GR 13: Quantum Gravity III

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

GR 13.1 Do 16:45 VMP6 HS A

Background-independent renormalization in spin foam quantum gravity — •Benjamin Bahr — Universität Hamburg

What has become known as "spin foam approach" realises the path integral for quantum gravity as a state sum model. This serves as a computational tool for the physical inner product of loop quantum gravity.

Despite many successes of this formulation in the task for constructing a background-independent theory for quantum gravity, many of its aspects remain unsolved. In particular the renormalization (i.e.: scale-dependent running of coupling constants) of these models is not yet well understood.

In this talk, I will report on the recent advances in defining a background-independent formulation of the Wilsonian RG flow equations. Furthermore, I will demonstrate how asymptotic and RG methods allow for making physical statements about the overall path integral. As an example, we show how the existence of a Minkowski-like vacuum depends on the value of coupling parameters in the state sum.

GR 13.2 Do 17:05 VMP6 HS A

Coupled intertwiner dynamics: a toy model for matter on spin foams — •Sebastian Steinhaus — University of Hamburg, II. Institute f. Theoretical Physics, Germany

The universal coupling of matter and gravity is one of the most important features of general relativity. In spin foam models, a path integral approach related to loop quantum gravity, matter couplings have been defined in the past, but little is known about the mutual dynamics. This is tightly related to the fact that the spin foams are defined on a lattice (more precisely a 2-complex), which generically results in several ambiguities. Furthermore, the geometry "seen" by matter is encoded in the spin foam itself and thus dynamical. One approach to investigate the continuum limit of such systems is via renormalizing (e.g. coarse graining) the theory.

In this talk I will present and discuss the before mentioned issues for a simpler 2D toy model, namely an Ising model coupled to a dynamical background. The distance / coupling between Ising spins will be given by the labels of this background. I investigate the phases of this model by a numerical algorithm (tensor network renormalization) and identify regions (in parameter space) in which the two systems are weakly coupled and regions in which they are strongly coupled.

Based on: Phys.Rev. D92 (2015) 064007 / arXiv:1506.04749 [gr-qc]

GR 13.3 Do 17:25 VMP6 HS A

Towards higher dimensional quantum geometries — •Johannes Thürigen — Albert-Einstein-Institut Potsdam

One way to a quantum description of spacetime geometry is random geometries as generated by matrix and tensor models. Since tensors of rank D come naturally with an interpretation as D-dimensional spacetime manifolds they are a in fact a proposal for D=4 dimensional quantum gravity. Nevertheless, despite huge progress in the understanding of tensor models in recent years, only tree-like and planar regimes have been identified in their 1/N expansion until now. In this contribution we will present a particular tensor model which raises the hope that it will become possible to control also regimes of effective higher dimensionality.

GR 13.4 Do 17:45 VMP6 HS A

Hamilton geometry - Dispersion relations and the geometry of spacetime — •Christian Pfeifer — ITP Uni Hannover, Hannover, Deutschland

One feature how a fundamental theory of quantum gravity is expected to manifest itself in observations is an effective modification of the standard dispersion relation of fundamental point particles in metric spacetime geometry. Since the point particle dispersion relation and the geometry of spacetime are closely intertwined any modification of the dispersion relation leads to a, possibly energy and momentum dependent, modification of the geometry of spacetime. In this talk I will interpret the dispersion relation as Hamilton function on the phase space of test particles on spacetime and show how one can derive the geometry of phase space from the Hamiltonian, similarly as one derives the geometry of spacetime from a metric. Since phase space is composed out of spacetime (configuration space) and momentum space the result for a general Hamiltonian is that not only the spacetime is curved but also the momentum space. Moreover, both, the curvature of spacetime and that of momentum space, depend in general on positions and momenta. I will demonstrate this framework on the example of a perturbation of the metric Hamiltonian $H = g^{-1}(p,p) + \ell h(p,p,p)$ which contains as special cases famous models used in quantum gravity phenomenology.

GR 13.5 Do 18:05 VMP6 HS A

Deformed kinematics and Planck scale modifications of Special Relativity — •Lukas Brunkhorst — ZARM, Universität Bremen

In the absence of gravitational fields, Special Relativity provides a well-tested framework for the description of classical point particle motion. And in fact, as will be shown, algebraic analysis reveals as well that there are not many plausible ways to depart from the Poincaré Lie group of spacetime automorphisms. Entering the category of Hopf algebra, the Kappa-Poincaré algebra then forms the attempt to include quantum gravitational effects. I will present its geometrical nature and discuss the derived notion of spacetime, as well as address the occurence of non-quadratic mass shell conditions.

GR 13.6 Do 18:25 VMP6 HS A

Generalized geometry and non-symmetric gravity — Branislav Jurco[1], •Fech Scen Khoo[2], Peter Schupp[3], and Jan Vysoky[4] — [1]Mathematical Institute, Faculty of Mathematics and Physics, Charles University, Prague, 186 75, Czech Republic. — [2]Department of Physics and Earth Sciences, Jacobs University, Bremen, 28759, Germany. — [3]Department of Physics and Earth Sciences, Jacobs University, Bremen, 28759, Germany. — [4]Mathematical Sciences Institute, Australian National University, Canberra, ACT, Australia.

Generalized geometry provides the framework for a systematic approach to non-symmetric metric gravity theory and naturally leads to an Einstein-Kalb-Ramond gravity theory with totally anti-symmetric contortion. The approach is related to the study of the effective closed string gravity actions.

GR 13.7 Do 18:45 VMP6 HS A

Geometrical structure of electrodynamics in 5D spacetimes as a candidate for quantum gravity — •Wolf-Dieter R. Stein — Helmholtz-Zentrum Berlin für Materialien und Energie, Berlin, Germany

Considering the Gauss-Bonnet-Chern-Theorem (GBC) for two and four dimensional space-like submanifolds of a five-dimensional spacetime a geometrically given structure of classical electrodynamics different from that discussed by Kaluza and Klein is investigated. Magnetic flux and charge quantization as a result of topology are discussed with regard to the recent finding of quantized orbital magnetic flux in atoms to be fundamental for the quantization of electrodynamics. The dynamics of the system will be discussed within canonical formalism and shows similarities to the time evolution of a quantum mechanical system. The model will be analysed in terms of being a candidate for a quantum theory of gravitation.