GR 16: Quantum Gravity III

Zeit: Freitag 11:00–13:15 Raum: NW-Bau - HS3

GR 16.1 Fr 11:00 NW-Bau - HS3

Pre-inflation from the multiverse and its effect on the cosmic microwave background — Mariam Bouhmadi-López[1,2], •Manuel Krämer[3], João Morais[1], and Salvador Robles-Pérez[4,5] — [1]Department of Theoretical Physics, University of the Basque Country UPV/EHU, Bilbao, Spain — [2]IKERBASQUE, Basque Foundation for Science, Bilbao, Spain — [3]Instytut Fizyki, Uniwersytet Szczeciński, Szczecin, Poland — [4]Instituto de Física Fundamental, CSIC, Madrid, Spain — [5]Estación Ecológica de Biocosmología, Medellín, Spain

We present two models of constructing a multiverse in the third quantization formalism, which results from a quantum-field-theoretical formulation of the Wheeler–DeWitt equation. In the first model based on eternal inflation, this formalism converts the eternally inflating universe into an ensemble of sub-universes that exhibit a distinctive pre-inflationary phase. Assuming that our observable universe is represented by such a sub-universe, we calculate the effect of the pre-inflationary phase onto the primordial scalar power spectrum and find that there is a suppression of power on the largest scales followed by a bump leading to an enhancement. In order to get a sizable effect for the suppression to explain the observed quadrupole anomaly in the CMB, the bump is enhanced too much to be compatible with the CMB data. In the second model, which involves an explicit quantum interaction between the sub-universes, we obtain a different pre-inflationary phase that better fits the CMB data and might even lead us towards an explanation of the CMB quadrupole discrepancy.

GR 16.2 Fr 11:15 NW-Bau - HS3

Dimensional flow of spacetime in lattice path integrals — •Johannes Thürigen — Humboldt-Universität zu Berlin

In many approaches to quantum gravity the spectral dimension has proven to be a very informative observable to understand the properties of quantum geometries. Calculating this quantity is a particular challenge for a spacetime as given by a Lattice gauge theories such as Spin foam models. Here I will present new results on a flow of the spectral dimension from D = 4 in the IR to a smaller value in the UV for superpositions of lattice geometries. These results can be applied to restricted Spin Foam models and shed new light on their renormalization properties.

GR 16.3 Fr 11:30 NW-Bau - HS3

Constraints on Non-Commutative SpaceTime using CMB Data in Coherent State approach — •Dipanshu Gupta[1,2] and Piero Nicolini[1,2] — [1]Frankfurt Institute for Advanced Studies, Frankfurt am Main, Germany — [2]Goethe Universität Frankfurt am Main, Frankfurt am Main, Germany

From the seminal work of Witten and Seiberg, it has been shown that noncommutativity is inherent in String Theory and a good low energy approximation for fields. We try to constrain the length scale of noncommutativity of spacetime using a new power spectrum of CMB Anisotropy derived using the Coherent State approach to noncommutativity instead of Star-Product approach in widespread literature. This formalism has many advantages, one of which is the preservation of Lorentz Invariance. We compute this new power spectrum and compare it with available data from CMB Experiments to put a new bound on the noncommutative parameter.

GR 16.4 Fr 11:45 NW-Bau - HS3

Spectral Dimension in Quantum Gravity and p-branes — •Marco Knipfer — Frankfurt Institute for Advanced Studies, Frankfurt am Main — Institute for Theoretical Physics, Goethe University Frankfurt, Frankfurt am Main

At the Planck scale the Universe is expected to suffer from wild quantum fluctuations. The latter can turn a classical spacetime from a smooth manifold to a sort of fractal. Fractals can have dimensions that differ from the standard topological dimension. A possible definition of the dimension of a fractal is offered by the concept of spectral dimension. Such a dimension is a measure of the dimensionality by inspecting how a particle diffuses on the spacetime manifold. An interesting feature is that most theories of quantum gravity have a scale dependant spectral dimension which approaches two at the Planck scale. We give an overview of the spectral dimension in different theories of quantum gravity and models incorporating quantum gravity effects. We also give a calculation of the spectral dimension when the diffusive processes is described in terms of p-branes by employing the quenched mini-superspace bosonic p-brane propagator.

GR 16.5 Fr 12:00 NW-Bau - HS3

Probability for primordial black holes in a lower dimensional universe — •Athanasios Tzikas — Frankfurt Institute for Advanced Studies, Frankfurt am Main, Germany

In recent years, many theoretical evidence illustrate the possibility that our universe may started as an effective lower dimensional spacetime before it became the 4-dimensional universe that we live today. Based on the Hartle-Hawking No-Boundary-Proposal and the mechanism of Spontaneous Dimensional Reduction, we present a possible history of a lower dimensional universe connected to the spontaneous production of primordial black holes.

GR 16.6 Fr 12:15 NW-Bau - HS3

Integrable Classical and Quantum Cosmological Models with Liouville Field — Alexander Andrianov[1,4], Chen Lan[2], Oleg Novikov[1], and •Yi-Fan Wang[3] — [1]Saint-Petersburg State University, Ulyanovskaya str. 1, Petrodvorets, Sankt-Petersburg 198504, Russland — [2]ELI-ALPS Research Institute, Budapesti út 5, H-67228 Szeged, Ungarn — [3]Institut für Theoretische Physik, Universität zu Köln, Zülpicher Straße 77, D-50937 Köln, Deutschland — [4]Institut de Ciències del Cosmos, Universitat de Barcelona, Martí i Franquès 1, E-08028 Barcelona, Spanien

A method is proposed for the exact integration of homogeneous cosmological models with a Liouville field , which is a scalar field with an exponential potential. The key of the method is to use an integral of motion to eliminate the lapse function as the redundant degree of freedom. Applying this method, equations of implicit curves as classical solutions in minisuperspace are derived in closed-form. From these, a direct correspondence with the Wheeler–DeWitt quantum cosmological theory is obtained.

The completeness and orthogonality of cosmological wave functions in the quantum context are carefully reconsidered, so is the Hermiticity of the phantom model, which leads to the exceptional result of a discrete spectrum.

The physical wave packets are established based on two definitions of norm, one is Schrödinger, the other is introduced from techniques of pseudo-Hermitian quantum mechanics. Numerical results of both cases are given and discussed.

GR 16.7 Fr 12:30 NW-Bau - HS3

Explanation of Cosmic Inflation by Gravitation — •Hans-Otto Carmesin[1,2,3] and Matthias Carmesin[4] — [1]Universität Bremen, Fachb. 1, Pf. 330440, 28334 Bremen — [2]Studienseminar Stade, Bahnhofstr. 5, 21682 Stade — [3]Gymnasium Athenaeum, Harsefelder Str. 40, 21680 Stade — [4]Universität Göttingen, Fak. f. Physik, 37077 Göttingen

From the Cosmic Microwave Background CMB the flatness problem and the horizon problem arose. An extraordinarily rapid increase of distances in the early universe, the Cosmic Inflation, was proposed as a possible solution by Guth in 1981, whereby suggested mechanisms for such an increase have been criticized (Steinhardt: Scientific American 2011). We propose a theory that explains the Cosmic Inflation by only one fundamental force: Gravitation (Carmesin, H.-O.: Vom Big Bang bis heute mit Gravitation, Model for the Dynamics of Space. Berlin: Verlag Dr. Köster 2017.). Our theory additionally applies quantum physics, contains no fit parameter, applies fundamental constants only, namely the constant of gravitation G, the velocity of light c and the Planck constant h. We discover a sequence of dimensional phase transitions at critical densities. Our results are in excellent quantitative agreement with observations, namely the critical density, the duration of cosmic inflation, the temperature fluctuations and the factor of increase correspond to the CMB and the flatness and horizon problems are solved.

GR 16.8 Fr 12:45 NW-Bau - HS3

Quantum gravity without additional theory - Compatibility of Schwarzschild metric and quantum mechanics — •René

Friedrich — Strasbourg

The current notion of spacetime depends on three assumptions which are in contradiction to special relativity and to the Schwarzschild metric, and this is the reason why the quantization of spacetime cannot work. Instead, the key to quantum gravity is the abandon of these three assumptions and the limitation of the notion of spacetime to its actual role, by the means of three insights:

1. Spacetime is not continuous, in particular not in spacelike direction, and thus it cannot be quantized.
2. For the solution of fundamental problems of physics about time, we must consider the notion of proper time instead of the coordinate time of spacetime.
3. Gravitation may be represented by Schwarzschild metric not only as the curved spacetime, but alternatively also as gravitational time dilation in absolute, uncurved space. From these three insights are following the characteristics of quantum gravity. The result: Gravity appears within quantum mechanics in the form of gravitational time dilation.

GR 16.9 Fr 13:00 NW-Bau - HS3

From condensed matter to quantum gravity: Quantum effects between neutron stars — •Johanna Karouby — Munich area, Germany

The 2017 Nobel Prize has been attributed to three pioneers in the discovery of gravitational waves. Historically, on September 14, 2015 the LIGO (Laser Interferometer Gravitational-Wave Observatory) experiment observed the first ever measured gravitational wave signal. The signals observed by LIGO come from pairs of coalescing black holes and more recently also from neutron stars! In this talk, I will present the computation of an exact quantum correction to the gravitational potential between a pair of polarizable objects such as neutron stars. I will show the case of two distant bodies and compute a quantum force from their induced quadrupole moments due to two graviton exchange. The effect is in close analogy to the Casimir-Polder and London-van der Waals forces between a pair of atoms from their induced dipole moments due to two photon exchange. The new effect is computed from the shift in vacuum energy of metric fluctuations due to the polarizability of the objects. I will present the computation for the potential energy at arbitrary distances compared to the wavelengths in the system, including the far and near regimes. In the far distance, or retarded, regime, the potential energy takes on a particularly simple form. Finally, I will provide estimates of this effect when applied to neutron stars.