Quantum Vacuum and Gravitation

Abstracts book

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Abstract ID : 0

The dynamics of the topological gauge sectors in a time-dependent curved background

Content :

It is argued that inflationary de Sitter phase may emerge as a result of dynamics of topological sectors in gauge systems. It might be relevant for understanding of the dark energy (at present epoch) or inflation at very early times. The effect is related to a non-dispersive contribution into the vacuum energy (contact term) and it is due to the degeneracy of topologically nontrivial sectors in strongly coupled gauge theory, and tunnelling events between them. This extra energy can not be expressed in terms of any local propagating degrees of freedom. Rather, this effect can be described in terms of auxiliary non-propagating fields. The phenomenon is similar to many well-known topologically ordered condensed matter systems when they are characterized by the global, rather than local parameters.

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Co-authors :

Presenter :

Track classification :

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Abstract ID : 1

Ground state of Gravity

Content :

I will discus an intriguing property of infinite derivative theory of gravity, which is ghost free at tree level and free from classical singularities.

The Gravitational Wald entropy of this infinite derivative theory of gravity has two contributions, one from infrared (IR) part, which goes as the standard Area law of gravity

for static spherically symmetric metric, while the ultraviolet (UV) part - the Wald's entropy vanishes exactly. This leads to a conjecture that there exits a non-trivial fixed point

of gravity around a static spherically symmetric background, where the gravity is in its absolute ground state without any excitation.

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Abstract ID : 3

Remarks on the average effective action in Functional Renormalization Group approach

Content :

Gauge dependence of the average effective action within standard Functional Renormalization Group approach is studied. It is shown that this dependence does not disappear even on its extremals. A new formulation being free of this singularity is proposed.

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Track classification :

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Abstract ID : 4

Infrared dynamics of interacting scalar fields in de Sitter space

Content :

I review recent progress in understanding the dynamics of light self-interacting scalar fields in de Sitter space at low (superhorizon) momenta. In this regime, perturbation theory is plagued by secular/infrared divergences due to the gravitational amplification of long wavelength quantum fluctuation and a correct description requires resummation schemes and/or nonperturbative tools. I present recent advances based on solutions of the Dyson-Schwinger equations and on nonperturbative renormalization group techniques.

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Track classification :

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Submitted on Tuesday 31 March 2015

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Abstract ID : 5

The Cosmic Microwave Background and Quantum Physics

Content :

I shall give an introduction to the physics of the CMB and discuss that its fluctuations and polarisation are initiated by to quantum fluctuations which have been amplified by the time dependent classical metric during inflation. I shall discuss how inflation is imprinted in the CMB and what are the main evidence that the CMB temperature fluctuations and polarisation stem from an phase of inflationary expansion.

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Track classification :

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Inertia of mirrors in vacuum

Content :

Vacuum field fluctuations exert a radiation reaction force on moving mirrors, which contains inertial components proportional to the acceleration. This force raises interesting questions, in connection with the principles of general relativity. In the case of two mirrors forming a cavity in particular, the reaction force fits the prediction of Einstein's law of inertia of energy.

Primary authors : Prof. REYNAUD, Serge (LKB, Paris)

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Presenter : Prof. REYNAUD, Serge (LKB, Paris)

Track classification :

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Abstract ID : 7

A many body problem on a two dimensional manifold

Content :

A system of non-interacting bosons interacting via an attractive contact interaction exhibits some interesting properties. Following some ideas of Rajeev, we study the renormalization of this model on a general two dimensional manifold. The resulting bound state spectrum can be understood through the study of the principal operator, which is an extension of the ideas of M. Krein in the mathematics literature. Using some Sobolev type estimates we analyze the mean field approximation of the ground state energy. Similar ideas are applied to the one-dimensional model and we show that one can recover the known results as well. Some open questions are to be presented.

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Track classification :

Contribution type : --not specified--

Submitted by : Prof. TURGUT, Osman Teoman

Submitted on Friday 10 April 2015

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Track judgments :

Abstract ID : 8

Quantum Equivalence of Massive Antisymmetric Tensor Field Models in Curved Space-Time

Content :

The effective actions in massive rank-2 and rank-3 antisymmetric tensor field models in curved space-time is studied. These models are classically equivalent to massive vector field and massive scalar field with minimal coupling to gravity respectively. It is proved that the effective action for massive rank-2 antisymmetric tensor field is exactly equal to that for massive vector field and the effective action for massive rank-3 antisymmetric tensor field is exactly equal to that for massive scalar field. The proof is based on an identity for mass-dependent zeta-functions associated with Laplacians acting on p-forms

Primary authors : Prof. BUCHBINDER, Joseph (Tomsk State Pedagogical University)

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Track classification :

Contribution type : --not specified--

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Abstract ID : 9

Analog of Hawking radiation in Bose-Einstein Condensates

Content :

The Hawking effect is not specific to gravity. An analog of it can be found in fluids undergoing supersonic flow (called acoustic black holes). We review ongoing attempts to observe it in condensed matter systems, and focus on a proposal to detect it through correlation measurements in Bose-Einstein condensates.

Primary authors : Dr. FABBRI, Alessandro (Centro Studi e Ricerche Enrico Fermi)

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Track classification :

Contribution type : --not specified--

Submitted by : Prof. ASOREY, Manuel

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Track judgments :

Abstract ID : 10

Hawking radiation in the presence of high energy dispersion and application to universal horizons

Content :

In this talk I will review the recent theoretical work concerning the emission of black hole radiation in the presence of high-energy dispersion and universal horizons.

Primary authors : Mr. MICHEL, Florent (Univesite Paris Sud Orsay)

Co-authors :

Presenter : Mr. MICHEL, Florent (Univesite Paris Sud Orsay)

Track classification :

Contribution type : --not specified--

Submitted by : Prof. ASOREY, Manuel

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Abstract ID : 11

Using the cosmological constant to learn about spacetime

Content :

The cosmological constant problem can be understood as the failure of the decoupling principle behind effective field theory, so that some quantities in the low-energy theory (general relativity plus the standard model of particle physics) are extremely sensitive to the high-energy properties. While this reflects the genuine character of the cosmological constant, finding an adequate effective field theory framework which avoids this naturalness problem may represent a step forward to understand nature. Following this intuition, we consider a minimal modification of the structure of general relativity which as an effective theory permits to work consistently at low energies, i.e., below the quantum gravity scale. This proposal respects the classical phenomenology of general relativity and the particle spectrum of the standard model, at the price of changing the usual picture of spacetime.

Primary authors : Mr. CARBALLO-RUBIO, Raul (Instituto Astrofisico de Andalucia)

Co-authors :

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Abstract ID : 12

On the partner particles for black hole evaporation

Content :

Due to the linearity of the field equations and the resulting bilinear structure of the Hamiltonian, quantum radiation effects such as black hole evaporation or particle creation in an expanding universe are typically described as (squeezing) processes where particles are created in pairs.
Here, we address the following question: given a mode (e.g., wave-packet) corresponding to a created particle (e.g., as part of Hawking radiation), what is its partner, i.e., the other particle of the pair?
After a general derivation of this partner mode, we will discuss some examples such as moving mirror radiation and speculate about possible implications for the black hole information puzzle.
ABC es una universidad en Brasil.

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Track classification :

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Submitted by : Prof. ASOREY, Manuel

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Track judgments :

Abstract ID : 13

Dark energy and nonlocal gravity

Content :

I will discuss the motivations for a recently proposed nonlocal modification of GR, and I will perform a detailed comparison of its predictions with cosmological data

Primary authors : Prof. MAGGIORE, Michele (Universite de Geneve)

Co-authors :

Presenter : Prof. MAGGIORE, Michele (Universite de Geneve)

Track classification :

Contribution type : --not specified--

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Abstract ID : 14

Renormalization and stability in higher derivative models of quantum gravity

Content :

The main difficulty of perturbative quantum gravity (QG) in 4d is related to the conflict between renormalizability and unitarity. The simplest version of QG is based on General Relativity and is non-renormalizable. One can construct renormalizable and even superrenormalizable versions of QG by introducing higher derivatives, but then one has to deal with the unphysical higher derivative massive ghosts. The dynamics of metric perturbations (gravitational waves) provides certain indications that the ghosts are actually not generated below the mass threshold, which is of the Planck order of magnitude. If this is true, the higher derivative models of QG can be seen as perfect theories below the Planck cut-off. The situation is very much different is the ghost is also a tachyon. In this case there is no Planck threshold for instabilities. One can show that, for a wide class of theories and models, the transition from ghost to tachyonic ghost is imminent in the far future of the LCDM universe.

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Co-authors :

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Track classification :

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Track judgments :

Abstract ID : 15

Inflation: present status and perspectives of future discoveries

Content :

Present knowledge about physical properties of an inflationary stage in the early Universe (curvature, its rate of change, inflaton mass, etc.) which follows from the latest observational data is reviewed and possibilities to make new fundamental discoveries are discussed. It is argued that the measured value of the slope n_s-1 of the primordial spectrum of scalar (density) perturbations, under some natural additional assumptions, implies small, but not too small amount of quantum primordial gravitational waves generated during inflation, r>10^{-3}, similar to that in the original R+R^2 inflationary model (1980). Thus, perspectives of their discovery seem promising. Features in the CMB temperature anisotropy power spectrum in the multipole range \ell = (20-40) are of interest in this respect, too, and may point to some new physics during inflation including the existence of new elementary particles more massive than the inflaton.

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Track classification :

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Abstract ID : 16

Non-singular models of black holes

Content :

Overview talk

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Track classification :

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Abstract ID : 17

Analog Gravity

Content :

Overview talk

Primary authors : Prof. UNRUH, William (University of British Columbia)

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Track classification :

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Abstract ID : 18

Quantum vacuum and cosmology

Content :

We review the role of the quantum vacuum in cosmology. In particular, we will address the following questions : What is the vacuum in cosmology ? Does inflation allow us to observe vacuum properties ? Can we compute the vacuum for Gravity ? How well justified are "natural guesses " for the value of the cosmological constant ? What is the role of scale symmetry and its spontaneous breaking ?

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Track classification :

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Track judgments :

Abstract ID : 19

The Cosmic Microwave Background and Quantum Physics

Content :

I shall give an introduction to the physics of the CMB and discuss that its fluctuations and polarisation are initiated by to quantum fluctuations which have been amplified by the time dependent classical metric during inflation. I shall discuss how inflation is imprinted in the CMB and what are the main evidence that the CMB temperature fluctuations and polarisation stem from an phase of inflationary expansion.

Primary authors : Prof. DURRER, Ruth (Geneva University)

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Track classification :

Contribution type : --not specified--

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Abstract ID : 20

Secularly growing loop corrections in strong field backgrounds

Content :

We discuss peculiarities of quantum fields in de Sitter space on the example of the self-interacting massive real scalar, minimally coupled to the gravity background. Non-conformal quantum field theories in de Sitter space show very special infrared behavior, which is not shared by quantum fields neither in flat nor in anti-de-Sitter space: in de Sitter space loops are not suppressed in comparison with tree level contributions because there are strong infrared corrections. But similar situation we encounter in the other strong field backgrounds. That is true even for massive fields. Our main concern is the interrelation between these infrared effects, the invariance of the quantum field theory under the de Sitter isometry and the (in)stability of de Sitter invariant states (and of dS space itself) under nonsymmetric perturbations.

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Presenter : Prof. AKHMEDOV, Emil (ITEP)

Track classification :

Contribution type : --not specified--

Submitted by : Mr. AKHMEDOV, Emil

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Track judgments :

Abstract ID : 21

Zeta functions, the Chowla-Selberg formula, and the Casimir effect

Content :

One of the landmarks in the theory of zeta funcions is the celebrated Chowla-Selberg formula. After summarizing the uses of the zeta function for the definition of regularized traces and determinants, the motivations behind the C-S formula will be discussed, together with some non-trivial generalizations of it and some applications in QFT.

Summary :

One of the landmarks in the theory of zeta funcions is the celebrated Chowla-Selberg formula. After summarizing the uses of the zeta function for the definition of regularized traces and determinants, the motivations behind the C-S formula will be discussed, together with some non-trivial generalizations of it and some applications in QFT.

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Track classification :

Contribution type : --not specified--

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Track judgments :

Abstract ID : 22

Quantum backreaction of a very light nonminimally coupled scalar and Dark Energy

Content :

Quantum fluctuations generated in the early Universe inflationary period have an energy-momentum tensor associated to them. This, in principle, represents an aditional source - quantum backreaction - to the (semiclassical) Einstein's equation, on top of the classical background fluids driving the expansion. There are models for which the backreaction from quantum fluctuations eventually becomes comparable to the background fluids in which case one expects considerable deviations from the classical GR dynamics. I will present a model of a nonminimally coupled, light massive scalar living on a FLRW background resembling the history of our Universe. The evolution of the fluctuations and its associated one loop energy-momentum tensor was calculated. For certain ranges of model parameters backreaction remains small throughout the history of the expansion (inflationary era and radiation era) and becomes comparable to the background fluid only in late time matter era. When it becomes important, backreaction is a cosmological constant type contribution. The relation to Dark Energy will be discussed.

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Track classification :

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Abstract ID : 23

Surface Tension and Negative Pressure Interior of a Non-Singular `Black Hole'

Content :

Surface Tension and Negative Pressure Interior of a Non-Singular `Black Hole'

Primary authors : Dr. MOTTOLA, Emil (LANL)

Co-authors :

Presenter :

Track classification :

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Track judgments :

Abstract ID : 25

Can effects of quantum gravity be observed in the Cosmic Microwave Background?

Content :

In any approach to quantum gravity, it is crucial to look for observational effects. In my talk, I discuss how quantum gravitational contributions to the anisotropy spectrum of the cosmic microwave background arise in the framework of quantum geometrodynamics (Wheeler-DeWitt equation). I present in detail the observational constraints coming from the CMB measurements performed by the PLANCK satellite. I also compare these results with the predictions from loop quantum cosmology.

Primary authors : Prof. KIEFER, Claus (University of Cologne)

Co-authors :

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Track classification :

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Abstract ID : 26

Particle production, backreaction, and the validity of the semiclassical approximation

Content :

Particle production and its effects on background classical fields plays a major role in areas such as preheating in chaotic inflation, models in which the universe has a contracting phase before its present expansion phase, and the decay of a strong electric field due to the Schwinger effect. In each case the effects of the produced particles on the classical background field can be taken into account via a semiclassical backreaction equation that couples the classical field to some quantity such as the stress-energy tensor of the quantum field(s). For this equation to be valid quantum fluctuations in the stress-energy tensor or whatever quantity couples to the classical field must not be too large. One way to test this is to investigate solutions to the linear response equation which results from perturbing the semiclassical backreaction equation about one of its solutions. In the case of semiclassical gravity this equation includes a term which involves an integral over the retarded two point function for the stress-energy tensor. In the other cases a similar integral over the relevant retarded two point function is present in the linear response equation. Thus if quantum fluctuations are large then one expects that gauge invariant solutions to the linear response equation to grow rapidly over some period of time. A simple method of finding approximate solutions to the linear response equation will be given. The validity of the semiclassical approximation will be discussed for the cases of preheating and the contracting phase of de Sitter space.

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Track classification :

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Track judgments :

Abstract ID : 27

Loop quantum cosmology and the CMB

Content :

Loop quantum cosmology has become a robust framework to describe the highest curvature regime of the early universe. We will summarize the theoretical framework, and explore the corrections to the inflationary predictions for the primordial spectrum of cosmological perturbations that the pre-inflationary, quantum gravity phase of the universe introduces. Non-Gaussianity and its relation to large scale anomalies in the CMB will be discussed.

Primary authors : Prof. AGULLO, Ivan (Louisiana State University)

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Track classification :

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Track judgments :

Abstract ID : 28

De Sitter breaking from gravitons at the one loop level

Content :

We evaluate the one-graviton loop contribution to the vacuum polarization on de Sitter background in a 1-parameter family of exact, de Sitter invariant gauges. Our result is computed using dimensional regularization and fully renormalized with BPHZ counterterms, which must include a noninvariant owing to the time-ordered interactions. Because the graviton propagator engenders a physical breaking of de Sitter invariance two structure functions are needed to express the result. In addition to its relevance for the gauge issue this is the first time a covariant gauge graviton propagator has been used to compute a noncoincident loop. A number of identities are derived which should facilitate further graviton loop computations.

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Track classification :

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Track judgments :

Abstract ID : 29

Asymptotic safety - from gauge theories to quantum gravity

Content :

Is is commonly believed that for a quantum field theory to be fundamental its high-energy behaviour should be controlled by a UV fixed point. A well-known example is asymptotic freedom of QCD where the fixed point is non-interacting. High-energy fixed points may also be interacting, a scenario known as asymptotic safety.

In this talk, I discuss the availability of asymptotically safe UV fixed points for 4D quantum field theories with (or without) gravity. This will include an overview of key challenges, methodologies, results, and future directions. If time permits, I will also discuss some implications of UV fixed points for particle physics and black holes.

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