arXiv:2206.00029].

Edward Wilson-Ewing #50

Abstract submission

Title: Shock waves from quantum black holes

Short abstract: I will present some results from the study of the quantum gravitational collapse of spherically symmetric pressureless dust. Using an effective equation derived from a loop quantization, for a variety of initial dust configurations: (i) trapped surfaces form and disappear as an initially collapsing density profile evolves into an outgoing shockwave; (ii) black hole lifetime is proportional to the square of its mass; and (iii) there is no mass inflation at inner apparent horizons.

Yuki Yokokura #53

Abstract submission

Title: Black Hole as a Bound State of Semi-classical Degrees of Freedom

Short abstract: In this talk, a black hole is considered as a gravitational bound state consisting of semi-classical degrees of freedom. For a simple configuration, the interior is found to be a continuous stack of AdS_2 times S^2 with AdS radius close to Planck length and behaves like a thermal state. Evaluating the entropy density and integrating it over the volume reproduces the area law exactly.