Third Workshop on Current Challenges in Cosmology

Report of Contributions

Contribution ID: **30** Type: **not specified**

Tracking the validity of the quasi-static and sub-horizon approximations in modified gravity

Friday 27 October 2023 16:35 (20 minutes)

Within the framework of modified gravity, the quasi-static and sub-horizon approximations are widely used in analyses aiming to identify departures from the concordance model at late-times. In general, it is assumed that time derivatives are subdominant with respect to spatial derivatives given that the relevant physical modes are those well inside the Hubble radius. In practice, the perturbation equations under these approximations are reduced to a tractable algebraic system in terms of the gravitational potentials and the perturbations of involved matter fields. Here, in the framework of $f(R)$ theories, we revisit standard results when these approximations are invoked using a new parameterization scheme that allows us to track the relevance of each time-derivative term in the perturbation equations. This new approach unveils correction terms which are neglected in the standard procedure. We assess the relevance of these differences by comparing results from both approaches against full numerical solutions for two well-known toy-models: the designer $f(R)$ model and the Hu-Sawicki model. We find that: i) the sub-horizon approximation can be safely applied to linear perturbation equations for scales $0.06\,h/\mathrm{Mpc}$
$lesssim k$
$lesssim 0.2\,h/\mathrm{Mpc}$, ii) in this "safety region", the quasi-static approximation provides a very accurate description of the late-time cosmological dynamics even when dark energy significantly contribute to the cosmic budget, and iii) our new methodology performs better than the standard procedure, even for several orders of magnitude in some cases. Although, the impact of this major improvement on the linear observables is minimal for the studied cases, this does not represent an invalidation for our approach. Instead, our findings indicate that the perturbation expressions derived under these approximations in more general modified gravity theories, such as Horndeski, should be also revisited.

Author: ORJUELA-QUINTANA, JOHN BAYRON (UNIVERSIDAD DEL VALLE)

Presenter: ORJUELA-QUINTANA, JOHN BAYRON (UNIVERSIDAD DEL VALLE)

Contribution ID: **32** Type: **not specified**

Scaling Solutions in Generalized Proca Theory and its Cosmological Implications

Friday 27 October 2023 17:15 (10 minutes)

In the framework of the generalized Proca theories, we derive for the first time the most general Lagrangian allowing for scaling solutions between dark energy and cold dark matter. At background level, we highlight two interesting features for this novel model. Firstly, although its equation of state of is exactly -1, the dark energy component has a dynamical behaviour due to its coupling with the cold dark matter. Secondly, the existence of an attractor point where the scaling condition holds and the universe can undergo accelerated expansion. At the perturbative level, we derive the growth equation for cold dark matter under the sub-horizon and quasi-static approximations. The solutions of this equation show that the strength of gravity can vary at late times, where the differences with respect to the concordance model depend on the parameters of the novel model.

Authors: VALENZUELA-TOLEDO, Cesar A. (Departamento de Física, Universidad del Valle); ORJUELA-QUINTANA, JOHN BAYRON (UNIVERSIDAD DEL VALLE); GARCIA SERNA, SANTIAGO

Presenter: GARCIA SERNA, SANTIAGO

Contribution ID: **33** Type: **not specified**

Analyzing Running Vacuum Energy and Viscous Dark Matter Models

Friday 27 October 2023 16:15 (20 minutes)

Running vacuum models and viscous dark matter scenarios beyond perfect fluid idealization are two appealing theoretical strategies that have been separately studied as alternatives to solve some problems rooted in the ΛCDM cosmological model. In this talk, I will explain the cosmological consequences of combining these two notions in a single cosmological setting, paying particular attention in the interplay between these two constituents in different cosmological periods. In particular, I will discuss a well-studied running vacuum model inspired by renormalization group, together with a recently proposed parameterization for the bulk viscosity [Eur. Phys. J. Plus (2023) 138:7381]. Further, by applying dynamical system analysis, I will explain the physical aspects of the new phase space that emerges from the combined models and derive stability conditions that ensure complete cosmological dynamics. It turns out, that four distinct classes of models arise, whose associated critical points are non-trivially renewed compared to the single scenarios. As a complementary strategy to dynamical system analysis, a detailed numerical exploration is performed to quantify the impact of both the running parameter and the bulk viscosity coefficient on the cosmological evolution.
Finally, I will present the conclusions including that for some values of the model parameters, the numerical solutions display qualitative differences from the ΛCDM model, which are phenomenologically appealing in light of cosmological observations.

Author: Prof. PALMA, Guillermo (Universidad de Santiago de Chile)

Presenter: Prof. PALMA, Guillermo (Universidad de Santiago de Chile)

Contribution ID: **34** Type: **not specified**

Structure formation in an anisotropic universe

Friday 27 October 2023 17:25 (10 minutes)

In this work, we investigate the growth of cosmological perturbations within a cosmological scenario where the early universe is dominated by dark matter and gradually becomes anisotropic at later times due to the presence of a small shear tensor associated with dark energy. To describe this, we employ the Bianchi I metric, which characterizes a spacetime background that is homogeneous but anisotropic. The equations of motion for a dark matter fluid are derived and solved both at linear and non-linear orders. This study is performed using a constant equation of state for the dark energy component and a time-dependent rate of anisotropic expansion.

Authors: VALENZUELA-TOLEDO, Cesar A. (Departamento de Física, Universidad del Valle); VALENCIA ZUÑIGA, GABRIELA ALEJANDRA (Universidad del Valle); Dr MOTOA-MANZANO, Josué (Universidad del Valle)

Presenter: VALENCIA ZUÑIGA, GABRIELA ALEJANDRA (Universidad del Valle)

Contribution ID: **36** Type: **not specified**

Hubble-induced phase transitions: Ricci-reheating, Cosmic Defects and Gravitational Waves

Friday 27 October 2023 10:15 (1 hour)

A post-inflationary epoch with a stiff equation of state parameter, like it happens in quintessential inflation, leads to an interesting phenomenology in the presence of non-minimally coupled spectator fields with internal symmetries. I will discuss how this scenario can provide an efficient reheating mechanism, the formation of cosmic defects and the production of gravitational waves and how these can be used to test early universe properties.

Presenter: BETTONI, Dario (León University)

Contribution ID: **37** Type: **not specified**

Cosmic Inflation and Dark Energy and Gravitational Waves (Remote Talk)

Tuesday 24 October 2023 10:15 (1 hour)

I will briefly introduce cosmic inflation and dark energy and combine them in quintessential inflation. A stochastic spectrum of primordial gravitational waves (PGWs) is expected from inflation, but it is unobservable in the near future. I will discuss some ways to boost the inflation generated PGWs, in quintessential inflation and beyond, which may result in characteristic observable spectra. If indeed observed, such PGWs can shed light on the background theory.

Presenter: DIMOPOULOS, Konstantinos (Lancaster University)

Contribution ID: **38** Type: **not specified**

Behind the scenes of an experiment

Monday 23 October 2023 14:00 (1 hour)

Understanding the expansion of the universe is the top priority of all space agencies. In this talk, we will discuss the primary cosmological observables capable of shedding light on these mysterious phenomena. We will also focus on the intense efforts that the European Space Agency is undertaking to understand the nature of accelerated expansion. In particular, we will present the Euclid Satellite.

Presenter: SAPONE, Domenico (FCFM, Universidad de Chile)

Contribution ID: **39** Type: **not specified**

The Vera C. Rubin Observatory, the LSSTCam, and the Legacy Survey of Space and Time. (Remote Talk)

Tuesday 24 October 2023 14:00 (1 hour)

The Vera C. Rubin Observatory, currently under construction on Cerro Pachón in Chile, will feature an 8.4-meter telescope, the largest digital camera in the world for astronomy (3200 megapixels), an automated data processing system, and an online public engagement platform. Rubin will conduct the Legacy Survey of Space and Time (LSST), and it will operate on an automated cadence, capturing an area the size of 40 full moons and returning to the same area of sky approximately every three nights after imaging the full sky. The Rubin Observatory was the top-ranked large ground-based project in the US 2010 Astrophysics Decadal Survey, and it will advance science in four main areas: the nature of dark matter and understanding dark energy, cataloging the Solar System, exploring the changing sky, and Milky Way structure and formation. Engineering and then science first light is expected in 2023 and full operations for the ten-year survey commencing in the second half of 2024. In this talk, I will introduce the Rubin Observatory, the LSST, and how to get involved via the Data Preview 0 in preparation for the survey. I will additionally focus on the LSSTCam and its detectors, and discuss the impacts of detector and other systematics on weak lensing —a fundamental probe that will be used by LSST and other stage IV surveys—for cosmological investigations.

Presenter: PLAZAS, Andrés (Standford University)

Contribution ID: **40** Type: **not specified**

An overview of DESI Lyman alpha forest data and science.

Tuesday 24 October 2023 09:00 (1 hour)

The Lyman alpha forest measured from the spectra of high-redshift quasars observed with DESI will provide a wealth of information for cosmology. It will allow us to unveil the expansion history with great precision by measuring the BAO scale at redshift above 2, through the measurement of the forest absorptions auto-correlation and cross-correlations with quasars. Furthermore, it will provide information on scales of about tens of Mpc, allowing to set strong constraints to massive neutrinos and dark matter with small scale suppression, such as warm and scalar field dark matter. In this talk I will give an overview of the Lyman alpha DESI early data and science as well as prospects for the first year analysis.

Presenter: GONZÁLEZ, Alma (Universidad de Guanajuato)

Contribution ID: **41** Type: **not specified**

Improving LSS analysis with velocities and model-independence

Monday 23 October 2023 09:00 (1 hour)

The large upcoming spectroscopic surveys like DESI and Euclid will enable a very precise measurement of the matter power spectrum and bispectrum on a vast range of scales. I will discuss how this precision can be improved with the combined use of galaxies and standard candles as tracers of the matter and velocity fields. I will show the benefits of using either supernovae or bright standard sirens as standard candles for this purpose. I will also discuss how this increase in precision can come hand-in-hand with improved accuracy by using a methodology which analyzes the mildly non-linear scales of the LSS data without the need to make any model assumptions on the nature of dark energy. Finally, I will forecast the achievable precision with this methodology for the most relevant cosmological parameters and discuss how this could resolve the issue of the cosmological tensions.

Presenter: QUARTÍN, Miguel (Universidade Federal do Rio de Janeiro)

Contribution ID: **42** Type: **not specified**

Short course. Exploring the public DESI data early release.

Tuesday 24 October 2023 16:15 (2 hours)

Presenter: GONZÁLEZ, Alma

Contribution ID: **43** Type: **not specified**

Teleparallel relativity

Wednesday 25 October 2023 09:00 (1 hour)

The principle of relativity is the requirement that the equations describing the laws of physics have the same form in all admissible frames of reference. To complete realisation of the principle required the recent refinement of Einstein's theories of gravity, since they did not distinguish the admissible reference frames (but confused reference frames with coordinate systems). The new canonical theory is presented as a unification of the "geometrical trinity of gravity", a triad of alternative geometrical formulations and the corresponding alternative interpretations of the gravitational interaction. Applications to black holes and cosmology will be discussed. The canonical theory provides the unique consistent definition of relativistic energy, thus resolving a long-standing foundational problem in physics and paving the way for general-relativistic quantum mechanics.

Presenter: KOIVISTO, Tomi (Tartu University)

Contribution ID: **44** Type: **not specified**

Metric-Affine Gravity: From theory to applications in black holes and cosmology.

Thursday 26 October 2023 14:00 (1 hour)

Metric-Affine Gravity constitutes a natural extension of General Relativity that incorporates the notions of torsion and nonmetricity in an enriched space-time geometry. In particular, the spin angular momentum of matter turns out to operate as a source of torsion, whereas the so-called dilation and shear currents of matter act as sources of nonmetricity. In this talk, I will introduce the basic concepts of these theories with the aim to present applications in both black holes and cosmology. I will present an exact static and spherically symmetric black hole solution with spin, dilation and shear charges corresponding to the broadest family of black holes found so far. Some rotating black-hole extensions and the corresponding algebraic classification of the gravitational fields will also be presented. In the last part of my talk, I will focus on cosmology and present the formulation of the linear cosmological perturbation theory using the 3+1 and SVT decomposition for the corresponding geometrical quantities involved in the theory. As an interesting example, the cosmological perturbation of the spin-3 field appearing in nonmetricity will be discussed.

Presenter: BAHAMONDE, Sebastian (Tokyo Institute of Technology)

Contribution ID: **45** Type: **not specified**

Generalized Coupled Vector Dark Energy Models

Friday 27 October 2023 16:55 (20 minutes)

I will present a detailed approach for building models of interacting dark energy that incorporate vector fields conformally and disformally coupled to dark matter, independent of the underlying gravity theory. This discussion will include a focus on establishing general conditions to prevent the presence of ghost instabilities within the theory. For concreteness, we will consider the standard Proca theory with a vector exponential potential to describe the vector-tensor sector. Additionally, specific coupling functions will be assumed to investigate the dynamics of the cosmological background using dynamical system techniques. To gain a more quantitative understanding of the effects of the coupling parameters on the cosmological background evolution, we will also perform numerical computations. These results shed light on how these couplings can significantly influence the cosmological dynamics during various stages of the Universe's evolution compared to the standard ΛCDM cosmological model.

Author: GOMEZ, Gabriel (Universidad de Santiago de Chile)

Presenter: GOMEZ, Gabriel (Universidad de Santiago de Chile)

Contribution ID: **46** Type: **not specified**

Robustness of the Geometrical Trinity of Gravity.

Wednesday 25 October 2023 10:15 (1 hour)

The equivalence principle naturally provides gravity with a geometrical character. However, the precise geometry we employ to describe it admits a certain flexibility. In particular, within a metric-affine framework, Einstein's gravity can be equivalently ascribed to the three independent objects that characterise a connection, i.e., curvature, torsion and non-metricity. After reviewing these three alternative descriptions of gravity, I will uncover a general teleparallel description of GR and how pathologies generally arise beyond the GR equivalents. Finally, I will discuss the inclusion of matter couplings within these frameworks.

Presenter: BELTRÁN JIMÉNEZ, José (Universidad de Salamanca)

Contribution ID: **47** Type: **not specified**

Public Talk. Lo que la física (no) sabe explicarnos

Wednesday 25 October 2023 19:00 (1 hour)

La física es un magnífico entramado de ideas que nos permite comprender mejor el universo que habitamos y dónde nos ubicamos en el mismo. A este fin, haremos un breve recorrido por los principales resultados de la física contemporánea, relacionándolos entre sí. El viaje nos llevará hasta las fronteras mismas del conocimiento⋯¡y más allá!
No se usarán ecuaciones y no es necesario conocimiento previo alguno. Pero no hay que dejarse en casa ni la curiosidad, ni la imaginación.

Presenter: ERRASTI DÍEZ, Verónica (Ludwig-Maximilians-Universität München (LMU Munich) & Excellence Cluster ORIGINS)

Contribution ID: **48** Type: **not specified**

Quadratic metric-affine gravity and stability of the vector sector

Thursday 26 October 2023 09:00 (1 hour)

In this talk, we will start by reviewing the geometrical entities that constitute the basis of metric-affine gravity: the metric and the connection, as well as the decomposition of the latter. Then the quadratic theory will be presented and we will show how strong the stability conditions for the four vector irreducible pieces of the torsion and the nonmetricity tensors are. These will reduce the number of parameters in the curvature-square sector from 16 to 5. We will also present the case of Weyl-Cartan gravity, proving that the stability of the vector sector completely fixes the dynamics of the full Lagrangian to just an Einstein-Proca theory or pure General Relativity.

Presenter: JIMÉNEZ CANO, Alejandro (Tartu University)

Contribution ID: **49** Type: **not specified**

Rethinking stability

Thursday 26 October 2023 10:15 (1 hour)

It's long been recognized that higher-order theories generically propagate an excess of degrees of freedom which, to make matters worse, are associated with negative (kinetic) energies. These are known as Ostrogradski instabilities. Until very recently, such instabilities were immediately disregarded as unphysical and methods were developed to construct theories that would avoid them. Indeed, this has been a very active research subject in the context of gravity theories, with a focus on cosmological applications. A trickle of counterexamples, numerical first and analytical shortly afterwards, confront the established understanding. These examples call for a profound reflection on stability, physically viable theories and theory-construction mechanisms.

Presenter: ERRASTI DÍEZ, Verónica (Ludwig-Maximilians-Universität München (LMU Munich) & Excellence Cluster ORIGINS)

Contribution ID: **50** Type: **not specified**

The mirage of luminal modified gravitational-wave propagation

Wednesday 25 October 2023 14:00 (1 hour)

Using conformal invariance of gravitational waves, we show that for a luminal modified gravity theory, the gravitational-wave propagation and luminosity distance are the same as in general relativity. The relation between the gravitational-wave and electromagnetic-wave luminosity distance gets however modified for electromagnetism minimally coupled to the Jordan frame metric. Using effective field theory we show that the modified relation obtained for luminal theories is also valid for non-luminal theories with Jordan frame matter-gravity coupling. We generalise our analysis to a time-dependent speed of gravitational waves with matter minimally coupled to either the Jordan or Einstein frame metrics.

Presenter: ENEA ROMANO, Antonio (Universidad de Antioquia)

Contribution ID: **51** Type: **not specified**

Short course. Exploring the public DESI data early release.

Thursday 26 October 2023 16:15 (2 hours)

Presenter: GONZÁLEZ, Alma (Universidad de Guanajuato)

Contribution ID: **52** Type: **not specified**

Lifting the weak lensing degeneracy with a field-based likelihood. (Remote talk)

Friday 27 October 2023 09:00 (1 hour)

With Euclid and the Vera Rubin Observatory starting their observations in the coming years, we need highly precise and accurate data analysis techniques to optimally extract the information from weak lensing data. However, the standard approach based on fitting some summary statistics is inevitably suboptimal and imposes approximations on the statistical and physical modeling. I will present a new method to analyse weak lensing based on a full physics model and field-based statistics. By analysing the data at the pixel level, this method lifts the weak lensing degeneracy and provides uncertainties on the cosmological parameters up to a factor 5 smaller than those from standard techniques on the same data. In addition to a gravity model, the method accounts for intrinsic alignments and baryon feedback. I will discuss the current status and ways to meet the challenges of this approach for its first real data application.

Presenter: PORQUERES, Natalia (Oxford University)

Contribution ID: **53** Type: **not specified**

Unveiling the Universe with Machine Learning: A Cosmological Perspective (Remote talk)

Monday 23 October 2023 10:15 (1 hour)

In the near future, forthcoming Large-Scale Structure (LSS) missions such as the DESI, eROSITA, Euclid, WFIRST , and LSST are poised to survey extensive cosmological volumes, collecting terabytes of data that promise to enhance our understanding of cosmological parameters with unprecedented precision. To achieve this ambitious objective, it is crucial to extract the maximum amount of information from data. However, we must tackle two primary challenges to conduct optimal cosmological analyses: the development of precise theoretical models in the non-linear regime and the creation of novel computational techniques to surmount the computational bottlenecks inherent in traditional simulation methods.

In this presentation, I will introduce an innovative machine learning (ML) approach designed to construct a deep learning emulator at the field level for cosmological simulations, with a primary focus on neutrino particles. I will demonstrate that the deep learning methodology offers a highly accurate alternative to conventional techniques by directly mapping non-standard cosmological simulations, including those involving neutrinos, from standard simulations. This approach has the potential to generate precise predictions for cosmological fields across a range of input parameters, facilitating faster and more efficient exploration of non-standard cosmological scenarios.

Presenter: GIUSARMA, Elena (Michigan Technological University)

Contribution ID: **54** Type: **not specified**

Optimal methods for retrieving information from upcoming surveys (Remote talk)

Friday 27 October 2023 14:00 (1 hour)

Due to the unprecedented sensitivity and large field of views, extracting the maximum amount of information remains a key challenge in future surveys. In this talk, I will discuss the current challenges in analyzing the expected big data from upcoming large scale surveys, and present several promising techniques to perform high-dimensional likelihood-free inference and emulation using generative models, namely normalizing flows, and diffusion models. I will then focus on my recent attempts to open the black-box of neural networks. In particular, I will show how a similarity measure metric of learning representation may be used to examine the relationship between similarity and performance of pre-trained neural networks on the CAMELS Multifield Dataset. By comparing representations between layers of two randomly-initialized neural network architectures, a correlation between similarity and accuracy in recovering cosmological parameters is observed. This analysis shows that exploring representation similarity against performance offers meaningful insights into complex deep learning models to generalize them to out-of-distribution samples.

Presenter: HASSAN, Sultan (Flatiron Inst. New York))

Contribution ID: **55** Type: **not specified**

Short Talks

Short talks, 15’ length by the participants.

Contribution ID: **56** Type: **not specified**

Evaluation of Dynamic Dark Energy Model

In this work we reviewed parametrizations of Dark Energy (DE) models focusing on potential late-time physics effects that could alleviate the Hubble Tension. We present a preliminary evaluation of the DE models proposed by Pan et. al. 2019, which consist of phenomenological parametrizations of the DE equation of state, $w = P/\rho$, in terms of the current value, w_0. In addition, we include in this evaluation a proposed DE model consisting of a sigmoid function of FLRW scale factor, a, and w_0.

Our analysis indicates that the Pan et. al. 2019 DE models yield H_0 values that are all within 0.6σ from each other, which renders them effectively equivalent, and highlights the weak discriminatory power of these DE parametrizations. These results are in part due to the shape of the functions proposed for $w(a)$, which in all cases define the dynamic variation of DE spread smoothly across redshift space. In contrast, our sigmoid model provides a stronger constraining of redshift and w_0 parameter space, by explicitly localizing the transition redshift point where the equation of state changes values from the past, $w = -1$ (consistent with CMB), to the present value w_0. Using the recent (Scolnic et. al., 2022) Pantheon+ SN Ia data, our sigmoid-DE model (Rueda-Blanco, et al., 2023) gives a best fit value for H_0 of $73^{+0.2}_{-0.6}$ km s^{-1} Mpc^{-1} (\emph{statistical}). Later on, we analyzed the issue of parameter degeneracy and discuss strategies to lessen their impact in our analysis. Finally, our findings indicate that the results depend critically on the treatment of the Ω_M parameter in the fits. Due to the known parameter degeneracy between H_0 and Ω_M, if the Ω_M parameter is left as a floating parameter in the fit, then the values for w_0 resulting from the fit tend towards the phantom sector ($w_0 < -1$). However, when the Ω_M parameter is held fix during the fit (which we claim should be the case in order to leave early CMB physics unperturbed) then the values of w_0 delivered by the fits tend towards values greater than -1. This work is part of a more extensive study of late-time physics models in the context of the Hubble Tension.

Authors: RUEDA BLANCO, Sebastian (Universidad Nacional de Colombia); Dr DELGADO CORREAL, Camilo (Universidad Distrital Francisco José de Caldas); Dr HIGUERA GARZÓN, Mario Armando (Universidad Nacional de Colombia); Dr TORRES ARZAYUS, Sergio (International Center for Relativistic Astrophysics Network)

Presenter: RUEDA BLANCO, Sebastian (Universidad Nacional de Colombia)

Contribution ID: **59** Type: **not specified**

Particle-like solutions in the generalized SU(2) Proca theory

Friday 27 October 2023 17:35 (10 minutes)

The generalized SU(2) Proca theory is a vector-tensor modified gravity theory where the action is invariant under both diffeomorphisms and global internal transformations of the SU(2) group. This work constitutes the first approach to investigate the physical properties of the theory at astrophysical scales. We have found solutions that naturally generalize the particle-like solutions of the Einstein-Yang-Mills equations, also known as gauge boson stars. Under the requirement that the solutions must be static, asymptotically flat, and globally regular, the t'Hooft-Polyakov magnetic monopole configuration for the vector field rises as one viable possibility. The solutions have been obtained analytically through asymptotic expansions and numerically by solving the boundary value problem. We have found new features in the solutions such as regions with negative effective energy density and imaginary effective charge. We have also obtained a new kind of globally charged solutions for some region in the parameter space of the theory. Furthermore, we have constructed equilibrium sequences and found turning points in some cases. These results hint towards the existence of stable solutions which are absent in the Einstein-Yang-Mills case.

Presenter: MARTÍNEZ, Jhan (Universidad Industrial de Santander)

Contribution ID: **60** Type: **not specified**

Some astrophysical properties of compact object solutions in the Generalized SU(2) Proca theory

Friday 27 October 2023 17:45 (10 minutes)

In this work, we studied some compact object solutions in the Generalized SU(2) Proca theory. This modified gravity model is a vector-tensor theory whose action is invariant under global transformations of the SU(2) group and includes second-order derivative self-interactions of the vector field beyond the massive Yang- Mills theory. First, we studied two Lagrangian pieces consisting of four gauge fields minimally coupled to metric tensor. These pieces give rise to an exact Reissner-Nordstrom black hole solution endowed with two different non-Abelian effective charges that depend on the free parameters of the theory. We analyzed the spacetime structure and found the parameter space that preserves the weak cosmic censorship conjecture. The joint analysis of observations of the EHT's first images of Sagittarius A* of our Galaxy and the Keck telescope set the first constraint on the free parameters of the theory beyond the theoretical bounds found. Also, we present some numerical solutions in the Generalized SU(2) Proca theory which describes a spherical and static black hole. We constructed equilibrium sequences and studied some thermodynamic properties. Finally, we studied the effective potential of soliton solutions in the Generalized SU(2) Proca theory. These objects are compact enough to generate a photon sphere making them black hole mimickers.

Presenter: RODRÍGUEZ, José (Universidad Industrial de Santander)

Contribution ID: **61** Type: **not specified**

Gravitational theories in the context of non-Riemannian geometries on the edge of Ockham's razor

Friday 27 October 2023 17:55 (10 minutes)

The Newtonian theory of gravity can be reformulated in the language of differential geometry as a non- relativistic theory in curved spacetime, where the source of the curvature is associated with the standard Newtonian gravitational potential. This is known as the Newton-Cartan (NC) theory, and although at a dynamic level it is absolutely equivalent to the standard Newtonian theory, the interpretation of geometric objects and the very structure of Newtonian spacetime is different. A determining factor of this reformulation is that it allows a parallel comparison, and in the same geometric language, of the postulates necessary to construct NC theory and Einstein's theory of General Relativity (GR). It is concluded that the GR theory is simpler than the NC theory since it requires fewer postulates for its construction. Based on these conclusions and adhering to the principle of Ockham's razor, it is reasonable to think that GR is the best option that nature has had to describe gravity. However, it has been shown that, at the dynamical level, GR is indistinguishable from its teleparallel and symmetric teleparallel versions in the context of non-Riemannian geometries. Therefore, in this work the question arises: which gravitational theory would be preferred by Nature based on its simplicity and the number of postulates required for its construction?

Presenter: JAIMES, William (Universidad Industrial de Santander)