GR 17: Quantum Gravity IV

Zeit: Freitag 11:15–12:55 Raum: VMP6 HS A

GR 17.1 Fr 11:15 VMP6 HS A

Testing the necessity of quantum gravity — •André Grossardt — Department of Physics, University of Trieste, Italy

What evidence do we have that the gravitational field must be quantised? I briefly review some of the most common arguments for quantum gravity and discuss an experimental proposal that could shed some light on this matter.

The experiment – a detailed analysis of the spectrum of a macroscopic oscillator – is feasible with existing technology, and is supposed to test the Schrödinger-Newton equation, a nonlinear, self-gravitating modification of quantum mechanics. This equation can be derived from the hypothesis that space-time is fundamentally classical and its curvature is sourced by the expectation values of quantum fields, which appears to be one of the most natural alternatives to a quantisation of the gravitational field.

GR 17.2 Fr 11:35 VMP6 HS A

Structural Features of the Weyl-Wheeler-DeWitt Equation — Claus Kiefer and •Branislav Nikolic — Institute for Theoretical Physics, University of Cologne, Germany

We discuss the canonical quantization of the action consisting of Einstein-Hilbert term plus Weyl-tensor squared term. The latter has the property of being invariant under local Weyl rescalings of the metric tensor (conformal transformations). We first discuss some classical aspects within the context of Hamiltonian formulation, constraints, and symmetries. We then perform the canonical quantization and discuss various properties of the arising new "Weyl-Wheeler-DeWitt" equation.

GR 17.3 Fr 11:55 VMP6 HS A

Asymptotic safety of gravity-matter systems — Jan Meibohm, Jan M. Pawlowski, and •Manuel Reichert — Institut für theoretische Physik, Universität Heidelberg

We study the ultraviolet stability of gravity-matter systems for general numbers of minimally coupled scalars and fermions. This is done within a functional renormalisation group setup. It includes full dynamical propagators and a genuine dynamical Newton's coupling, which is extracted from the graviton three-point function.

We find ultraviolet stability of general gravity-fermion systems. Gravity-scalar systems are also found to be ultraviolet stable within validity bounds for the chosen generic class of regulators, based on the size of the anomalous dimension. Remarkably, the ultraviolet fixed points for the dynamical couplings are found to be significantly different from those of their associated background counterparts, once matter fields are included. In summary, the asymptotic safety scenario does not put constraints on the matter content of the theory within the validity bounds for the chosen generic class of regulators.

GR 17.4 Fr 12:15 VMP6 HS A

Renormalization of Hořava Gravity — •Christian F. Steinwachs[1], Andrei O. Barvinsky[2,3], Diego Blas[4], Mario Herrero-Valea[5], and Sergey M. Sibiryakov[4,6,7] — [1]Physikalisches Institut, Albert-Ludwigs-Universität, Freiburg — [2]Theory Department, Lebedev Physics Institute, Moscow — [3]Pacific Institue for Theoretical Physics, Department of Physics and Astronomy UBC, Vancouver — [4]CERN, Theory Division, Geneva — [5]Instituto de Física Teórica UAM/CSIC, Madrid — [6]Institut de Théorie des Phénomènes Physiques, Lausanne — [7]Institute for Nuclear Research of the Russian Academy of Sciences, Moscow

We prove perturbative renormalizability of *projectable* Hořava gravity. The key element of the argument is the choice of a gauge which ensures the correct anisotropic scaling of the propagators and their uniform falloff at large frequencies and momenta. This guarantees that the counterterms required to absorb the loop divergences are local and marginal or relevant with respect to the anisotropic scaling. Gauge invariance of the counterterms is achieved by making use of the background-covariant formalism. We also comment on the difficulties of this approach when addressing the renormalizability of the *non-projectable* model.

GR 17.5 Fr 12:35 VMP6 HS A

Heat kernel coherent states for $SU(3)$ gauge theories in the loop quantum gravity framework — •Thorsten Lang — Friedrich-Alexander Universität Erlangen-Nürnberg

At the heart of loop quantum gravity lies a framework for the diffeomorphism invariant quantization of gauge theories. The Hilbert spaces consist of states that carry representations of the corresponding gauge groups on their edges. In order to probe the semiclassical properties of a quantum gauge theory in this framework, a method for the construction of coherent states, based on an earlier construction by Hall that makes use of the heat kernel on compact connected semisimple Lie groups, was proposed by Thiemann. These states are expected to satisfy many desirable semiclassical properties, some of which need to be studied on a case by case basis. While the construction was carried out and the semiclassical properties were studied in the case of $U(1)$ for the electromagnetic sector and $SU(2)$, which is relevant for the gravitational and electroweak sectors, the remaining group of immediate physical interest is $SU(3)$, which is the gauge group of quantum chromodynamics. We present our construction of the states for this group and discuss our progress on establishing their peakedness properties.