GR 12: Quantum gravity (joint session MP/GR)

Time: Thursday 11:00–12:40 Location: MP-H5

Invited Talk GR 12.1 Thu 11:00 MP-H5

Reduced phase space quantisation in Loop quantum gravity and loop quantum cosmology — •Kristina Giesel[1], Bao-Fei Li[2], and Parampreet Singh[2] — [1]Institute for Quantum Gravity, Department of Physics, FAU Erlangen-Nürnberg, Staudtstr. 7, 91058 Erlangen, Germany — [2]Department of Physics and Astronomy, Louisiana State University, Baton Rouge, LA 70803, USA

In this talk an overview over results that apply a reduced phase space quantisation to formulate the dynamics of loop quantum gravity and loop quantum cosmology will be presented. It will be briefly discussed how a reduced phase space for GR can be derived by coupling additional reference matter. The reduced phase space for GR is taking as a starting point for a loop quantisation either in full LQG or in the symmetry reduced case of LQC. Different choices of reference matter yield in general different quantum models and several existing models will be compared. In the framework of LQC it will be analysed how different choices of reference matter can lead to different physical properties of the models and it will be discussed what kind of conditions appropriate reference matter should satisfy in this context.

Invited Talk GR 12.2 Thu 11:30 MP-H5

Quantum fields propagating on curved backgrounds and their influence on spacetime curvature — •Nicola Pinamonti — Department of Mathematics, University of Genova, Italy

We shall review the theory of quantum fields propagating on curved backgrounds in the semiclassical approximation. Within this approximation matter is described by quantum fields propagating on a classical curved spacetime and their influence on spacetime curvature is taken into account by means of semiclassical Einstein equations. Typical known effects in this approximation are particle creation on cosmological spacetime, Hawking radiation in the case of black hole backgrounds and their evaporation. The semiclassical analysis we would like to present requires a careful study of the form of the correlation functions of the state which describes matter. The thorough analysis of their ultraviolet divergences and their renormalization is necessary to obtain meaningful expressions for the expectation values of the matter stress energy tensor. The resulting stress energy tensor will have nontrivial effects on the curvature on cosmological spacetimes too. In the latter case, semiclassical Einstein equations give origin to a well posed dynamical system provided the quantum state for matter is chosen in an appropriate way. The question of existence of exact solutions of such system will be discussed and some implication for cosmology will be presented. In the case of black hole physics, exploiting the stress tensor properties, we will give a local model of black hole evaporation.

GR 12.3 Thu 12:00 MP-H5

A master equation for gravitationally induced decoherence of a scalar field — •Max Joseph Fahn, Kristina Giesel, and Michael Kobler — Institute for Quantum Gravity, Department of Physics, FAU Erlangen-Nürnberg, Staudtstr. 7, 91058 Erlangen, Germany

In the talk, we present the derivation of a decoherence model containing a scalar field coupled to a gravitational environment. With such a model, one can predict quantum gravity effects in the scalar field's dynamics that arise due to the presence of gravity. Starting with full general relativity in Hamiltonian form expressed in Ashtekar's connection formulation, we focus on weak gravitational interactions in an asymptotically flat universe, modelled by gravitational waves propagating on a fixed background, and the scalar field as matter component. Firstly, we construct appropriate observables (gauge invariant quantities) for the model which become elementary variables in the reduced phase space of the model. Afterwards a reduced phase space quantisation using Fock quantisation is performed. With the help of the projection operator technique, we derive a second order time-convolutionless master equation, that is an effective evolution equation which predicts the temporal evolution of the scalar field, including the gravitational interaction effectively in terms of certain operators, whose form is a result of the model under consideration and several physical assumptions. These additional terms 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.

GR 12.4 Thu 12:20 MP-H5

Quantum (supersymmetric) black holes in loop quantum gravity — •Konstantin Eder — FAU Erlangen-Nürnberg

Black holes are immediate and unavoidable consequences of Einstein's theory of gravity whose existence nowadays has been confirmed with remarkable accuracy. Albeit leading to a huge success of the theory, there are also various open questions that point out its incompleteness. One of them is about the huge amount of microstates needed to explain the entropy of black holes as predicted by Bekenstein and Hawking: What are these micostates? Answering it poses a challenge for any formulation for quantum theory of gravity. In loop quantum gravity a very intriguing picture has been developed that suggests an answer in terms of topological Chern-Simon degrees of freedom induced by quantized geometry on the horizon. In this talk, we first give a general review on the description of black hole horizons in LQG. Then, we will give an outlook on recents results towards their generalization to the supersymmetric context. There, it turns out, using tools from super Cartan geometry, that the unique boundary theory in chiral supergravity corresponds to that of a super Chern-Simons theory. This enables one to transfer ideas from the bosonic to the supersymmetric setting.