QG^2-2008 Abstracts

Emanuele Alesci

GRAVITON PROPAGATOR: Difficulties with the BC vertex and perspective with the new models

We briefly review the construction of the graviton propagator in the context of LQG and we show how the Barrett-Crane vertex fails to give the correct long-distance limit. The same kind of calculation however, can give the correct propagator using an alternative vertex with a specific asymptotic behavior. It is still an open issue if the vertex amplitudes of the new models satisfy the requirements for yielding the correct two point function or more in general GR in the classical limit. We present three lines of research (analytical, numerical and one connected with the construction of the physical projector) with some preliminary results that can give new insight to this problem.

Sergey Alexandrov

Covariant LQG and spin foam quantization

After a brief review of a covariant approach to loop quantum gravity and of important notion of projected spin networks, I revise the spin foam quantization procedure of 4-dimensional general relativity.

In particular, I discuss how the simplicity and the closure constraints should be implemented and demonstrate the precise agreement between the canonical and the path integral quantizations at the kinematical level.

Michele Arzano

Non-locality, quantum symmetries and kappa-quantum fields

We start by reviewing a general argument showing how non-local effects in quantum field theory can lead to a description of space-time symmetries in terms of quantum algebras rather than ordinary Lie algebras.

We then focus on a particular example of such quantum algebras, the kappa-Poincare' Hopf algebra, discuss its relation to noncommutative spacetime and present the salient properties of classical fields enjoying these symmetries. A novel approach to the canonical quantization of a linear scalar field with such Hopf algebra symmetries will be then outlined and we will show how kappa-quantum fields exhibit a natural mode cutoff at the Planck scale and a deformed energy-momentum dispersion relation. Finally we will discuss work in progress in the understanding the rich structure emerging in the multiparticle sector of the theory, in particular the "momentum dependent" statistics of kappa-bosons and the emergence of entanglement for the free field modes.

Paolo Aschieri

Symmetries and dynamics of noncommutative spaces

We study a wide class of noncommutative manifolds and their quantum Lie algebra of infinitesimal diffeomeorphisms. In this way, symmetries principles can be implemented. We consider the example of general covariance in noncommutative spacetime that leads to a noncommutative gravity theory. The issue of Noether theorem for noncommutative field theories is addressed and answered by introducing a dynamical star-product.

Benjamin Bahr

On the quantization of connection theories with categories

The way one quantizes the kinematical structure of Loop Quantum Gravity is deeply connected to category theory. Fundamental is the notion of the path groupoid, i.e. the collection of all paths in a manifold. In this language e.g. connections, gauge transformations and diffeomorphisms arise as functors, natural transformations and (path groupoid) automorphisms.

In this talk it will be shown how similar constructions can be carried out for any sufficiently well-behaved groupoid, and that the choice of groupoid, which only contains combinatorial information about paths, already determines analytical properties such as a topology and a measure (the analogue of the Ashtekar-Isham-Lewandowski measure) on quantum configuration space. Both are automatically invariant under the action of gauge transformations and groupoid automorphisms (which play the role of "diffeomorphisms" in this context). The uniqueness of measure and topology will be discussed.

Examples for these structures are, besides LQG, also lattice gauge theory and Chern-Simons theory.

Fernando Barbero

Loops, black holes, and number theory

I will discuss a new efficient method, which combines number theoretic and combinatorial ideas, to exactly compute black hole entropy in the framework of Loop Quantum Gravity. The main steps are the complete characterization of the relevant sector of the spectrum of the area operator -including degeneracies- and a procedure to find the number of solutions to the projection constraint for spherical black holes. I will illustrate the power of the method by showing the results of a computer implementation of the proposed algorithm that confirms and extends previous results on the detailed structure of the black hole degeneracy spectrum.

Glenn Barnich

Central extensions in flat spacetimes-Duality and thermodynamics of black hole dyons

Two loosely connected results involving some of the more subtle aspects of symmetries in gauge theories are presented. The first concerns the question of classical central charges in gravitational theories. I will show the existence of a new central extension in 3-D flat spacetime at null infinity. The other topic is black holes which carry both electric and magnetic charge and how to discuss their thermodynamics. I will discuss an extended double potential formalism that makes electric- magnetic black hole duality manifest and allows one to discuss the thermodynamics in the grand canonical ensemble.

Paulo Bertozzini

Modular spectral geometry for algebraic quantum gravity

We propose a reconstruction of non-commutative spectral geometries (formally similar to A.Connes' spectral triples), via Tomita-Takesaki modular theory, from suitable states on (categories of) operator algebras and we conjecture their possible role in an algebraic theory of quantum gravity.

Further details on the topic presented are contained in the final part of the survey paper: http://arxiv.org/abs/0801.2826. The research is an ongoing project in collaboration with Dr. Roberto Conti (University of Newcastle - Australia) and Prof. Wicharn Lewkeeratiyutkul (Chulalongkorn University - Bangkok).

Eugenio Bianchi

The length operator in Loop Quantum Gravity

In this talk I discuss the dual picture provided by the quantum geometry of a spin network state. From this perspective, I introduce a new operator in Loop Quantum Gravity - the length operator. I will describe its geometrical meaning and derive some of its properties. In particular, I will show that it is diagonalized by appropriate superpositions over intertwiners of spin network states and that it has a discrete spectrum. A series of eigenstates and eigenvalues is presented and an explicit check of its semiclassical properties is discussed. Ideas from simplicial geometry will play a key role in the analysis.

Martin Bojowald

Mixed and squeezed states in applications of loop quantum gravity

Applications of quantum gravity require a notion of semiclassical states to specify regimes of interest. Concrete examples include the graviton propagator from spin foams and cosmological scenarios in loop quantum cosmology. Often, such states are taken to be of the well-known pure Gaussian form which allows one to peak a state sharply on classical values of basic variables. When long evolution times or wide spatial extensions are involved, however, relevant states typically deviate from this form which can have important implications. This is discussed by way of the mentioned examples, with conclusions for the semiclassical limit of loop quantum gravity.

Yuri Bonder

Quantum Gravity Phenomenology without Lorentz Invariance Violation

We describe a scheme for the exploration of quantum gravity phenomenology focussing on effects that could be thought as arising from a fundamental granularity of space-time. In contrast with the simplest assumptions, such granularity is assumed to respect Lorentz Invariance but is otherwise left unspecified. The proposal is fully observer covariant, it involves non-trivial couplings of curvature to matter fields and leads to a well defined phenomenology. We present the effective Hamiltonian which could be used to analyze concrete experimental situations, and a particular experiment is described.

Andrzej Borowiec

Quantizations of D=4 Lorentz algebra

Quantum deformations of Lie algebras are classified by means of the corresponding Poisson structures and classical r- matrices. Drinfeld’s twist method gives an effective technique for performing such deformations by moving them to co-algebraic sector. The Lorentz and Poincare algebras play a central role in relativistic Physics of fundamental interactions. Their classical r-matrices have been classified, some time ago, by S. Zakrzewski. Our aim is to provide a detailed an explicit description of all quantizations of the Lorentz algebra. Some extensions to the Poincare and super-Poincare algebras will be also mentioned.

The talk is based on joint papers with J. Lukierski and V.N. Tolstoy.

Guillermo Chac�n Acosta

Polymer quantum mechanics and thermodynamics of simple systems

We study the thermodynamics of two models, a crystal made up of harmonic oscillators and an ideal gas of particles in a box, both treated within the polymeric, as opposed to Schr�dinger, quantization. Modifications to quantities like internal energy or entropy are obtained which depend on the minimal scale parameter of polymer quantum mechanics. These toy models elucidate the role such non standard quantization may play in a statistical description of many body systems.

Florian Conrady

Semiclassical analysis of spin foam models of 4d gravity

We show that the Riemannian spin foam models by Freidel and Krasnov (FK) and Engle, Pereira and Rovelli (EPR) are equivalent to path integrals and give an explicit formula for the associated actions. We also determine suitable boundary terms, so that the path integrals preserve compositions of cobordisms. For general Immirzi parameter, the boundary states are given by Alexandrov's and Livine's projected states for SU(2)xSU(2). We use this path integral representation to derive classical equations for the spin foam models. With the help of an ansatz, the equations for the connection can be solved exactly: in analogy to continuum first-order gravity, the solutions are given by a co-tetrad on the simplicial complex and by a Levi--Civita connection that is uniquely fixed by the co-tetrad. When evaluated on these solutions, the action of the FK model is equal to the Regge action.

(collaboration with Laurent Freidel)

Rachel Dawe Martins

C^*- categories and finite spectral triples

The noncommutative standard model includes an analogue of general relativity for "internal space''. To make it quantum, one first step might be to categorify the notion of spectral triple. We consider a categorified (double) Fell bundle over a discrete (double) groupoid, which is a type of C^*- category. We construct from this a finite spectral triple, checking the axioms. The Dirac operator becomes a morphism, (for which the motivation comes from the inverse of the Dirac operator being the fermion propagator).

Jacobo Diaz-Polo

Black hole entropy: the richness of discreteness and number theory

A detailed analysis of the isolated horizon degeneracy spectrum within loop quantum gravity shows a characteristic band structure that gives rise to an effective discretization for the entropy of microscopic black holes. It is possible to understand the origin of this behaviour in terms of a simple qualitative model. A recently developed new approach, based in number theory, allows to tackle the combinatorial problem in a much more efficient way, providing us with the right tools for a complete asymptotical analysis.

Winston Fairbairn

On gravitational defects, particles and strings

I will discuss the inclusion of point and string matter in the deSitter gauge theory formulation of four-dimensional gravity. I will explain how to extract the degrees of freedom of spinning matter from the gauge symmetries of the gravitational field, and how this formalism relates to the description of particle and string theories in terms of Poincare group coordinates. I will conclude by discussing potential outcomes of the formalism for the inclusion of matter in spinfoam models of four-dimensional quantum gravity.

Joao Faria Martins

Invariants of Welded Virtual Knots Via Crossed Module Invariants of Knotted Surfaces

We define an invariant of welded virtual knots from each finite crossed module by considering crossed module invariants of ribbon knotted surfaces which are naturally associated with them. We show the relation with Yetter's invariant of manifolds. (Joint work with Louis H. Kauffman)

Christian Fleischhack

On the Configuration Spaces of Loop Quantum Cosmology and Loop Quantum Gravity

The set of homogeneous isotropic connections, as used in loop quantum cosmology, forms a line l in the space of all connections. In constrast to straight paths, general paths in the base manifold define parallel transports that do not depend almost periodically on l. This implies that the embedding above does not continuously extend to an embedding of the configuration space of homogeneous isotropic loop quantum cosmology into that of loop quantum gravity.

Kristina Giesel

Loop Quantum Gravity: Reduced Phase Space Quantisation

One of the unresolved problems in Loop Quantum Gravity is the detailed understanding of the dynamics described by the so called Quantum -- Einstein -- Equations. In this talk we present another approach than standard constraint quantisation to the dynamics of Loop Quantum Gravity. In the context of the so called Relational formalism one can construct observables for General Relativity. These observables satisfy an algebra for which representaions can be found easily. The evolution of these observables is generated by a so called physical Hamiltonian by means of which a gauge -- invariant version of the Quantum -- Einstein -- Equations can be derived. Finally we discuss the advantages and disadvantages in the constraint quantisation and in the reduced phase space quantisation approach.

Florian Girelli

Deformed Special Relativity from Spinfoams?

After recalling the main features of a scalar field theory in Deformed Special Relativity, I will explain how to derive it (more exactly its euclidian version) from a Group Field Theory.

Andrzej Goerlich

Background Geometry in 4D Causal Dynamical Triangulations

Dynamical Triangulation is a background independent approach to quantum gravity. Imposing causal structure of the universe we observe a classical 4D de

Sitter spacetime as a "background" geometry. From the study of the spatial volume fluctuations one can determine the effective action for the scale factor. In this framework no degrees of freedom were frozen, however, the obtained action agrees with the minisuperspace model, which has maximum symmetry.

This talk is based on the paper Phys. Rev. Lett. 100, 091304 (2008) [http://arxiv.org/pdf/0712.2485]

Jesper Grimstrup

On Spectral Triples in Quantum Gravity

In my talk I will present a semi-finite spectral triple over a space of connections. The triple involves an algebra of holonomy loops and a Dirac-type operator which resembles a global functional derivation operator. The interaction between the Dirac operator and the algebra reproduces the Poisson structure of General Relativity. Moreover, the associated separable Hilbert space corresponds, up to a discrete symmetry group, to the Hilbert space of diffeomorphism invariant states known from Loop Quantum Gravity. The square of the Dirac operator has the form of a global area-squared operator. The construction is based on a countable set of graphs.

Harald Grosse

Renormalizable Noncommutative Quantum Field Theory

We overcome the IR/UV mixing of ncQFT for scalar fields by identifying all relevant/marginal operators and obtain bounded renormalization group flows. We formulate models for fermions and for gauge fields.

The resulting Minkowski models show wedge locality.

Razvan Gheorghe Gurau

Renormalization and Non Commutative Quantum Field Theory in curved background

Jonathan Hackett

Conserved structures in Trivalent Braided Ribbon Networks

Following an introduction to the basic mathematics involved in Braided Ribbon Networks, two existence of two classes of invariant structures will be introduced. The existence of infinite number of microlocal excitations will be proven, and a correspondence between semi-local structures in braided ribbon networks and the particles of the standard model will be demonstrated.

Franz Hinterleitner

Remarks on doubly special relativity and gravity

Modifications of special relativity in the form of so-called doubly special relativity theories (DSR) or by the introduction of an energy-momentum dependent Planck constant (generalized uncertainty principle, GUP) are compared with classical gravitational effects in an interaction process. For DSR a restrictive condition for the equivalence of the low-energy limit and Newtonian gravity is found. GUP, on the other hand, yields an effective repulsion, in analogy to replusive effects in loop quantum cosmology.

Stefan Hollands

Quantum field theory in curved spacetime, the operator product expansion, and dark energy

I present a novel approach to quantum field theory, wherein the operator product expansion is raised to the level of a fundamental and defining property of the theory. I argue that the coefficients in such an expansion must obey powerful consistency as well as covariance conditions.

Such conditions can be used to give a completely new mathematical framework e.g. for perturbation theory, which in this formalism can be viewed as the computation of a certain cohomology of "Hochschild" type. The formalism also leads to some new insights about the proper normalization of expectation values of composite operators, and in particular sheds some interesting light on the issue of dark energy.

Otto Kong

Linear Realization of the Quantum (Deformed) Special Relativity for an AdS_5 Quantum World --- Going Beyond Space-Time

We discuss our recently introduced perspective of a quantum relativity with deformation parameters implicitly giving rise to the quantum hbar and realizing the symmetry linearly on an AdS_5 geometry as a hypersurface within a 6-geometry corresponding to 4 space-time coordinates plus 2 extra coordinates that are to be understood as neither space nor time. This suggests at the deep quantum/microscopic level, space-time is to be considered as part of a structure beyond space-time. We explore how physics is to be depicted in the radically new foundation.

Thomas Krajewski

Quasi-quantum groups as higher projective representations

A quasi-quantum group is a deformation of the Drinfeld double of the group algebra of a finite group induced by a 3-cocycle. In this talk, we present a geometrical construction of the quasi-quantum groups based on gerbes and their holonomies, in complete analogy with the way projective representations arise in quantum mechanics.

Aaron Lauda

Categorification of quantum groups

Crane and Frenkel proposed that 4-dimensional TQFTs could be obtained by categorifying quantum groups at root of unity using their canonical bases. In my talk I will explain how the quantum enveloping algebra of quantum sl(2) at generic q can be categorified. If time permits I will also explain joint work with Mikhail Khovanov on how this construction can be generalized to quantum sl(n).

Stephano Liberati

Constraining Planck-suppressed Lorentz Violations via High Energy Astrophysics

The structure of spacetime at the Planck scale may lead to a breakdown of Lorentz invariance at high energies in the form of nonlinear dispersion relations for the fundamental particles. In spite of the fact that the extra Lorentz-breaking terms are generally suppressed by inverse powers of the Planck mass, it is possible to constraint their magnitude through observations well below the Planck scale by exploiting the extreme sensitivity of some high energy astrophysics phenomena. In this talk I shall review these possible "windows on quantum gravity" and discuss the current best constraints (within the effective field theory framework) for QED with O(E/M) or $O(E^2/M^2)$ Lorentz Violation.

Fedele Lizzi

Noncommutative Field Theory with the Moyal and Wick-Voros products: Twist and s-Matrix

I will construct a quartic field theory based with the Wick (or Voros or normal ordered) product and compare it with the known theory based with the Moyal product. The two theories appear to be different at the level of their Green's function. When the analysis is carried over at the level of the physically relevant S-matrix, in the twist deformed context, we show that the amplitudes are the same.

Renate Loll

de Sitter universe from quantum bits

I will describe recent results in quantum gravity obtained in the approach of causal dynamical triangulations. They show that a four-dimensional, large-scale de Sitter universe emerges from a nonperturbative and background-independent sum over histories.

Yongge Ma

Quasi-local energy operators in loop quantum gravity

A few quasi-local energy operators are constructed in the kinemical Hilbert space of loop quantum gravity. Their properties are studied in detail. The operator corresponding to the Geroch quasi-local energy is employed to reveal the holographic principle in loop quantum gravity.

Mercedes Martin-Benito

Hybrid Quantum Cosmology: combining Loop and Fock quantizations in the Gowdy model

With the aim at analyzing the physical consequences of including inhomogeneities in loop quantum cosmology, we consider the quantization of the linearly polarized Gowdy T3 model. We perform a hybrid quantization of this infinite dimensional model which combines loop and Fock techniques. We discuss the main results of this quantization, which include the resolution of the cosmological singularity, the polymeric quantization of the internal time and the concept of evolution, the representation of the quantum constraints and their explicit solutions, the Hilbert structure of the physical states, and the recovery of a conventional Fock quantization for the inhomogeneities.

Catherine Meusburger

3d Loop quantum gravity and combinatorial quantisation

The Chern-Simons formulation of 3d gravity allows one to quantise the theory via combinatorial quantisation formalisms for Chern-Simons theories. We analyse the link between this quantisation formalism and loop quantum gravity for Euclidean 3d gravity without cosmological constant. We relate the physical observables and the construction of the physical Hilbert space in the two approaches and show how the quantum group SU(2) acts on general spin network states. For the torus universe, we explicitly construct the physical Hilbert space, discuss the expectation values and spectra of diffeomorphism invariant observables and their physical interpretation.

Aleksandar Mikovic

Spin foam perturbation theory for 3d quantum gravity

We describe the spin foam perturbation theory for the three-dimensional Euclidean Quantum Gravity. We analyze the perturbative expansion of the partition function in the dilute gas limit and show that the Baez conjecture does not hold for arbitrary triangulations. However, it holds for a special class of triangulations which are based on the baricentric divisions of 3-manifold cubulations. In this case we calculate the partition function.

Jeffrey Morton

Extended Topological Quantum Field Theories and Quantum Gravity

Extended Topological Quantum Field Theories (ETQFTs) are atool from quantum topology which give invariants for manifolds with corners, related to the Dijkgraaf-Witten models. I will discuss ETQFT's and how they can be used to describe topological field theories coupled to codimension-2 matter. For example, Ponzano-Regge gravity in3 dimensions coupled to point particles having mass and spin, or BFtheory in 4 dimensions coupled to strings or networks. I will show how the Extended TQFT picture can be described in terms of gauge theory with suitable gauge groups, and a "higher-algebraic" version of a sum-over-histories.

William Nelson

Lattice refinement in Loop Quantum Cosmology: The matter Hamiltonian, stability and large scale effect from quantum corrections.

Until recently the effect of lattice refinement was neglect in Loop Quantum Cosmology, however this leads to apparent instabilities at large scales. In particular the presence of such an instability during inflation will be described and shown to disappear once lattice refinement is modelled. This will then be extended to a wide class of lattice refinement models and matter Hamiltonians, and the regions of stability found. Finally it will be shown that, in general such large scale instabilities initially resemble additional matter components, opening the possibility that dark energy and/or dark matter might be a large scale manifestation of quantum corrections.

Fabrizio Nesti

Standard Model and Gravity from Spinors

I review recent work on the extension of the Lorentz gauge group of gravity to include the weak interactions (Graviweak Unification), as well as a related setup stemmimng from algebraic spinor theory, where a Standard model fermionic family is accomodated in Left-Right symmetric fashion, and where Gravity plus the Standard Model gauge group emerge at Planck scale.

Daniele Oriti

Group field theory and simplicial quantum gravity

We present work in progress toward a new group field theory for quantum gravity in 4 dimensions. We define a generalised GFT formalism whose quantum states are given by extended spin network functions, labelled by both Lie algebra and group elements, with imposed covariance under group action, and whose Feynman amplitudes, i.e. the corresponding spin foam model, have the correct type of variables and several features of a path integral for gravity in a simplicial Plebanski formulation, incorporating the constraints that reduce BF theory to gravity, and with additional restrictions that give to the same amplitudes the form of path integrals of a 1st order Regge calculus. Moreover, the extension of the model to include an Immirzi parameter seems straightforward. We discuss the open issues that still need to be addressed in completing the construction and the possibility of restricting the same group field theory to define, in perturbative expansion, a sum over equilateral triangulations weighted by the same Regge action, i.e. a quantum dynamical triangulations model.

Tomasz Pawlowski

Concept of evolution in Bianchi I model within LQC

We analyse the dynamics of a vacuum Bianchi I model quantized within the framework of Loop Quantum Cosmology. In such a system the lack of a matter field suitable to become a good internal time complicates the introduction of a standard evolution picture. We overcome this difficulty by constructing a set of families of (unitarily related) observables which however possess a neat physical interpretation only in a certain approximation. By testing this construction in the isotropic system with massless scalar field we determine the extent of physical data which can be extracted in that way. Applying this knowledge to the system under consideration we describe the dynamics of states which are semiclassical at late times.

Malcolm Perry

The origins of dualities in General Relativity

Roger Picken

A quantum Goldman bracket in 2+1 quantum gravity

In the context of 2+1 quantum gravity on the torus quantum holonomy matrices are assigned to loops, leading to a q-deformed representation of the fundamental group (matrices for homotopic loops are related by phases coming from the signed area of the homotopy). This yields a quantum version of the Goldman bracket for loops on surfaces. The area phases play an interesting role here, and are connected to a quantum version of Pick's formula for the area of a planar polygon with vertices on an integer lattice, and (I suspect) to parallel transport for non-abelian gerbes.

Jorge Pullin

Loop quantum gravity black holes: towards the complete space-time

We discuss the quantization of spherically symmetric gravity in loop quantum gravity. We are able to find a gauge fixing where the constraints are manageable, having an Abelian algebra. We study the classical theory that results from holonomizing the variables and in particular find a solution that reproduces the Schwarzschild solution in Kruskal-like coordinates in the general relativistic limit.

The solution away from the limit corresponds to a non-singular space-time where the singularity is replaced by a bounce tunneling into another universe.

Christoph Rahmede

Old and new results from the Wilsonian approach to gravity

I will present several recent results on the asymptotic safety approach to Quantum Gravity based on the application of a type of Wilsonian Renormalization Group Equation published in arXiv:0805.2909.

In particular, I will show how this method reproduces well-known old results from perturbation theory while the obtained Renormalization Group Equations posess a nontrivial fixed point structure even under the inclusion of matter.

Fernando Ruiz

Seiberg-Witten diffeomorphism-invariant non-commutative deformations of gravity are constructed and classified. The requirement of diffeomorphism invariance has its origin in the physical requisite of being able to make predictions in a observer-independent way, which in turn leads to a position-dependent bivector θ describing non-commutativity. This is contrast with other approaches in the literature based on constant non-commutativity and violating diffeomorphism invariance. The net result is that, up to order two in θ, the only non-Minkowskian metric admitting Seiberg-Witten deformations of the type.

Tapio Salminen

Noncommutative QFT: A confrontation of symmetries (in collaboration with M. Chaichian, K. Nishijima and A. Tureanu)

The concept of a noncommutative field is formulated based on the interplay of twisted Poincare symmetry and residual Lorentz symmetry. Various implications, such as the light-wedge causality condition and the integrability condition for Tomonaga-Schwinger equation, are presented. Based on this analysis, the claim of the identity between commutative QFT and noncommutative QFT with twisted Poincare symmetry is refuted.

Saurav Samanta

The unimodular formulation of noncommutative general relativity

Based on gauging the Poincare group, is extended to a general Lie algebra valued noncommutative structure. Exploiting the Seiberg - Witten map technique we formulate the theory as a perturbative Lagrangian theory. We show that notwithstanding the introduction of more general noncommutative structure there is no first order correction, exactly as happens for a canonical (i.e. constant) noncommutativity.

Alejandro Satz

Semiclassical correlations in quantum Regge calculus

We explore the semiclassical regime of nonperturbative quantum Regge calculus by using a version of the boundary state formalism developed for spin foam models. Correlations among simplicial 3d-geometry observables in the boundary of a 4d region can be computed using a nonperturbative path integral for the interior if the boundary quantum state is peaked in a classical configuration. We discuss several examples, issues of triangulation dependence, the conditions for a good semiclassical boundary state, and the relation with the semiclassical limit of spin foam models.

Bernd Schroers

Duality between quantum gravity and kappa-Poincare symmetry in 3d

In three space-time dimensions there exist Chern-Simons formulations of both Einstein gravity and of interacting particle theories with kappa-Poincare symmetry. The two models are part of a family of models and are related by a duality which I will describe. After quantisation the models enjoy quantum group symmetries which are also related by a duality transformation. I will explain this duality and offer some possible interpretations. The talk is based on joint work with Catherine Meusburger and Shahn Majid.

Peter Schupp

Noncommutative Gravity and Schwarzschild Solution

We give an introduction to the formulation of general relativity in a noncommutative spacetime background and discuss the possibility of exact solutions.

Maryam Shaeri

Super-inflation and perturbations in LQC

An inflationary epoch is currently the most promising model for the origin of large-scale structure in the universe. Predictions of inflation are fully compatible with the most recent observations. But, in what fundamental theory will inflation be seen to arise? We have investigated accommodating inflation in the context of Loop Quantum Cosmology. This is carried out for the two types of quantum modifications introduced by LQC: the inverse volume corrections, and the holonomy corrections. Predictions arising from these corrections are discussed and compared to those of the standard inflation.

Lorenzo Sindoni

Emergent gravitodynamics in Bose-Einstein condensates

Analogue models for gravity are condensed matter systems providing a kinematical analogy with field theory in curved spacetimes. A dynamical analogy for gravitational phenomena, equivalent to the Einstein equations, is still missing. We present a model, based on Bose-Einstein condensates, which fills this gap, at least at the Newtonian level. A modified Poisson equation is found for the gravitational interaction, containing a source term for matter as well as a cosmological constant term. We discuss the microscopic origin of the various gravitational constants, and we give some hints for an extension to the relativistic case.

Paramphreet Singh

Lessons from exactly solvable Loop quantum cosmology

We present an exactly solvable model of loop quantum cosmology which allows us to achieve a full control on the underlying quantum theory. Various so far open questions in loop quantum cosmology can now be answered. These include the genericity of the occurrence of quantum bounce at Planck scale and the fundamental discreteness of loop quantum cosmology. We show that critical energy density found in numerical simulations turns out to be a supremum in the physical Hilbert space. We also show the way semiclassicality is preserved across the quantum bounce leading to interesting possibilites to construct viable alternative models of the early universe.

The talk will primarily be based on following papers:

1. A. Ashtekar, A. Corichi, P. Singh, "On the robustness of key features of loop quantum cosmology,'' Phys. Rev. D77, 024046 (2008), arXiv:0710.3565 [gr-qc]

2. A. Corichi, P. Singh, "Quantum bounce and cosmic recall,'' Phys. Rev. Lett. 100, 161302 (2008), arXiv:0710.4543 [gr-qc]

Jozef Skakala

Finslerian structure versus birefringence

Many of the toy models for "quantum gravity phenomenology" that are currently under consideration exhibit Planck-scale breakdown of Lorentz invariance and/or Planck-scale birefringent (or multi-refringent) effects. Mathematically, these physical effects are often encoded in Fresnel equations and/ or Finsler geometries (pseudo- Finsler spacetimes). In this work we wish to address the question of whether a single Finsler metric can (usefully) be used to simultaneously encode all the geometric information due to all the multi-refringent modes (in the same way that the Fresnel equations specify all the multi-refringent modes on an equal footing). Using the optical physics of bi-axial crystals as a guide, we shall demonstrate that for physical reasons one is often much better off dealing with a separate Finsler spacetime for each propagating mode, and not trying to assemble all the separate Finsler spacetimes into an overarching universal Finsler geometry. This result is somewhat unexpected, since as long as one is only interested in propagation-cone structure, a single universal Fresnel equation does encode the overarching causal structure.

David Sloan

Lessons for Quantum Cosmology from the BKL Conjecture

We present a Hamiltonian formulation of the BKL conjecture and examine its implications for quantum cosmology. Through an application of the conjecture we reduce the phase space and constraints of general relativity to a system which is more readily quantized. The classical dynamics of this system is described and an approach to quantization is presented.

Artem Starodubtsev

Gravitational interaction of particles in SO(5) spinfoam model

We consider perturbation theory for General Relativity coupled to particles around the topological sector. We find that in second order of the expansion the interaction includes an exchange of spin 2 particle which in the limit of small cosmological constant becomes massless. In this framework gravitational interaction gets combined with topological interaction which can be described as q-deformation. We discuss how q-deformation could regularize loop divergences of perturbation theory.

Harold Steinacker

Dynamical quantum spaces, matrix models and gravity

A mechanism for gravity emerging from Yang-Mills matrix models is exhibited. The matrix model desribes general noncommutative spaces, which in the semi-classical limit aquire an effective metric depending on the dynamical Poisson structure and the embedding metric. This leads to an emergent gravity intimately related to noncommutativity, absorbing the "would-be U(1) gauge fields". The induced gravitational action captures the UV/IR mixing of NC gauge theory. The quantization is discussed qualitatively, which singles out the IKKT model as a prime candidate for a quantum theory of gravity coupled to matter. The case of nontrivially embedded NC branes is also covered, motivated by the Newtonian limit. A mechanism for avoiding the cosmological constant problem is identified.

Christoph Stephan

Neutrino Masses in Noncommutative Geometry

During the last two decades Alain Connes developed noncommutative Geometry, which allows to unify two of the basic theories of modern physics: General Relativity and the Standard Model of particle Physics. In its original version the noncommutative Standard Model allowed only Dirac masses for Neutrinos. Recently Alain Connes and John barrett showed that this is due to the fact that the internal space of noncommutative Geometry is Euclidian in an algebraic sense. If one changes its signature from Euclidian to Minkowskian signature, Majorana mass terms are in priciple allowed and the SeeSaw mechanism appears naturally.

In this talk I will give an overview of the different possibilities to introduce neutrino masses into the noncommutative Standard Model a la Connes. Since Majorana masses for right-handed Neutrinos result in an incompatibility with Connes' axiom of orientability for noncommutative spaces, I will present a model which offers a bypass to obtain the SeeSaw mechanism by enlarging the Standard Model particle content while respecting the whole set of axioms.

Victor Taveras

Corrections to the Friedmann Equations from LQC

Corrections to the Friedmann equations from loop quantum gravity are found for the case of a universe with a free scalar field. The effective Hamiltonian constraint and the effective equations of motion are found using the geometric formulation of quantum mechanics. Additionally, the effective Friedmann equations are shown to be consistent to within our order of approximation and include corrections due to quantum effects.

Tamer Tlas

A new class of Group Field Theories (GFTs) will be described. In 3d the spinfoam amplitudes generated by these GFTs are path integrals for a clearly identified Regge action in 1st order form (including higher order corrections). In 4d, the action is that of discrete BF theory with an orientation restriction on the hinge volumes similar to that characterising gravity. This new class of GFTs may represent a concrete unifying framework for simplicial quantum gravity approaches.

Jamie Vicary

Geometrical formulation of finite-dimensional C*-algebras

We describe an equivalence between finite-dimensional C*-algebras and a class of $\dagger$-Frobenius monoids, for which the key structure is an inner product rather than a norm. These $\dagger$-Frobenius monoids are defined in a geometrical rather than an algebraic way, and so offer a dramatically different point of view on C*-algebras. From this perspective we obtain a new categorical method for describing generalisations of C*-algebras, and we also obtain a new categorical presentation of the finite-dimensional spectral theorem.

Francesca Vidotto

Stepping out of homogeneity in loop quantum cosmology

I discuss an extension of loop quantum cosmology outside the homogeneous approximation. The model provides a tool for describing general fluctuations of quantum geometry near the initial singularity. The dynamics of the model reduces to that of loop quantum cosmology in the Born-Oppenheimer approximation. This result corroborates the assumptions that ground loop cosmology, sheds light on the physical and mathematical relation between loop cosmology and full loop quantum gravity, and on the nature of the cosmological approximation.

Fabien Vignes-Tourneret

Renormalisation Group on Non-commutative Space

Given the need to study gravitation at small scales, non-commutative geometry is a promising framework for the unification of the fundamental forces. But its succeses in this direction are only valid at the classical level. To solve this problem, a first step consists in studying models of quantum field theory on a fixed non-commutative space. In this talk we review the advances made the last few years in that domain. We insist on the interpretation of these results in terms of the renormalisation group � la Wilson.

Yidun Wan

C, P, T, and Conserved Quantities of Braid Excitations in Quantum Gravity

We derive conservation laws from interactions of braid-like excitations of embedded framed spin networks in Quantum Gravity. We also demonstrate that the set of stable braid-like excitations form a noncommutative algebra under braid interaction, in which the set of actively-interacting braids is a subalgebra. We show that four-valent braids allow seven and only seven discrete transformations. These transformations can be uniquely mapped to C, P, T, and their products. Each CPT multiplet of actively-interacting braids is found to be uniquely characterized by a non-negative integer. Finally, braid interactions turn out to be invariant under C, P, and T.

Joshua Willis

Recoupling Computation of Lorentzian 10J Symbols

I review recent work on computing the Lorentzian 10J symbol by extending the algorithm Christensen and Egan have used for the Riemannian 10J symbol. That algorithm relies on recoupling for SU(2) spin networks; our new algorithm similarly relies on an extension of recoupling theory to the non-compact Lorentz group. This recoupling theory demands an extension of the Lorentzian spin-networks of Barrett and Crane to "non-simple" representations of SL(2,C), and thus may be helpful in computations with new proposals for the Lorentzian vertex that do not strongly enforce simplicity constraints.

Edward Wilson-Ewing

The covariant entropy bound and loop quantum cosmology

We examine Bousso's covariant entropy bound conjecture in the context of radiation filled, spatially flat, Friedmann-Robertson-Walker models. The bound is violated near the big bang. However, the hope has been that quantum gravity effects would intervene and protect it. Loop quantum cosmology provides a near ideal setting for investigating this issue as quantum geometry effects resolve the singularity and the wave function is sharply peaked at a quantum corrected but smooth geometry which can supply the structure needed to test the bound. We find that the bound is respected. We suggest that the bound need not be an essential ingredient for a quantum gravity theory but may emerge from it under suitable circumstances.

Derek K. Wise

Topologically Massive Gravity with a Cosmological Constant

Topologically massive 3d gravity is a theory that comes with all of the basic conceptual difficulties of quantizing full-fledged 4d general relativity: it is diffeomorphism invariant and, unlike 3d Einstein gravity, has propagating degrees of freedom. So far, relatively little is known about quantizing this system. But even a linearized analysis reveals a wealth of interesting features, particularly when a cosmological constant is introduced. For example, with a negative cosmological constant, the theory's massive graviton modes have masses branched according to chirality. There are also special values of the topological mass parameter where the massive gravitons exhibit null propagation, and other values where the linearized theory becomes equivalent to topologically massive electrodynamics. I will review the basic features of topologically massive gravity, and discuss some recent results peculiar to the theory in the presence of a cosmological constant.

(Joint work with S. Carlip, S. Deser, and A. Waldron. See arXiv:0803.3998 for references.)