GR 3: Quantum Gravity II

Zeit: Montag 16:45–19:05 Raum: VMP6 HS A

GR 3.1 Mo 16:45 VMP6 HS A

The group field theory formalism for quantum gravity: progress and prospects — •Daniele Oriti — Max Planck Institute for Gravitational Physics (Albert Einstein Institute)

I review the basic aspects of the group field theory formalism for quantum gravity, and its relation with the loop quantum gravity approach, and with discrete quantum gravity. I highlight recent results and forthcoming challenges for what concerns group field theory renormalisation, both perturbative and non-perturbative, and the extraction of effective continuum physics, in particular cosmological dynamics.

GR 3.2 Mo 17:05 VMP6 HS A

Effective Spacetimes from Quantum Cosmology — •Andrea Dapor — Institute for Quantum Gravity, University of Erlangen-Nürnberg

I will describe a general mechanism for the emergence of a classical spacetime from an underlying theory of quantum cosmology coupled to matter. This idea is based on QFT on quantum spacetime, and the emergent classical metric is not just the naïve expectation value of a "metric operator" on the quantum state of geometry. In fact, if the matter sector consists of as simple a species as a massive real scalar field, then the emergent classical metric depends explicitly on the momentum of the particle used to probe it. This is therefore an explicit realization of the concept known in the literature as "rainbow metric" (the name comes from the analogy with propagation of light in cristals, where photons of different colors move along different pahts). Application of this method to homogeneous isotropic Loop Quantum Cosmology will be presented, and the intensity of local Lorentz-violation will be estimated. Time permitting, I will also sketch some preliminary results in the context of anisotropic cosmologies.

GR 3.3 Mo 17:25 VMP6 HS A

Boundary conditions, black holes and the Duflo map in LQG — •Thomas Zilker and Hanno Sahlmann — FAU Erlangen-Nürnberg

This talk will focus on the boundary condition satisfied by spherically symmetric isolated horizons in their SU(2)-invariant formulation. After briefly discussing its geometric interpretation, I will then present an approach to quantize this boundary condition in the framework of loop quantum gravity. The Duflo map provides a possible solution to the ordering ambiguities occurring in this approach.

GR 3.4 Mo 17:45 VMP6 HS A

Chaos, Dirac observerbles and constraint quantization — •Philipp Höhn[1], Bianca Dittrich[2], Tim Koslowski[3], and Mike Nelson[4] — [1]Institute for Quantum Optics and Quantum Information, Austrian Academy of Sciences, Vienna, Austria — [2]Perimeter Institute for Theoretical Physics, Waterloo, Canada — [3]Instituto de Ciencias Nucleares, Universidad Nacional Autonoma de Mexico, Mexico — [4]African Institute for Mathematical Sciences, Legon, Accra, Ghana

There is strong evidence that a generic general relativistic spacetime features chaotic dynamics. This has severe (and often ignored) repercussions for the quantization and interpretation of the dynamics as a chaotic (Hamiltonian) constrained system generally does not give rise to a Poisson algebra of Dirac observables. Nevertheless, in certain cases one can explicitly quantize such systems. By means of toy models, I will discuss general challenges and some surprising consequences for the quantum theory of chaotic constrained systems which presumably will also appear in canonical quantum gravity.

GR 3.5 Mo 18:05 VMP6 HS A

The algebra of observables in Gaussian normal (space)time coordinates — •Norbert Bodendorfer[1], Pawel Duch[2], Jerzy Lewandowski[1], and Jedrzej Swiezewski[1] — [1]Faculty of Physics, University of Warsaw, Pasteura 5, 02-093, Warsaw, Poland — [2]Institute of Physics, Jagiellonian University, Lojasiewicza 11, 30-348 Krakow, Poland

We discuss the locality properties of general relativistic observable algebras based on Gaussian normal space and spacetime coordinates. While a suitable local algebra can be constructed in the spatial case, this fails in the spacetime case. The relevance of these results for quantum gravity and the AdS/CFT correspondence are discussed.

GR 3.6 Mo 18:25 VMP6 HS A

Quantum Gravity a la Aharonov-Bohm — •Marcin Kisielowski — University of Erlangen-Nürnberg, Erlangen, Germany

In the Regge approximation to General Relativity a space-time is a simplicial complex equipped with a metric structure determined by the edge lengths. For each such Regge space-time we construct a smooth manifold equipped with flat connection and a compatible tetrad. The resulting manifold is not simply connected – we will say that it is a manifold with defects. Although the connection is flat a parallel transport around a closed loop can be non-trivial. This is a mathematical basis of the Aharonov-Bohm effect: the magnetic field is zero outside thin and long solenoid but the holonomy around a loop encircling the solenoid is non-trivial. Using this analogy we introduce a (distributional) curvature on the simplicial complex. This allows us to define the Eintein-Hilbert-Palatini action as a measure, which coincides with the Regge action. We apply this alternative formulation of Regge calculus to construct a path-integral measure on histories of the gravitational field and arrive at a spin-foam model of Quantum Gravity. In my talk I will focus on 3D Euclidean gravity.

GR 3.7 Mo 18:45 VMP6 HS A

Towards the Quantum-Yang-Mills Spectrum — •Klaus Liegener — Friedrich-Alexander-Universität, Erlangen, Deutschland

A fundamental quantum theory of all interactions must include the gravitational quantum field. Thus, a quantum gravity theory is needed. With this goal in mind to describe the standard model coupled to gravity, we focus in this work on the quantum Einstein-Yang-Mills sector quantised by the methods of Loop Quantum Gravity (LQG). We point out the improved UV behaviour of the coupled system compared to pure quantum Yang-Mills theory on a fixed classical background spacetime, as was considered in a seminal work by Kogut and Susskind. Furthermore, we develop a calculational scheme by which the fundamental spectrum of the quantum Yang-Mills Hamiltonian can be computed in principle and by which one can make contact to the Wilsonian renormalisation group, possibly purely within the Hamiltonian framework. We extend already established calculations for the SU(2) gauge group to SU(3), meaning that the full standard model can now be tackled with our formalism.