GR 9: Quantum Gravity (joint session MP/GR)

Zeit: Mittwoch 17:00–19:10 Raum: HS 4

Hauptvortrag GR 9.1 Mi 17:00 HS 4

Geodesic Incomplete but Quantum Complete Spacetimes — •Stefan Hofmann — Arnold Sommerfeld Center for Theoretical Physics at LMU Munich, Germany

Important spacetimes such as black holes and Friedmann cosmologies border on space-like singularities. In the vicinity of these geodesic borders, the evolution of quantum fields is described by semigroups. Semigroups allow for a complete quantum evolution if the probabilistic measure for quantum fields to populate the geodesic border becomes zero, and if the norm of quantum states is monotonously decreasing towards the geodesic border.

It is shown that black holes are quantum complete albeit geodesic incomplete. The relation to Hawking's hidden surface is discussed. Furthermore, a quantum complete prelude to inflation is presented. The apparent clash of completeness cultures is discussed and resolved.

GR 9.2 Mi 17:40 HS 4

Towards Gaussian states for the holonomy-flux Weyl algebra — •Robert Seeger — Institut für Quantengravitation, Friedrich-Alexander-Universität Erlangen-Nürnberg (FAU)

An important challenge in loop quantum gravity is to find semiclassical states. This is difficult because states in the Hilbert space are excitations over a vacuum in which geometry is highly degenerate. Additionally, fluctuations are distributed very unevenly between configuration and momentum variables in this state. Coherent states that have been proposed to balance the uncertainties more evenly can, up to now, only do this for finitely many degrees of freedom. Our work is motivated by the desire to obtain Gaussian states that encompass all degrees of freedom. To implement this idea mathematically we reformulate the U(1) holonomy-flux algebra in any dimension as a Weyl algebra, and discuss generalisations to SU(2). We then define and investigate a new class of states on these algebras which behave like quasifree states on momentum variables.

10 Minuten Pause

GR 9.3 Mi 18:10 HS 4

Quantum Gravity Phenomenology: Modified dispersion relations on curved spacetimes - circular orbits and time delays — •Christian Pfeifer — University of Tartu, Tartu, Estonia

The Hamiltonian formulation of modified dispersion relations allows for their implementation on generic curved spacetimes, and thus enables us to derive effective quantum gravity corrections to the behaviour of probe particles.

In this talk I will consider general first order perturbation of the general relativistic dispersion relation on Schwarzschild and Friedmann-Lemaitre-Robertson-Walker spacetime. For the Schwarzschild case I present the correction to the innermost circular photon orbits; for the FLRW case general I discuss corrections to the cosmological redshift, and the emerging time delay in the time of arrival of simultaneously emitted photons. These results extend existing analyses which consider particularly chosen modified dispersion relations and usually neglect curved spacetime effects. Compared to the predictions of general relativity, the dependence of the observables on the four momentum of the particle is increased. This signature is in principle detectable in observations with instruments of sufficient sensitivity, for example in the shadows of black holes and the time of arrival measurements of high energetic photons from gamma ray bursts.

GR 9.4 Mi 18:30 HS 4

Canonical cosmological perturbation theory with geometrical clocks — •Kristina Giesel[1], Adrian Herzog[1], and Parampreet Singh[2] — [1]FAU Erlangen-Nuernberg, Institut fuer Theoretische Physik III, 91058 Erlangen — [2]Louisiana State University, Baton Rouge, Louisiana, USA

We apply the extended ADM-phase space formulation originally introduced by Pons et al to canonical cosmological perturbation theory and analyze the relationship between various gauge choices made in this framework and the choice of geometrical clocks in the relational formalism. We show that various gauge invariant variables obtained in the conventional analysis of cosmological perturbation theory correspond to Dirac observables tied to a specific choice of geometrical clocks. As examples, we show that the Bardeen potentials and the Mukhanov-Sasaki variable emerge naturally in our analysis as observables when gauge fixing conditions are determined via clocks in the Hamiltonian framework. Furthermore, we will show that the extended ADM phase space provides a framework in which the relation between conventional and canonical cosmological perturbation theory can be naturally analyzed and how existing results in the canonical approach can be generalized.

GR 9.5 Mi 18:50 HS 4

Hamiltonian Renormalization — •Thorsten Lang, Klaus Liegener, and Thomas Thiemann — FAU Erlangen-Nürnberg

We propose a renormalization procedure in the Hamiltonian formalism with applications in canonical quantum gravity. The procedure is motivated from path integral renormalization by applying the Osterwalder-Schrader reconstruction.