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BOOK OF ABSTRACTS

Uniwersytet Wrocławski

Action MP 1405
Quantum Structure of Spacetime

UNIWERSYTET JAGIELLOŃSKI W KRAKOWIE

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Giovanni Amelino-Camelia (University of Naples Federico II)

Probing the fabric of spacetime with GRB photons and neutrinos

ABSTRACT: TBA

Michał Artymowski (Jagiellonian University & University of Warsaw)

Hill-climbing inflation

ABSTRACT: I will present the idea of an inflationary model driven by the inflaton in the scalar-tensor theory. I will present the class of models, which lead to hill-climbing evolution of the field. I will also present a particular model, for which the inflaton belongs to the dark sector of the Universe and the reheating can only be generated by gravity. I will show possible implications of such a model on primordial gravitational waves and on dark matter abundance.

Paolo Aschieri (University of Eastern Piedmont)

Quantum symmetries, observables and dispersion relations in flat and curved noncommutative space-times

ABSTRACT: Equations of motion for massless fields in noncommutative spacetimes are derived from quantum symmetry principles and the corresponding noncommutative differential geometry. Turning on a curved metric we obtain nontrivial dispersion relations due to the combined effect of curvature and noncommutativity.

Abhay Ashtekar (Pennsylvania State University)

Null infinity, radiation fields and the BMS group: Some surprises

ABSTRACT: Although radiation fields at null infinity have been analyzed extensively in the literature since the GR 3 conference in Warsaw, a few surprising results have emerged recently both at the classical and quantum level. Some of them have lead to interesting conjectures concerning BMS supertranslations and the infrared behavior of the gravitational field. The talk will be a broad overview of these developments.

Eric Bergshoeff (University of Groningen)

String Theory and Non-relativistic Gravity

ABSTRACT: I will show how non-relativistic strings move in a background geometry that is different from the usual non-relativistic gravity theory known as Newton-Cartan gravity. I will discuss the non-relativistic T-duality transformations of these background fields and point out an interesting relation with relativistic string theory. Furthermore, I will construct an action for these background fields in four spacetime dimensions.

Iwo Białynicki-Birula (Center for Theoretical Physics, Polish Academy of Sciences)

Trapping of bodies by gravitational waves endowed with angular momentum

ABSTRACT: It has been shown some time ago that electromagnetic waves endowed with angular momentum trap charged particles near the beam center. In this talk I will show that the trapping also occurs for gravitational wave endowed with angular momentum. Such waves are not uncommon. In particular, they are emitted by inspiralling black holes which must get rid of their orbital angular momentum.

Arkadiusz Błaut (University of Wroclaw)

On a response of a laser interferometer to gravitational waves

ABSTRACT: Laser interferometer response to all ten modes of a plane gravitational wave is given. The final result, the time of flight of a laser signal exchanged between freely moving observers and the derived Doppler tracking, is shown to be gauge-invariant with respect to a class of suitable gauge transformations. The result can be extended to include an arbitrary weak gravitational field.

Krzysztof Bolejko (University of Sydney)

Hubble law or Hubble-Lemaitre law?

ABSTRACT: Recently, the Executive Committee of the International Astronomical Union proposed a resolution on a suggested renaming of the Hubble Law. The Resolution "recommend that from now on the expansion of the Universe be referred to as the 'Hubble-Lemaitre law'" [Resolution B4 XXX GA IAU, www.iau.org]. This resolution caused a lot of debate, which resulted in deferring the voting. In my talk I will present relevant historical events related to the discovery of the expansion of the Universe. I will briefly discuss Georges Lemaitre and show why it is justified to honour and give credit to his work. Finally, I will present some arguments for and against the IAU resolution.

Gioele Botta (University of Warsaw)

Quantum reduced loop gravity effective dynamics from a statistical regularization scheme

ABSTRACT: We introduce a new regularization scheme for quantum cosmology in Loop Quantum Gravity using the tools of Quantum Reduced Loop Gravity. In particular we show how the two regularization schemes adopted in Loop Quantum Cosmology can be seen as particular case of our new scheme. Within this new scheme a new corrected effective Hamiltonian for a FRLW ($k = 0$) universe is presented and we show how the corrections with respect to Loop Quantum Cosmology lead to a strong departure from the time symmetric bounce scenario, which is replaced by the so called emergent-bouncing universe. The extension of this scheme for the anisotropic case will be discussed.

Bernd Brügmann (University of Jena)

Gravitational Waves and Numerical Relativity

ABSTRACT: The first detection of gravitational waves from black holes and neutron star mergers is a fantastic success for gravitational wave physics. Part of the success story are advances in numerical general relativity that allow us to simulate binaries with increasing levels of complexity. In this talk we focus on recent progress in numerical general relativity which allow us to perform computer simulations of neutron stars, and how such simulations may be connected to gravitational wave observations.

Piotr T. Chruściel (University of Vienna)

Stationary black holes with negative cosmological constant

ABSTRACT: I will present a construction of large families of singularity-free stationary solutions of Einstein equations, for a large class of matter models including vacuum, with a negative cosmological constant. The solutions, which are of course real-valued Lorentzian metrics, are determined by a set of free data at conformal infinity, and the construction proceeds through elliptic equations for complex-valued tensor fields. One thus obtains infinite dimensional families of both strictly stationary spacetimes and black hole spacetimes.

Adam Chudecki (Lodz University of Technology)

Complex and real type [N]x[N] spaces

ABSTRACT: Hyperheavenly spaces of the type [N]x[N] are analyzed. Such spaces are classified according to properties of the congruences of totally null and geodesic surfaces (null strings) and according to properties of the intersection of these congruences. There are six different types of complex spaces of the type [N]x[N]. Four of them have been recognized as complex generic spaces for the well-known vacuum type [N] Lorentzian spaces (pp waves, Kundt class, Robinson-Trautman class, twisting class). Lorentzian slices of three of these complex spaces have been found. Two types admit only real neutral slices. Especially interesting are types equipped with twisting congruence of null geodesics. The metric of the complex space of the type [N]x[N] which admitt twisting congruence of null geodesics is presented. Unfortunately, this metric admits only real neutral slice.

Ewa Czuchry (National Centre for Nuclear Research, Warsaw)

Toda system as a quantum approximation to the anisotropy of Mixmaster universe

ABSTRACT: A regularisation approach to the study of the quantum dynamics of the Mixmaster universe is presented. Such a regularisation allows to approximate the anisotropy potential with the explicitly integrable periodic 3-particle Toda system. Such an approach is based on a covariant Weyl-Heisenberg integral quantization which naturally amplifies the dynamical role of the underlying Toda system by smoothing out the three channels of the anisotropy potential. As for the Toda system the respective eigenfunctions can be explicitly constructed; these findings pave the way to a novel perturbative approach to the quantum Mixmaster dynamics.

Denis Dobkowski-Ryłko (University of Warsaw)

The Petrov type D equation on the cross sections of topologically different isolated horizons

ABSTRACT: The Petrov type D equation imposed on the 2-metric tensor and the rotation scalar of a cross section of the isolated horizons is studied. It can be used to uniquely distinguish the Kerr-(anti) de Sitter spacetime in the case the isolated horizon has a topology of S_2 x R. The horizons are assumed to be stationary to the second order and the solutions are derived assuming the embeddability in 4-dimensional spacetime that satisfies the vacuum Einstein equations with (possibly 0) cosmological constant. For the closed 2-dimensional surfaces of genus > 0 all of the type D equation solutions have constant Gauss curvature and zero rotation. Isolated horizons of the topology of S_3 have also been considered. In that case the family of solutions is 3-dimensional and explicit expressions of the 2-metric and the rotation scalar are found.

Polina Dyadina (Lomonosov Moscow State University)

Post-Keplerian formalism for hybrid metric-Palatini f(R)-gravity

ABSTRACT: The post-Keplerian formalism was developed for hybrid f(R)-gravity. The model was tested in the strong field regime of binary pulsars. Using scalar-tensor representation of hybrid f(R)-gravity we impose restrictions on the parameters of the theory and show that hybrid f(R)-gravity is not ruled out by the observations in strong field regime.

Laurent Freidel (Perimeter Institute)

Geometry of Relative Locality

ABSTRACT: In this talk I will review some of the general motivation behind relative locality which is an extension of the relativity principle. I will show how this leads at the classical level to a new concept of geometry, the Born geometry which allows the differential structure to be itself dynamical. How it leads at the quantum level to a new concept of space: Modular space and exemplify how it affects the effective geometry of string theory.

Jakub Gizbert-Studnicki (Jagiellonian University)

Quantum gravity on a torus

ABSTRACT: I will discuss a quantum gravity model defined by Causal Dynamical Triangulations (CDT). Identification of phase structure and order of the phase transitions constitute first steps in the quest for a continuum limit of CDT where, following the asymptotic safety conjecture, the resulting theory of quantum gravity becomes nonperturbatively renormalizable. Previous studies of 4-dim CDT focused on a model with fixed spatial topology of a 3-sphere leading to many interesting results, including identification of four distinct phases of geometry, some of which are separated by second (or higher) order phase transition lines. I will present recent results concerning phase diagram of CDT with spatial topology of a 3-torus and discuss properties of the, so called, phase C whose geometry both in spherical and toroidal case shows good semiclassical behaviour. If time permits I will also comment on the recent idea of reintroducing semiclassical coordinates in the CDT setup.

Krzysztof Głód (Jagiellonian University)

Strict solutions in the linear theory of cosmological perturbations up to second order

ABSTRACT We consider scalar perturbations of the spatially flat Friedmann-Lemaitre cosmological model. We formulate conditions for the metric functions under which basic gauge-invariant kinematic and dynamic fields of the perturbed model vanish at the first order of the linear perturbation theory. Then we combine these conditions to construct especially interesting perturbed models with specific properties. We particularly study the models with inhomogeneities characterized by the perfect fluid energy-momentum tensor and the models with inhomogeneities which behave monotonically with time. Finally, we perform the strict extension of the simplest cases of the considered models to the second order. We determine necessary assumptions for this development and present explicit solutions for the metric functions.

Giulia Gubitosi (Radboud University Nijmegen)

Nontrivial properties of momentum space and relative locality in κ*-Poincaré and q-de Sitter algebras*

ABSTRACT: While it has been know for some time that the momentum space associated to the κ-Poincaré algebra has the geometry of a de Sitter manifold, only very recently the same conclusion has been reached for the q-de Sitter algebra, where however the momentum space comprises the dual momenta to the boost generators besides the momenta that are dual to the translation generators. I will present the construction of such momentum spaces for the two algebras and discuss their relation to the phenomenology of relative locality.

Zbigniew Haba (University of Wroclaw)

Power spectrum of stochastic inflation

ABSTRACT: I discuss the power spectrum of cosmological and temperature perturbations on the basis of the Einstein-Klein-Gordon system in an approximation of a cold or warm inflation. The problem can be reduced to stochastic wave or diffusion equations. Various methods of calculation are considered and their possible equivalence or inequivalence explored.

Orest Hrycyna (National Centre for Nuclear Research, Warsaw)

The Brans-Dicke cosmology with non-minimally coupled scalar field

ABSTRACT: I will discuss a non-singular beginning of the Universe (i.e. the initial de Sitter state) in Brans-Dicke cosmological model with non-minimally coupled scalar field. Additionally, I will present a novel, dynamical GR limit in this theory.

Jacek Jezierski & **Tomasz Smołka** (University of Warsaw)

Simple description of generalized electromagnetic and gravitational hopfions

ABSTRACT: Hopfions are a family of `solitonary' field solutions which have non-trivial topological structure. I will focus on two physical applications of Hopfions: electromagnetism and linear

gravitation. I will show that electromagnetic (or linearized gravity) field can be quasi-locally described in terms of complex scalar field. New definition of topological charge for linearized gravity will be presented. Using Hopfion solution, I will discuss problem of energy in linearized gravitation. The talk is based on: arXiv:1802.01467 [gr-qc].

Jerzy Jurkiewicz (Jagiellonian University)

Causal Dynamical Triangulations – status report

ABSTRACT: In the talk I plan to start with a brief introduction to the CDT model in 4d and discuss shortly a list of results obtained for the case of a spherical spatial topology. New results correspond to a study of the model with a toroidal spatial topology. I plan to explain why we expect that this formulation may give more information and make a short list of propositions which may eventually lead to obtain a full semi-classical effective action of the model and possible quantum theories.

Igor Kanatchikov (University of St Andrews & National Quantum Information Centre, Sopot)

Precanonical Quantization in Curved Space-Time and the Functional Schrödinger Representation

ABSTRACT: Precanonical quantization of fields originates from a space-time symmetric (De Donder-Weyl) version of the Hamiltonian formalism in field theory. It leads to the description of quantum fields in terms of Clifford-algebra-valued wave functions on the finite-dimensional space of space-time and field variables which obey a Dirac-like analogue of the Schrödinger equation on this space. We show how this description of scalar fields in curved space-time leads to the standard functional Schrödinger representation in the limiting case of an infinite value of an ultraviolet parameter $\varkappa$ introduced by precanonical quantization. We also briefly discuss applications of precanonical quantization in quantum YM theory and quantum gravity.

Jerzy Kijowski (Center for Theoretical Physics, Polish Academy of Sciences)

New approach to Trautman-Bondi energy: how much energy is carried by gravitational waves

ABSTRACT: It is shown that the quantity known as the "Trautman-Bondi energy" (in older papers: "Bondi mass") is universal. It exists not only in General Relativity Theory, but also in any special-relativistic field theory which exhibits radiation phenomena (like e.g. clasical electrodynamics). Even if the technicalities (due to the non-linear character of the gravity theory) are relativiely heavy, the whole idea to label field configurations by "radiation data" instead of the "Cauchy data" is extremely simple and will be illustrated on important physical examples. In this approach, the main result, namely: the monotonic decrease of the T-B energy, follows immediately from the conservation of the total energy equal to the value of the total field Hamiltonian.

Jerzy Kowalski-Glikman (University of Wroclaw & National Centre for Nuclear Research, Warsaw)

Unruh effect without spacetime

ABSTRACT: I show that the Unruh effect can be associated with the partitioning of the real line, and derived from the basic representation theory of the group of affine transformations in one

dimension. This result shows that thermal distributions naturally emerge in connecting quantum states belonging to representations related to distinct notions of translational symmetry.

Aleksander Kozak (University of Wroclaw)

Palatini frames in scalar-tensor theories

ABSTRACT: Conformal transformations play an important role in the scalar-tensor theories of gravity, as they allow one to carry out calculations in a more convenient frame, simplifying the field equations. In the Palatini approach, however, the metric structure of space-time is decoupled from its affine structure, so that transformation of the metric tensor does not entail a corresponding change in the linear connection. One needs to define independent transformation for the connection, reducing to the standard formula in case the connection is Levi-Civita with respect to the metric. In my presentation, I shall present a scalar-tensor theory taking into account such transformation, called 'generalized almost-geodesic mapping', and discuss properties of the solution to the field equation for the connection. I will also introduce invariant quantities, whose functional form remains unchanged irrespective of the conformal frame, and show how they can be applied to analysis of possible equivalence between F(R) and scalar-tensor theories of gravity.

Andrzej Krasiński (N. Copernicus Astronomical Center, Polish Academy of Sciences)

Blueshifted light from the last-scattering epoch

ABSTRACT: Some light rays emitted from the Big Bang (BB) in Lemaitre-Tolman (L-T) and Szekeres (Sz) models reach all observers with an infinite blueshift. This happens when at the emission point the BB function t_B(r) has nonzero derivative and the ray propagates radially (in L-T) or along one of two preferred directions (in Sz). Consequently, some rays emitted during the last scattering period should be reaching us with a finite blueshift. This is a prediction of general relativity, which is an otherwise well-tested theory, so it should be investigated for its consequences for observations. This author recently proposed that blueshifted rays are observed as gamma-ray bursts (GRBs). In four consecutive papers it was shown that (1) L-T-based models of GRB sources successfully account for the energies of the GRBs, the large distances to them, their multitude, and for the existence of the afterglows (but not for the durations of the GRBs and of the afterglows and for their [hypothetical] collimation into narrow jets); (2) In Sz-based models large blueshifts may arise only along two opposite directions, so the collimation is immediately accounted for; (3) A Sz model generates a stronger blueshift than an L-T model with the same BB profile; (4) The short duration of the GRBs is accounted for if the blueshifted ray, on its way to the present observer, passes through another Sz region, where it undergoes the cosmic drift (i.e. a deflection by a time-dependent angle). The last two remaining problems are (i) to account for the measured durations of the afterglows and (ii) to make the angular diameters of the sources in the model compatible with the limits imposed by observations. Work on these is in progress.

Andrzej Królak (Institute of Mathematics, Polish Academy of Sciences)

Latest news from the gravitational wave detector projects

ABSTRACT: I shall present the current status of the ground-based gravitational wave detector projects: LIGO, Virgo, Kagra, and LIGO-India and the plans for the observations in the following years. I shall summarize results of the analysis of the LIGO and Virgo data obtained this year. In particular I shall present results of the searches of the gravitational radiation from binary star coalescence, pulsars, supernovae and stochastic background. I shall present the latest test of general relativity that were obtained from these data.

Searches for gravitational wave signals from rotating neutron stars in LIGO and Virgo data

ABSTRACT: I shall present the most recent results of the search for gravitational wave signals from rotating neutron stars in LIGO and Virgo data. I shall give a summary of the searches perfomed by the groups of the LIGO-Virgo consortium. I shall give details of the searches perfomed by the data analysis team from the Polgraw-Virgo group.

Wojciech Kulczycki (Jagiellonian University)

Mass and angular velocity in general-relativistic Keplerian disks around black holes

ABSTRACT: In my talk I consider self-gravitating toroidal disks around black holes that rotate according to the general-relativistic Keplerian rotation law. I investigate the problem of the existence of inequalities that could be used to estimate masses of such systems. The obtained bounds have a form of expressions containing quantities connected to the angular velocity of the particles in the disk. The numerical data fit these results.

Taejin Lee (Kangwon National University)

Four-Graviton Scattering and String Path Integral in the Proper-time Gauge

ABSTRACT: We evaluate the four-closed-string scattering amplitude by using the string path integral in the proper-time gauge. Identifying the Fock space representation of the four-closed-string-vertex, we obtain a field theoretic expression of the closed string scattering amplitudes. In the zero-slope limit, the four-closed-string scattering amplitude is shown to reduce to the four-graviton-scattering amplitude of the Einstein gravity. Given that the four-closed-string interaction is generated by the three-closed-string interaction, the quantum theory of gravity may be described consistently as a low energy limit of the closed string field theory which contains a cubic closed string interaction only.

Jerzy Lewandowski (University of Warsaw)

Isolated horizons, the Petrov type D equation and the Near Horizon Geometry equation

ABSTRACT: 3-dimensional null surfaces that are Killing horizons to the second order are considered. They are embedded in 4-dimensional spacetimes that satisfy the vacuum Einstein equations with arbitrary cosmological constant. Internal geometry of 2-dimensional cross sections of the horizons consists of induced metric tensor and a rotation 1-form potential. It is subject to the type D equation. The equation is interesting from the both, mathematical and physical points of view. Mathematically

it involves geometry, holomorphic structures and algebraic topology. Physically, the equation knows the secret of black holes: the only axisymmetric solutions on topological sphere correspond to the Kerr / Kerr-de Sitter / Kerr-anti-de-Sitter non-extremal black holes or to the near horizon limit of the extremal ones. In the case of bifurcated horizons the type D equation implies another spacial symmetry. In this way the axial symmetry may be ensured without the rigidity theorem. The type D equation does not allow rotating horizons of topology different than that of the sphere (or its quotient). That completes a new local non-hair theorem. The type D equation is also an integrability condition for the Near Horizon Geometry equation and leads to new results on the solution existence issue.

Patryk Mach (Jagiellonian University)

Keplerian self-gravitating tori around black holes

ABSTRACT: I will discuss models of equilibria consisting of a self-gravitating gaseous disk (torus) and a spinning central black hole. The emphasis will be put on Keplerian rotation, which seems to occur both in large systems in active galactic nuclei and also in a transient phase during neutron stars mergers. General-relativistic Keplerian rotation law capable of describing self-gravitating tori around spinless black holes was derived in 2015 by Edward Malec and me. It was first used to obtain post-Newtonian models, but it also turns out to be a robust prescription for constructing fully general-relativistic equilibria. In 2017, together with Janusz Karkowski, Wojciech Kulczycki, Edward Malec, Michał Piróg and Andrzej Odrzywołek, we generalized the former rotation law, taking into account the spin of the central black hole. In this talk I will discuss these developments, and also review the properties of corresponding numerical solutions of the stationary Einstein-Euler system of equations.

Shahn Majid (Queen Mary University of London)

Poisson-Riemannian geometry

ABSTRACT: I explain recent results towards a semiclassical theory of quantum Riemannian geometry. This amounts to classical fields and field equations that govern first-order corrections to classical gravity due to Planck scale effects, i.e. a new paradigm of `classical-quantum gravity'. As well as a Poisson tensor on spacetime, there is a Poisson-compatible connection that controls the quantisation of differential structures, with torsion but compatible with the Riemannian metric, and field equations coupling the three fields. The general theory is from my work with E. Beggs. In work with C. Fritz it was shown that the equations have an essentially unique solution for a spherically symmetric static spacetime and generic spherically symmetric Poisson tensor, forcing the quantisation to be a non-associative fuzzy sphere at each constant time and radius. These and other known solutions of the field equations will be described. If time, I will also present some contrasting finite models of quantum Riemannian geometry.

Edward Malec (Jagiellonian University)

General-relativistic rotation of heavy fluid bodies

ABSTRACT: (Based on joint work with Patryk Mach, Michał Piróg, Wojciech Kulczycki, Andrzej Odrzywołek and Janusz Karkowski.) I shall report recent results, obtained in Cracow, on rotation of

self-gravitating disks around spinless or spinning black holes. This solves a significant part of an old problem on rotation laws in general relativistic hydrodynamics.

Tomáš Málek (Institute of Mathematics, Czech Academy of Sciences)

Universal Metrics

ABSTRACT: Universal metrics are exact vacuum solutions to all higher-order gravity theories with the Lagrangian described by any polynomial curvature invariant constructed from the metric, the Riemann tensor and its covariant derivatives of arbitrary order. These metrics are thus insensitive to higher-order corrections to the Einstein gravity. We study universal Lorentzian metrics of any dimension belonging to the Kundt class of non-expanding, non-shearing and non-twisting spacetimes. We also discuss Walker metrics of neutral signature admitting a field of parallel null 2-planes and identify universal metrics within this class.

Przemysław Małkiewicz (National Centre for Nuclear Research, Warsaw)

Reductions of cosmological perturbation theory via the Dirac procedure

ABSTRACT: We perform the Dirac procedure in the context of the Arnowitt-Deser-Misner Hamiltonian formalism expanded around the Friedmann universe. We discuss and employ some basic concepts such as Dirac observables, Dirac bracket, gauge-fixing conditions, reduced phase space, physical Hamiltonian and gauge-relating canonical isomorphism. Following the Dirac procedure we derive the reduced phase space for cosmological perturbations, which we interpret in terms of some popular in literature gauges. We focus on the universe filled with a single fluid and next we extend our result to the multi-fluid case. The discussed formalism is a starting point for future quantization of the cosmological perturbations and the cosmological background in a consistent manner.

Michal Marvan (Silesian University in Opava)

Scalar invariants of spacetimes with symmetries and the problem of equivalence

ABSTRACT: The standard solution to the problem of equivalence in general relativity, the Cartan-Karlhede algorithm, requires computation of scalar invariants from second up to ninth order in the worst case. However, a majority of known metrics admit Killing fields and, consequently, also adapted coordinate systems. In adapted coordinates, the pseudogroup of admissible coordinate transformation reduces and new scalar invariants appear. Dealing with the important case of two commuting Killing fields, we show that generic orthogonally transitive metrics have four independent first-order scalar invariants, while generic orthogonally intransitive metrics have six independent first-order scalar invariants and a first-order invariant frame. We discuss their geometric meaning, explicit formulas, and consequences.

Lionel Mason (University of Oxford)

Gravitational perturbation theory from ambitwistor strings

ABSTRACT: This talk will review the development of twistor and ambitwistor strings and how they lead to remarkably simple and beautiful formulae for the perturbative S-matrix of gravity and other theories. It will also discuss various applications to asymptotic symmetries, and generalizations.

Jakub Mielczarek (Jagiellonian University & Aix-Marseille University)

Quantum Gravity on a Quantum Chip

ABSTRACT: This talk aims at emphasizing the potential of a synergy between quantum gravity and the quantum computing technologies. Such a combination would be beneficial for both understanding the Planck scale physics and the stimulation of development of the quantum technologies. This is especially important in the present early days of commercial quantum computers, when challenges originating from the basic research may catalyze the technological progress. Our attention will be focused on simulations of a Planck scale system with the use of existing adiabatic quantum computers. Current possibilities, technological challenges and prospects for the future will be outlined.

Djordje Minic (Virginia Tech)

Manifest quantum non-locality in quantum mechanics, quantum field theory and quantum gravity

ABSTRACT: In this talk we will discuss manifest quantum non-locality in quantum mechanics while concentrating on the essential features of any quantum theory, such as linear superposition and entanglement. We will reveal the hidden quantum space-time geometry behind this non-locality, that is also consistent with causality. We will then illustrate how this same quantum space-time geometry appears in the context of quantum gravity, and finally, discuss the meaning of such quantum non-locality in the context of quantum field theory, while pointing out a new generic prediction that follows from this novel view on quantum theory and quantum gravity.

Sergey Odintsov (ICREA & ICE-CSIC, Barcelona)

Unifying inflation with dark energy: the case of modified gravity

ABSTRACT: I give the introduction to modified gravity. Mainly, F(R) gravity is considered but also other theories, like modified Gauss-Bonnet gravity are mentioned. It is shown the basic properties of such theory and how one can construct viable models from F(R) gravity. The possibility to unify the early-time inflation with late-time acceleration is described in detail following the line developed in the series of our works. Special attention is paid to construction of realistic inflation. Not only slow-roll inflation but also constant-roll inflation is discussed in F(R) gravity. The account of quantum gravity R^2-like contribution is done. The possibility to describe in realistic way the constant-roll F(R) epoch with exponential dark energy era is presented in detail. The correct autonomous dynamical system approach to F(R) gravity which gives stable and instable de Sitter vacuum is developed. The possibility of bounce cosmology in F(R) is briefly discussed. The lecture is based significally on recent

review: S.Nojiri, S.D.Odintsov and V.K.Oikonomou, ``Modified Gravity Theories on a Nutshell: Inflation, Bounce and Late-time Evolution,'' [arXiv:1705.11098 [gr-qc]].

Andrzej Odrzywołek (Jagiellonian University)

Rotation law emerging from GR numerical simulation of merging neutron stars

ABSTRACT: Relativistic ,,Keplerian'' rotation law has been derived, in analytical form, for stationary massive self-gravitating toroids with rotating black hole at the center. Question arises, whether similar phenomenon could be found in more realistic, dynamic situation. Analysis of provided data computed in the 3D GR numerical simulation (De Pietri et all PRD 2016) clearly show emergence of rotation law. However, fitting procedure return surprising ,,Kerr parameter'' value for toroid of a = 1.5.

Marcello Ortaggio (Institute of Mathematics, Czech Academy of Sciences)

Ultrarelativistic boost of a black hole in the magnetic universe of Levi-Civita–Bertotti–Robinson

ABSTRACT: We discuss the Aichelburg-Sexl limit of an exact Einstein-Maxwell solution constructed by Alekseev and Garcia which describes a Schwarzschild black hole immersed in the magnetic universe of Levi-Civita, Bertotti and Robinson (LCBR). Boosting the static source to the speed of light, while sending its mass to zero, produces a non-expanding, spherical impulsive wave traveling in the LCBR universe. The obtained line-element belongs to the Kundt class of spacetimes. Its relation with known families of exact gravitational waves of finite duration is pointed out.

Tomasz Pawłowski (Center for Theoretical Physics, Polish Academy of Sciences)

Emergent de Sitter epoch of the quantum Cosmos

ABSTRACT: The quantum nature of the Big Bang is reexamined in the framework of Loop Quantum Cosmology. The strict application of a regularization procedure to the Hamiltonian, originally developed for the Hamiltonian in loop quantum gravity, leads to a qualitative modification of the LQC bounce paradigm. Quantum gravity effects still lead to a quantum bounce connecting deterministically large classical Universes. However, the evolution features a large epoch of de Sitter Universe, with emergent cosmological constant of Planckian order, smoothly transiting into a flat expanding Universe.

Michał Piróg (Jagiellonian University)

Post-Newtonian model as an intermediate step to the description of the general relativistic rotation in self-gravitating, Keplerian tori around black holes

ABSTRACT: Models composed of a rotating black hole and a massive self-gravitating torus are not available for analytical methods because of their high mathematical complexity. I will present numerical results which show that the nature of the ''Keplerian rotation'' is different in the Newtonian and first post-Newtonian approximation within GR. In the Newtonian gravity -- according to the Poincarè-Wavre theorem -- the angular velocity is the function of one parameter -- the

distance from the rotation axis. In general relativity it is a function of both -- radial and polar angle coordinates. In my talk I am going to focus on the angular velocity of the fluid in ''black-hole-torus'' systems and clarify and underline the role of the 1PN description as an intermediate step in going from Newtonian to the general-relativistic description.

Istvan Racz (Wigner Research Centre for Physics & University of Warsaw)

Construction of quasi-convex foliations with monotonous Geroch mass

ABSTRACT: A generic construction of three-dimensional Riemannian spaces with prescribed scalar curvature and with quasi-convex foliations is introduced such that the corresponding quasi-local Geroch mass is to be monotonously non-decreasing with respect to the applied generalized inverse mean curvature flows.

Giacomo Rosati (INFN Cagliari)

q-de Sitter and κ-Poincaré symmetries in Chern-Simons (2+1)D gravity with cosmological constant

ABSTRACT: Exploiting the "quantum duality principle" between Hopf algebras and Lie Poisson groups I show that, within a Chern-Simons formulation, a point particle coupled to Lorentzian (2+1)D gravity with cosmological constant acquires, in a deformation-quantization scheme, deformed relativistic symmetries of q-de Sitter type that reduce to (2+1)D κ-Poincaré symmetries in the limit of vanishing cosmological constant.

Szymon Sikora (Jagiellonian University)

The approximate solutions of the high order cosmological perturbation theory

ABSTRACT: During this talk, I will present the method of the construction of the approximate solutions in the framework of the cosmological perturbation theory up to the third order. I will restrict to the synchronous gauge and impose the particular symmetry condition by demanding that the metric is invariant under every permutation of the spatial coordinates. In this setup, I will show how to specify the metric functions so that the resulting energy-momentum tensor approximates the dust energy-momentum tensor. I will comment on the particular observables in the considered spacetime.

Andrzej Sitarz (Jagiellonian University)

Bimetric gravity from spectral action

ABSTRACT: A simple two-sheet spacetime model is studied from the point of view of noncommutative geometry, yielding a new interpretation and sound motivation for the theories of bimetric gravity while at the same time restricting the possible freedom of parameters in the action functional.

Leszek Sokołowski (Jagiellonian University)

Alternative theories of gravitation must be restricted by elimination of the conformal tensor from their Lagrangians

ABSTRACT: This is a final version of a research programme, whose successive stages were presented at POTOR 3 and POTOR 4. Any Lagrangian of a metric theory of gravity, being a smooth function of the full curvature tensor is acceptable from a mathematical point of view and which of them forms the correct theory must be determined on the basis of a large set of solutions to corresponding field equations, which are confirmed by a vast collection of observational data. However, a sufficient amount of observational data are currently unavailable and if one claims that Einstein-Hilbert Lagrangian requires a modification by additional curvature terms, then the correct choice must be done on purely theoretical grounds. We apply both classical and quantum field theory concepts and assuming that the gravity theory we seek for, actually represents a multiplet of fields-particles, we show that the maximum number of attainable field-theoretical degrees of freedom is seven rather than eight. Any Weyl tensor contribution to the Lagrangian is unphysical and redundant.

Sebastian Szybka (Jagiellonian University)

Backreaction of gravitational and scalar waves

ABSTRACT: Within the Green-Wald backreaction framework, one may calculate the effect of small scale inhomogeneities on the global structure of a background spacetime. I will discuss properties of a background spacetime representing cylindrically symmetric high frequency gravitational and scalar standing waves.

Jacek Tafel (University of Warsaw)

The Penrose inequality for an axially perturbed Schwarzschild black hole

ABSTRACT: This is a joint work with J. Kopiński. We consider axially symmetric vacuum initial data with conformally at metric. In this case the momentum constraint is completely solved in terms of one function of two variables. We study the Lichnerowicz equation with a boundary condition on the sphere which assures that this surface becomes marginally trapped after a conformal transformation. We show that the Penrose inequality M >= sqrt(A/16π), where M is the total mass and A is the surface area of the horizon, is satisfied for sufficiently small addition of the exterior curvature to the Schwarzschild data.

Paul K. Townsend (University of Cambridge)

Third-way consistency for 3D Yang-Mills and 3D Gravity

ABSTRACT: Any proposed set of gauge/gravity field equations must be consistent with the Bianchi identities implied by gauge invariance. This consistency condition is guaranteed by the existence of an action, but the action could depend on auxiliary fields that can be eliminated only from the field equations. This results in ``third-way'' consistent gauge/gravity field equations that cannot be found by standard methods. A simple modified Yang-Mills theory in 2+1 dimensions illustrates the point. For gravity in 2+1 dimensions, the known ``massive gravity'' examples will be found as special cases

of a general construction. Finally, prospects for an extension to higher spacetime dimensions will be discussed.

Aneta Wojnar (M. Curie-Skłodowska University & University of Espírito Santo)

Palatini stars

ABSTRACT: I will briefly present the so far progress on relativistic stars in Palatini gravity. One may expect the discussion on the stability problem as well as the very first approach to some special types of stars whose stellar structure is provided by the modified gravity.

Naqing Xie (Fudan University)

On Some Estimates of Hawking Mass for CMC Surfaces

ABSTRACT: We apply the Riemannian Penrose inequality and the Riemannian positive mass theorem to derive inequalities on the boundary of a class of compact Riemannian 3-manifolds with nonnegative scalar curvature. The boundary of such a manifold has a CMC component, i.e., a 2-sphere with positive constant mean curvature; and the rest of the boundary, if nonempty, consists of closed minimal surfaces. A key step in our proof is the construction of a collar extension that is inspired by the method of Mantoulidis-Schoen. These inequalities can be viewed as certain estimates of the Hawking mass. This talk is based on a joint work with Pengzi Miao at University of Miami.

Kentaroh Yoshida (Kyoto University)

Yang-Baxter deformations and generalized supergravity

ABSTRACT: Recently, there has been a fundamental and significant development about the Green-Schwarz (GS) formulation of superstring theory. In this formulation, the kappa-symmetry plays a central role to ensure the consistency of the theory. In 2016, Tseytlin and Wulff showed that the kappa-symmetry constraints of the GS superstring defined on an arbitrary background lead to a ``generalized'' supergravity, which contains an additional (non-dynamical) vector field, rather than the standard supergravity. This result indicates that we might have overlooked a potentially important ingredient in the low-energy effective theory of string theory for long time, and may open up new directions including phenomenology and cosmology. In this talk, I will briefly introduce the recent progress on the generalized supergravity by focusing upon Yang-Baxter deformations and non-geometric aspects.

Posters

Lennart Brocki & **Josua Unger** (University of Wroclaw)

Quantum Ergosphere and Brick Wall Entropy

ABSTRACT: In a first attempt to obtain a microscopic derivation of black hole entropy 't Hooft had to introduce by hand a cutoff close to the horizon, the so-called brick wall. Here we argue that taking into account the backreaction from the Hawking radiation on the spacetime removes the need for such an ad hoc assumption. By identifying the quantum ergosphere, a consequence of the backreaction, with the brick wall we can determine the value of the cutoff parameter in terms of the total luminosity. The standard entropy of a black hole is recovered approximately.

Marcin Daszkiewicz (University of Wroclaw)

Two-particle system in the presence of ħ-corrected Coulomb potential

ABSTRACT: We examine the ħ-corrected Coulomb potential for scalar QED in the quantum-mechanical context, i.e., we derive the corresponding ground energy corrections for Helium atom in such a way, that the obtained result (E_helium = -78.94 eV) reproduces the experimental data with accuracy δE = E_Helium - E_experimental = 0.09 eV. Precisely, we demonstrate, that the performed at the first level of perturbation expansion calculation remains finite only after the proper regularization of the model, by introducing the cutoff parameter rcut. Its value is found numerically and it is equal to 0.12 Å , i.e., r_cut = 5L_c with L_c denoting the Compton length of the wave.

Filip Ficek (Jagiellonian University)

Weak field dynamics of Schrödinger-Newton-Hooke equation

ABSTRACT: We consider the Schrödinger-Newton-Hooke equation which describes a self-gravitating Bose-Einstein condensate in a harmonic trap, but can also be viewed as a nonrelativistic limit of the Einstein-Klein-Gordon equations with negative cosmological constant. It has several interesting features, depending on the spatial dimension of the considered system. In particular, the weak field approximation of this system in 4+1-dimensional case is of the special interest as it admits the existence of the invariant manifold. This is joint work with Piotr Bizoń and Oleg Evnin.

Sofya Labazova (Lomonosov Moscow State University)

Test of massive Brans-Dicke theory in binary pulsars

ABSTRACT: We applied the parameterized post-Keplerian approach for massive Brans-Dicke theory. Using the binary pulsar system's data we obtain restrictions on the parameters of this theory.

Ciprian Sporea (West University of Timisoara)

Scattering of spin 1/2 particles by Bardeen regular black holes

ABSTRACT: In this poster I will give a brief summary of the results I obtained for scattering of fermions by Bardeen black holes. After obtaining the scattering modes by solving the Dirac equation in this geometry, I use the partial wave method to derive an analytical expression for the phase shifts that enter into the definitions of partial amplitudes that define the scattering cross sections and the induced polarization. It is then showed that, like in the case of Schwarzschild and

Reissner-Nordström, the phenomena of glory and spiral scattering are present.

Marian Wiatr (University of Warsaw)

How to localize energy in classical field theory

ABSTRACT: Imposing appropriate boundary conditions, field evolution within a bounded region V becomes an isolated Hamiltonian system (in the strong, functional-analytic sense). The value of its Hamiltonian function is identified with the (quasi-local) field energy contained in V. The goal of this approach is to clarify the notion of the quasi-local gravitational field energy.