The 9th Conference of the Polish Society on Relativity

Book of abstracts

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Abstracts

Invited speakers

Hamiltonians and quantum gravity: present and future

Fernando Barbero
Spanish National Research Council

One of the main avenues to quantize gravity is through the use of canonical methods. For singular field theories such as general relativity it is very useful to rely on a geometric approach to the Hamiltonian formulation. This is very useful, in particular, when the spacetime manifold has spatial boundaries. In my talk I will discuss and review these geometric methods and show how they work in several examples. In particular, I will provide a quick derivation of the real Ashtekar formulation from the Holst action.

Gravitational-wave astronomy in 2023 with LIGO, Virgo and KAGRA

Eric Chassande-Mottin
French National Centre for Scientific Research

This presentation will offer an update on the current state of gravitational-wave astronomy as of 2023, focusing on the activities of the LIGO, Virgo, and KAGRA interferometric detectors. After their first observation in 2015 and three subsequent observation runs, LIGO-Virgo-KAGRA collaborations have identified 90 potential sources(each with a probability of astrophysical origin larger than 50 %). These sources predominantly consist of mergers involving compact binary systems, such as neutron stars, black holes, or a combination of both. The start of the fourth observation run in May 2023 marks a significant milestone that will expand the catalog of gravitational-wave sources. These observations have not only advanced our understanding of astrophysics, particularly in terms of massive star evolution and the formation of stellar-mass black holes but have also had implications for cosmology and fundamental physics, including various tests of General Relativity. In this presentation, we will highlight key findings and provide insights into the current plans for improvements starting with the upcoming fifth observation run (O5) and potential directions beyond O5.

Equivalence principle, de-Sitter space, and twistor theory

Maciej Dunajski
University of Cambridge

I discuss the impact of the positive cosmological constant on the interplay between the equivalence principle in general relativity, and the rules of quantum mechanics. There is an ambiguity in the definition of a phase of a wave function measured by inertial and accelerating observes which is a non-relativistic analogue of the Unruh effect. This will be put in the framework of a non—relativistic limit of twistor space.

Long-term simulations of binary neutron star mergers: thermal effects, post-merger remnant oscillations, and non-convex dynamics

Jose Antonio Font
University of Valencia

Numerical-relativity simulations of binary neutron star (BNS) mergers are fundamental to advance our understanding of those systems and to assess the role they play across various fields: relativistic astrophysics (as the central engine of short gamma-ray bursts and kilonovae), gravitational physics (as prime sources of gravitational waves), cosmology (as standard sirens), and nuclear physics (to constraint the equation of state (EOS) of dense matter at supranuclear densities). While the inspiral phase can be accurately described by post-Newtonian approximations, the merger and post-merger phases can only be studied with non-linear numerical simulations in full general relativity. In this talk I will review recent results from our new long-term simulations of BNS mergers. The importance of finite-temperature effects in the post-merger remnant's long-term dynamics and gravitational-wave emission will be highlighted. Moreover, I will also discuss the detectability prospects of high-frequency features present in the late-time spectrum along with the potential inference of thermal effects through the analysis of the waveforms. Finally, I will examine the role non-convex EOS may play in the merger dynamics and how this effect might lead to questionable interpretations of physical results.

Black Hole Stability Problems in GR

Elena Giorgi
Columbia University

In this talk, I will give an overview of the stability problems for black hole solutions, starting with the mode stability results in black hole perturbation theory in the 80's to more recent mathematical proofs, as the linear and the fully non-linear stability of black hole solutions require new mathematical techniques. Finally, I will present some aspects of our recent proof with Klainerman and Szeftel of the non-linear stability of the slowly rotating Kerr black hole.

The challenges of ΛCDM and the physics transition approaches

Leandros Perivolaropoulos
University of Ioannina

I first review the three main classes of observational challenges to the standard cosmological model (ΛCDM): the Hubble tension, the growth of perturbations tension and the cosmic dipoles. I then focus on essence of the Hubble tension and describe the assumptions involved in its existence. I also classify the models that have been proposed for its resolution in three broad classes: Early time models that change the sound horizon scale, late time models that deform the Hubble expansion history $H(z)$ and ultralate time models that change the physics of the late time distance calibrators (SnIa, Cepheids, TRGB etc). I show that in each one of these classes the most succesful representative models involve some kind of abrupt event (transition) that may occur either at early times before recombination ($z > 1100$, eg new early dark energy) or at late times ($z \sim 1$, eg sign switching cosmological constant) or at ultralate times ($z < 0.01$ eg gravitational transition that changes the physics of SnIa). The potential of each class to resolve the other two challenges will be briefly discussed. Finally, I focus on the ultralate late class of models and discuss observational hints for their predicted signals and possible theoretical models that may support them.

Cosmic Distance Ladder

Bartłomiej Zgirski
Nicolaus Copernicus Astronomical Center

Distance determinations are among the fundamental tasks in astronomy. They not only allow for the proper calibration of the energetics of different astrophysical phenomena but are also crucial for determining important cosmological parameters, including the Hubble parameter.

There is no single universal method for cosmic distance determinations. In practice, we work with the cosmic distance ladder, where short-range methods calibrate zero points of long-range methods. The most precise and accurate distances to astrophysical objects and systems are obtained using geometric methods such as parallax or relying on the analysis of detached eclipsing binary stars. These methods allow us to anchor our secondary methods applied in the determination of distances to nearby galaxies. Classical Cepheids, the tip of the Red Giant Branch, and carbon stars are representatives of the secondary distance indicators. The final rung of the ladder is associated with distances to galaxies in the Hubble flow obtained using properly calibrated luminosities of supernovae.

An important problem in modern astronomy is the discrepancy between values of the Hubble parameter obtained from observations of the early and late Universe, known as the Hubble tension. Namely, the model-dependent value based on the analysis of the cosmic microwave background observed with the Planck space observatory does not agree with the value based on the determination of the parameter using supernovae calibrated by classical Cepheids. This puzzling issue could be associated with the need to check for unaccounted systematic errors in the distance determination methods or the necessity to revise the Lambda cold dark matter cosmological model. Thus, it is important to use, in parallel, different distance determination methods at the same scales in order to check for potential systematic biases that depend on the used method.

As a member of the Araucaria Project, an international team of astronomers working on the cosmic distance scale, I will highlight the methods we use. I will also present a new Polish observatory in the Chilean Atacama Desert that will allow us to gather both photometric and spectroscopic data in the optical and near-infrared domains for the purpose of our project and beyond.

Participants

Modified Poisson equation in $f(Q)$ gravity

Débora Aguiar Gomes
University of Tartu

The standard theory of star evolution fails to explain various aspects of stellar structure. This study aims to address this limitation by reexamining stellar theory through the lens of Modified Gravity. Specifically, we apply the weak field limit to $f(Q)$ theories, deriving the modified Poisson equation. We explore different forms of the $f(Q)$ functions and their impact on the Poisson equation. Additionally, we investigate modifications to the hydrostatic equilibrium equation and the Lane-Emden equation, along with their practical applications.

κ-deformed finite boost for a two-particle system

Andrea Bevilacqua
National Centre for Nuclear Research

In this talk I will first introduce the κ-Minkowski spacetime, whose coordinates satisfy the $AN(3)$ algebra. By building the group elements associated to the $AN(3)$ algebra I will then introduce the momentum-space group manifold, and I will emphasize its relation with the κ-Poincaré (Hopf) algebra, which describes the symmetries of κ-Minkowski spacetime. This will then allow us to build the finite boost for a two-particle state. I will then turn to the study of how particles and antiparticles behave in κ-Minkowski spacetime, and to do so I will briefly introduce the action of a complex scalar field and show the translation charges. Starting from these results, I will then consider a particle/antiparticle pair resulting from the decay of some initial particle, both in its center of mass and in a boosted reference frame, using the results obtained in the first part of the talk. The behaviour of particles and antiparticles in a boosted frame will then be discussed, highlighting the important and interesting differences with the non-deformed case.

The time problem and primordial perturbations

Alice Boldrin
National Centre for Nuclear Research

The problem of time in physics arises from the conceptual discrepancies between non-relativistic and relativistic time. The principle of general covariance in general relativity gives us the freedom to choose an arbitrary clock for our theory. In quantum mechanics, however, different choices of internal time variables are known to produce unitarily inequivalent quantum models. In my presentation I will propose a fully analytical model of primordial gravitational waves propagating in a Friedman-Lemaitre-Robinson-Walker background with different clocks to study what are (if any) the dynamical predictions of quantum gravity models for large classical universes, which do not depend on the employed time variable. Solving the Hamiltonian constraint of the model and fixing the internal time variable prior to quantization, we are able to study all the existing clocks and quantize them in a way that ensures a fixed "operator ordering". Hence, any quantum ambiguity found is safely ascribed to the different choice of clock.

Para-Kahler and para-Hermite Einstein spaces

Adam Chudecki
Łódź University of Technology

It is shown how hyperheavenly spaces formalism can be used to find an explicit examples of para-Kahler and para-Hermite Einstein spaces. All algebraically degenerate para-Kahler Einstein spaces are known explicitly. On the other hand, there are only several explicit examples of para-Hermite Einstein spaces. Classfication of such spaces according to different criteriae is also presented.

Kerr geodesics in terms of Weierstrass elliptic functions

Adam Cieślik
Jagiellonian University

I will present the theory of Kerr geodesics. Based on a Weierstrass-Biermann theorem, I will derive two formulas, one for radial motion and one for altitude motion, both describing all non radial, timelike and null trajectories in terms of Weierstrass elliptic functions. These will be a generalisation of last year's method, which describes geodesics in the Schwarzschild metric. Two single expressions work remarkably for an entire geodesic trajectory, whether equatorial or not, even if it passes through turning points. With their help, I will show how to derive expressions for the azimuthal angle and coordinate time along the geodesic.

Gauge theories with boundaries and its application to GR

Alejandro Corichi
CCM-UNAM, Mexico

We shall give a summary to an extension of Dirac algorithm to theories with boundaries, and its application to GR, in particular to the physics of Black Holes through the Isolated Horizons formalism (IH).

Quantum computations in Loop Quantum Gravity

Grzegorz Czelusta
Jagiellonian University

One of the possible applications of quantum computers in the near future are quantum simulations of physical systems. In Loop Quantum Gravity the quantum geometry of space is represented by superposition of the so-called spin networks. A construction of quantum circuits that generate states of the Ising-type spin networks is described. The results of the implementation of the approach on the IBM superconducting quantum computers are presented. Moreover, some theoretical quantum information properties of spin networks are described.

A generalization of Einstein's quadrupole formula for radiated energy in de Sitter spacetime

Denis Dobkowski-Ryłko
University of Warsaw

We consider gravitational radiation produced by a time changing matter source in de Sitter spacetime. A Killing horizon is used as a generalization of the conformal boundary from the radiation theory in Minkowski spacetime. We derived the expression for the energy of the radiation passing through the horizon. Our result takes the form of a generalized quadrupole formula expressed in terms of the mass and pressure quadrupole moments and is written explicitly up to the first order in $\sqrt{\Lambda}$. The zeroth order term recovers the famous Einstein's quadrupole formula obtained for the perturbed Minkowski spacetime, whereas the first order term is a new correction.

Quasinormal modes for Reissner-Nordström-anti-de Sitter black holes

Filip Ficek
University of Vienna

In this talk we present the method letting us study quasinormal modes of Reissner-Nordström-anti-de Sitter black holes in both regular and extremal cases within a single framework. We also discuss interesting effects that can be observed as one approaches the extremal charge. This is joint work with Claude Warnick.

Constant intrinsic curvature surfaces in AdS/CFT

Mario Flory
Jagiellonian University

More than 130 years ago, Jean-Gaston Darboux remarked that surfaces of constant extrinsic curvature seem to play a much more prominent role in mathematical physics than surfaces of constant intrinsic (Gaussian) curvature. At least in the AdS/CFT correspondence, this observation seems to hold true to this day, as evidenced e.g. by the success of the Ryu-Takayanagi formula. Here, motivated by recent studies of so called holographic complexity measures and their connection with the gravitational action, I will comment on a possible role that constant intrinsic curvature surfaces might play in the holographic dictionary. I will also show how such surfaces can be constructed particularly easily in an AdS_3 background.

Four-dimensional Causal Dynamical Triangulations - the status report

Jakub Gizbert-Studnicki
Jagiellonian University

Causal Dynamical Triangulations (CDT) is a lattice regularization of the theory of quantum gravity, based on the formalism of Regge Calculus and Feynman path integrals. Due to mathematical complexity, analytical solutions exists only in two dimensions, and the four-dimensional model is analyzed by numerical simulations. In my talk I will briefly introduce the four-dimensional CDT and present its most important results, including the dynamically emerging semiclassical universe, the non-trivial phase structure, the impact of spacetime topology and the search for a continuum limit. If time permits, I will also discuss extensions of the pure gravity model to include scalar fields and prospects for further developments of the CDT approach.

Two divergenceless fields in inertial and irrotational flow

Krzysztof Głód

Jagiellonian University

For inertial and irrotational flow in space-time, we derive and give conditions under which there exist two algebraically independent fields whose divergence vanishes. We comment on the applicability of this result to the description of weak gravitational waves propagating in the Friedmann–Lemaitre cosmological model.

Projection evolution and quantum spacetime

Andrzej Góźdź

Maria Curie Sklodowska University Lublin

The projection evolution formalism allows to treat time and space on the same footing. This fundamental property is a base for a natural constructions of quantum spacetimes which emerge from the quantum state space K at a given evolution step. The quantum state space K is based on a classical configuration space X of quantum systems. A kind of POV measure obtained from a generalization of the coherent states defines the quantum configuration space of the system. The quantum spacetime, in turn, emerges from this POV measure. For this purpose, the additional fiber bundle structure on X with the base X_{ST} is superimposed. X_{ST} represents a support of a set of the classical spacetimes.

The geometric optics limit of gravitational wave lensing in Palatini f(R) gravity

Sreekanth Harikumar

National Centre for Nuclear Research

Recent advancements in gravitational wave detection have led to the speculation that certain signals could be gravitationally lensed, resulting in signal amplification. This phenomenon not only opens up new scientific frontiers for precision cosmology studies and the detection of stellar-mass objects and intermediate-mass black holes, but also provides an opportunity to test and constrain different theories of gravity. This presentation focuses on comparing Palatini $f(R)$ gravity with General Relativity, examining specific aspects and examples. By employing the eikonal approximation to explore the geometric-optical limit of lensing and deriving the evolution of gravitational waves, we demonstrate deviations in the amplification factor for the Singular Isothermal Sphere, contrasting with General Relativity's predictions.

Gas environmental effect on gravitational waves from supermassive binary black holes

Fatemeh Hossein Nouri

Center for Theoretical Physics PAS

The merger of supermassive black holes (BBH) produces low frequency gravitational waves (GW), which are potentially detectable by future Laser Interferometer Space Antenna (LISA). Such binary systems are usually embedded in an accretion disk environment at the center of the active galactic nuclei (AGNs). Recent studies suggest the plasma environment creates measurable imprints on the GW signal for extreme mass ratio binaries. The effect of the gaseous environment on the GW signal is strongly dependent on the disk's parameters, therefore the future low-frequency GW observations may provide us with precious information about the physics of AGN accretion disks. We investigate this effect by measuring the disk torques on the binary system by modeling several magnetized tori. Using GRMHD HARM-COOL code, we perform 2D simulations of weakly-magnetized thin accretion disks, with a possible truncation and transition to advection dominated accretion flow (ADAF). We study the angular momentum transport and turbulence generated by the magnetorotational instability (MRI) in our numerical simulations. We quantify the disk's effective alpha viscosity and its evolution over time.

Conformal Yano-Killing tensor and its applications in GR

Jacek Jezierski

University of Warsaw

Properties of (skew-symmetric) conformal Yano–Killing tensors are reviewed. The examples of CYK tensors in Minkowski, Kerr, de Sitter and anti-de Sitter spacetimes are discussed.

Basic facts and definitions of the spin–2 field and conformal Yano-Killing tensors are introduced. Application of those two objects provides a precise definition of quasi-local gravitational charge. It leads to geometric definition of the asymptotic flat spacetime:"strong asymptotic flatness", which guarantees well defined total angular momentum. Conformal rescaling of conformal Yano–Killing tensors and relations between Yano and CYK tensors are discussed. Pullback of these objects to a submanifold is used to construct all solutions of a CYK equation in anti-de Sitter and de Sitter spacetimes.

Properties of asymptotic conformal Yano–Killing tensors are examined for asymptotic anti-de Sitter spacetimes. Explicit asymptotic forms of them are derived. The results are used to construct asymptotic charges in asymptotic AdS spacetime. Well known examples like Schwarzschild-AdS, Kerr-AdS and NUT-AdS are examined carefully in the construction of the concept of energy, angular momentum and dual mass in asymptotic AdS spacetime.

Other applications: symmetric Killing tensors and constants of motion along geodesics.

Finally, a new construction of charges (conserved quantities) for the gravity field in the (3+1) decomposition is proposed. The construction is based on (3+1) splitting of conformal Yano–Killing tensor. We obtain charges, defined on Cauchy surface, which are composed from components of Weyl tensor and conformal Killing vector. The relations between the conserved quantities and its classical ADM counterparts are revisited. Asymptotic behavior of the conserved quantities is described. The charges are calculated for several examples of initial data, including the Bowen-York spinning black hole.

The corrected Zeldovich formula for the cosmological constant and Milgrom's minimal acceleration from precanonical quantum gravity

Igor Kanattsikov
KCIK, Gdansk, Poland & IAS - Project Archimedes, France

We derive the corrected empirical Zeldovich formula for the cosmological constant Λ and the formula for the Milgromian minimal acceleration $a_0 = 8\pi G\hbar\kappa$, and the mysterious relation between them: $a_0 \sim \sqrt{\Lambda}$, from the re-ordering of operators in the precanonical analogue of the Schrödinger equation for quantum gravity derived earlier, and its simplest solutions. The parameter κ of the dimension of the inverse spatial volume is introduced by precanonical quantization. The observable values of Λ and a_0 correspond to the subnuclear scale of κ, which is consistent with our estimations of the mass gap in the quantum nonabelian gauge theories $\Delta m \sim (g^2\hbar^4\kappa)^{1/3}$, where g is a gauge coupling constant. The current theoretical uncertainties in determining κ from the mass gap lead to errors in our theoretically derived values of Λ and a_0 up to 12 and 6 orders of magnitude, respectively.

Variational Principles in Physics (How to use them, how not to use them, and what it means for the theory of gravity)

Jerzy Kijowski
Center for Theoretical Physics PAS

It will be shown that the conventional strategy of deriving field equations from a variational principle necessarily leads to nonsense. A new strategy will be proposed to overcome this difficulty. When applied to gravity, this approach consists in treating both space-time structures: metric and affine, on equal terms, whereas the metricity condition imposed on the space-time connection is one of the field equations. In this approach, Einstein's theory of gravity (i.e. General Relativity Theory) appears as one of three sectors of a much richer theory in which, unlike conventional metric formulation, Einstein's field equations do not allow for any "ad hoc" modification. We argue that this more general theory correctly unifies gravity, electromagnetism, and - perhaps - the theory of dark matter.

Symplectic charges in the Yang-Mills theory of the normal conformal Cartan connection: applications to gravity

Jerzy Lewandowski
University of Warsaw

It is known that a source-free Yang-Mills theory with the normal conformal Cartan connection used as the gauge potential gives rise to equations of motion equivalent to the vanishing of the Bach tensor. We investigate the conformally invariant presymplectic potential current obtained from this theory and find that on the solutions to the Einstein field equations, it can be decomposed into a topological term derived from the Euler density and a part proportional to the potential of the standard Einstein-Hilbert Lagrangian. The pullback of our potential to the asymptotic boundary of asymptotically de Sitter spacetimes turns out to coincide with the current obtained from the holographically renormalized gravitational action. This provides an alternative derivation of a symplectic structure on scri without resorting to holographic techniques. We also calculate our current at the null infinity of asymptotically flat spacetimes and in particular show that it vanishes for variations induced by the BMS symmetries. In addition, we calculate the Noether currents and charges corresponding to gauge transformations and diffeomorphisms.

Stationary solutions of the general-relativistic Vlasov equation: Monte Carlo approach

Patryk Mach
Jagiellonian University

We develop a Monte Carlo simulation method to compute stationary solutions of the general-relativistic Vlasov equation describing a gas of non-colliding particles. As specific examples, we select planar or spherically symmetric accretion models on the Schwarzschild background spacetime. In both cases the gas extends to infinity, which poses an additional difficulty in the Monte Carlo approach. We discuss models with monoenergetic particles as well as solutions obeying the Maxwell-Juttner distribution at infinity. For all models, exact expressions for the particle current density are known or can be computed analytically. In all cases, the results of our Monte Carlo simulation agree with exact expressions for the particle current density.

Chaos and Einstein–Rosen waves

Syed Umair Husain Naqvi
Jagiellonian University

We demonstrate the existence of chaotic geodesics for the Einstein–Rosen standing gravitational waves. The complex dynamics of massive test particles are governed by a chaotic heteroclinic network. We present the fractal associated with the system under investigation. Gravitational standing waves produce intricate patterns through test particles in a vague analogy to mechanical vibrations generating Chladni figures and complicated shapes of Faraday waves.

Non-trivial U(1)-horizons of Petrov Type D and their embedding

Maciej Ossowski
University of Warsaw

The black hole horizons may be studied in local theory, independent of the bulk spacetime. For a local Isolated Horizon ("a Killing horizon to a second order") the Einstein Equations and the Petrov Type D conditions provide us with so called Type D Equation. Its solutions determine completely the geometry of the horizon. I will present the remaining element of classification of smooth Type D Isolated Horizons, namely the horizons admitting a $U(1)$ - principle bundle over a compact Riemann surface with genus > 0, both in the case of a trivial and non-trivial bundles. They are naturally embeddable in toric and hyperbolic generalizations of Taub-NUT spacetime, if one imposes $U(1)$ bundle structure in the spacetime by introducing a cyclic time - similarly to Misner's interpretation of spherical NUT spacetimes. I will revisit the problem of horizons with section being spheres with conical singularities and provide a geometrical characterization of horizons embeddable in the accelerated Kerr-NUT-(anti-) de Sitter spacetime. Talk will be based on joint work with Jerzy Lewandowski and Denis-Dobkowski Ryłko.

Quantum system ascribed to the Oppenheimer-Snyder model of massive star

Aleksandra Pedrak
National Centre for Nuclear Research

The affine coherent state (ACS) quantization method is an effective quantization method adapted to the construction of a quantum spherical symmetric gravitational model. The ACS quantization has relatively simple mathematical formalism. It allows for quantization both the spatial and temporal coordinates, and it allows to reproduce the classical quantity as a expectation value of an appropriate quantum observable. During my talk I will present the ACS quantization of the Oppenheimer-Snyder (OS) model. The general assumptions of the ACS method will be discussed. I will present the quantum description of the OS model based on the analysis of characteristic quantum observables wit the particular emphasis on gravitational singularity area.

Observational imprints of horizonless bosonic and perfect fluid objects

João Rosa
University of Gdansk

Recent astrophysical observations by the GRAVITY collaboration and the EHT have suggested the existence of black-hole-like objects in the universe. However, black-hole spacetimes are problematic from a mathematical and physical point of view. To overcome this limitation, several alternative compact objects have been proposed, including perfect fluid stars, bosonic stars, Proca stars, fermionic stars, and wormholes. In this talk, we explore the validity of these alternatives by simulating the observational properties of accretion disks and isotropically emitting sources orbiting a central exotic compact object. Specifically, we investigate whether these alternative objects can replicate the observational properties of black-hole spacetimes, namely if they could cast a shadow and how their astrometric properties, e.g. the magnitude and centroid of the observation, compare with the black-hole scenario.

Fundamental tensors of GR as spectral functionals

Andrzej Sitarz
Jagiellonian University

The metric, Einstein and torsion tensors are three fundamental objects of Riemannian geometry and General Relativity. I'll show that these object appear naturally as spectral functionals, thus allowing generalizations to various extensions of Riemannian geometry/gravity theories and models of quantum spacetime. Based on joint work with L.Dabrowski and P.Zalecki.

Black hole vs dark matter model

Robert Stańczy
University of Wrocław

We extend our results published in Comm. Math. Phys. 2021 and J. Diff. Eqs 2023 to cover relativistic case as in Math. Meth. Appl. Sci. 2023 modelling dark matter model for Tolman-Oppenheimer-Volkoff Equation

$$- rp'(r)(r - 2m(r)) = (m(r) + 4\pi r^3 p(r))(\rho(r) + p(r))$$

as an alternative to black hole model studied recently by Klainerman, Szeftel and Giorgi or Dafermos, Holzegel, Rodnianski and Taylor both in static Schwarzschild and rotating Kerr geometries. For the introduction see the review papers of Giorgi and Bieri. The results obtained by Genzel and Ghez for Sagittarius A* were analyzed among others by Ruffini and Chavanis in the framework of dark matter with the modified relativistic Michie- King distribution function yielding the relevant equation of state providing the energy momentum tensor for Einstein equation. We analyze the stationary model reformulating it as a dynamical system for which the global Lyapunov function is obtained thus yielding the limit mass for the system predicting gravitational collapse into a black hole.

Carrollian and Galilean limits of deformed symmetries in 3D gravity

Tomasz Trześniewski
University of Wrocław

Non-Lorentzian kinematical symmetries, especially the ones corresponding to the Galilei or Carroll relativistic limits (i.e., the speed of light taken to infinity or to zero), are nowadays the subject of vigorous investigations. This also concerns (quantum) deformations of such symmetries, described in the formalism of Lie bialgebras and Hopf algebras. The case of 2+1-dimensional spacetime is of particular interest due to the emergence of deformed symmetries already in the classical theory of gravity. Based on the complete classification of deformations of (2+1)d spacetime isometry algebras, one may derive their Carrollian and Galilean counterparts. In fact, all quantum deformations of (anti-)de Sitter-Carroll algebra are easily obtained via its well-known isomorphism with either Poincaré or Euclidean algebra, while quantum contractions from the (anti-)de Sitter to (anti-)de Sitter-Carroll case lead to (almost) the same results. The analogous contractions from the (anti-)de Sitter to (anti-)de Sitter-Galilei case provide a variety of (or possibly all) coboundary deformations of (anti-)de Sitter-Galilei algebra. Finally, Carrollian and Galilean contractions of deformations of Poincaré algebra lead to coboundary deformations of Carroll and Galilei algebras, which can also be recovered via contractions in the limit of vanishing cosmological.

Canonical approach to rotating weakly isolated horizonsy

Tatjana Vukasinac
Universidad Michoacana de San Nicolas de Hidalgo (UMSNH), Mexico

We present a canonical Hamiltonian analysis of gravity in selfdual variables, describing spacetimes with a rotating weakly isolated horizon as an internal boundary.

Multi-messenger Astronomy in LVK O4-O5 Science Runs

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With the event GW170817 / AT 2017gfo, a new era of multi-messenger astronomy was inaugurated. This event was the first of its kind to be observed in both the electromagnetic and gravitational wave bands. As the LVK O4 Science Run has already commenced, we anticipate the detection of more such events. In this talk, I aim to discuss the prospects of observing similar events during the O4 and O5 runs, and delve into reasons behind the absence of such detections during the LVK O3 Science Run. Additionally, I will emphasise the significance of the upcoming observations by the Vera C. Rubin Observatory in advancing multi-messenger astronomy.

Ultracompact stars in the light of minimal geometric deformation

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Adopting gravitational decoupling through minimal geometric deformation (MGD) procedure, we develop an analytical version of gravastar model with non-uniform and anisotropic features, in the framework of modified gravity theory. This new non-uniform model describes an ultracompact stellar structure of Schwarzschild radius, whose interior solution smoothly joins a conformally deformed Schwarzschild exterior solution, and it is matched to the standard Schwarzschild exterior solution under certain conditions. The constructed solution presents a family of stellar models satisfying some of the fundamental properties of a stable configuration, including a positive energy density everywhere with monotonically decreasing behavior from the center to surface. Besides, a non uniform pressure is observed with monotonic behaviour. The behaviour of energy conditions is analyzed inside the stellar configurations.
