

FUture Gravitational Alternatives Meeting

FUGA - October 3-4, 2018

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Schedule

Posted by: **Diego Rubiera-Garcia** | May 30th, 2018 |

Title: Big Bang Nucleosynthesis and Cosmic Microwave Background Constraints on Nonminimally Coupled Theories of Gravity.

Speaker: David Benisty (Ben Gurion University, Israel)

Abstract: In nonminimally coupled theories of gravity, the Lagrangian density of matter appears explicitly in the equations of motion for the metric fields, making it essential to understanding the consequences of the model. In this presentation we will look at the impact of a proposal that the average on-shell Lagrangian of a perfect fluid should be given by $L = T$, where T is the trace of the energy-momentum tensor, which is shown to have profound implications for the aforementioned theories, leading to stringent constraints from big bang nucleosynthesis and cosmic microwave background data.

Title: A correspondence between 1st and 2nd order formalism by a metricity constraint.

Speaker: David Benisty (Ben Gurion University, Israel)

Abstract: a Lagrange multiplier coupled to the covariant derivative of the metric, a metricity constraint is implemented. The new contributions which come from the variation of the Lagrange multiplier transform the field equations from the first order to the second order formalism, yet the action is formulated in the first order. In this way all the higher derivatives terms in the second order formalism appear as derivatives of the Lagrange multiplier. Using the same method for breaking metricity condition and building conformal invariant theory is briefly discussed, so the method goes beyond just the study of first order or second formulations of gravity, in fact vast new possible theories of gravity are envisioned this way.

Title: Stellar structure in Palatini gravity.

Speaker: Aneta Wojnar (Curie University, Poland)

Abstract: The recent progress in the stellar structure focusing on the Palatini gravity will be presented. We will discuss problems and proposed solutions which have appeared so far. A brief introduction to Palatini $f(R)$ gravity will also be provided.

Title: Dark Matter in Alternative Theories of Gravity.

Speaker: José A.R. Cembranos (Universidad Complutense de Madrid, Spain)

Abstract: TBA.

Title: Gauge-fixing of black hole perturbations in the beyond Horndeski theories.

Speaker: Cecilia Gergely (University of Szeged)

Abstract: The cosmological perturbations in the beyond Horndeski theories have been efficiently constrained by the direct detection of gravitational waves (both dispersion relations and coincident gamma-ray counterparts), also by observations of galaxy clusters. For the perturbations of spherically symmetric, static black holes a more cumbersome 2+1+1 decomposition of space-time, based on an orthogonal double foliation has been explored successfully for the discussion of the odd sector. The orthogonality however consumed one gauge degree of freedom, hampering the discussion of the even sector of the scalar part of perturbations. We worked out a novel 2+1+1 decomposition of space-time and gravitational dynamics, based on a non-orthogonal double foliation and explored this new formalism for the discussion of i) the Hamiltonian formalism in GR, and ii) the perturbations of the spherically symmetric metric tensor and scalar field in generic scalar-tensor theories, achieving an unambiguous gauge-fixing. This opens up the way for the discussion of the full spectrum of perturbations of spherically symmetric scalar-tensor gravity, including both the odd and even sectors of the scalar part of perturbations.

Title: Unified DE/DM model from Dynamical spacetime.

Speaker: Eduardo Guendelman (Ben Gurion University, Israel)

Abstract: A unification of dark matter and dark energy based on a dynamical space time theory is suggested. By introducing a dynamical space time vector field χ_μ as a Lagrange multiplier, a conservation of an energy momentum tensor $T_{\mu\nu}(\chi)$ is implemented. This Lagrangian generalizes the "Unified dark energy and dark matter from a scalar field different from quintessence" [Phys.RevD 81, 043520 (2010)] which did not consider a Lagrangian formulation. This generalization allows the solutions which were found previously, but in addition to that also non singular bouncing solutions that rapidly approach to the Λ CDM model. The dynamical time vector field exactly coincides with the cosmic time for the a Λ CDM solution and suffers a slight shift (advances slower) with respect to the cosmic time in the region close to the bounce for the bouncing non singular solutions. In addition we introduced some exponential potential which could enter into the $T_{\mu\nu}(\chi)$ stress energy tensor or coupled directly to the measure $\sqrt{-g}$ gives a possible interaction between DE and DM and could explain the coincidence problem.

Title: Palatini frames in scalar-tensor theories.

Speaker: Aleksander Kozak (University of Wrocław, Poland)

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 a 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. The theory will be analysed in both the Einstein and the Jordan frame. 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 in the Palatini formalism.

Title: TBA.

Speaker: Nils Albin Nilsson (National Centre for Nuclear Research, Warsaw, Poland)

Abstract: Not provided.

Title: Scaling solutions with cubic Horndeski.

Speaker: Nelson Nunes (Instituto de Astrofísica e Ciências do Espaço, Lisboa)

Abstract: We show the existence of scaling solutions in the presence of cubic Horndeski interactions. We build a dark energy scenario and conclude that in comparison to standard quintessence the cubic coupling allows for a wider parameter space; the equation of state parameter can be closer to -1 today; and the abundance of the scalar field can be smaller at high redshifts. Finally, we show that the cubic coupling leads to the modified evolution of perturbations which can be distinguished from quintessence.

Title: $f(R)$ gravity modifications: from the action to the data.

Speaker: María Ortiz Baños (Euskal Herriko Unibertsitatea, Bilbao)

Abstract: It is a very well established matter nowadays that many modified gravity models can offer a sound alternative to General Relativity for the description of the accelerated expansion of the universe. But it is also equally well known that no clear and sharp discrimination between any alternative theory and the classical one has been found so far. In this work, we attempt at formulating a different approach starting from the general class of $f(R)$ theories as test probes: we try to reformulate $f(R)$ Lagrangian terms as explicit functions of the redshift, i.e., as $f(z)$. In this context, the $f(R)$ setting to the consensus cosmological model, the Λ CDM model, can be written as a polynomial including just a constant and a third-order term. Starting from this result, we propose various different polynomial parameterizations $f(z)$, including new terms which would allow for deviations from Λ CDM, and we thoroughly compare them with observational data. While on the one hand we have found no statistical preference for our proposals (even if some of them are as good as Λ CDM by using Bayesian Evidence comparison), we think that our novel approach could provide a different perspective for the development of new and observationally reliable alternative models of gravity.

Title: Thin shells and shockwaves in generalized Brans-Dicke theories.

Speaker: Bence Racskó (University of Szeged, Institute of Physics)

Abstract: In General Relativity, matching two spacetime regions along a spacelike or timelike hypersurface is described by Israel's junction conditions, which prescribe the continuity of the induced metric and relate the jump in the extrinsic curvature to the matter content of the junction surface. Israel's formalism breaks down when the surface is null, as is the case for shockwaves propagating at the speed of light, and must be modified by introducing an arbitrary transversal vector field, a method due to Barrabés and Israel. Recent observations have confirmed that gravitational waves propagate with the speed of light, and as such, impulsive gravitational waves may be perceived as null hypersurfaces in spacetime, and the Barrabés-Israel formalism may be used to describe them. The most general scalar-tensor theory with second order field equations is Horndeski's theory, which was severely constrained by the gravitational wave observations. We derive generic junction conditions for the subclass of allowed Horndeski theories with linear dependence on the scalar field's kinetic term, using a transverse vector that is applicable to all hypersurfaces, and specify an easy to use form of the junction conditions valid only for null hypersurfaces utilizing a formalism involving double null vectors along the surface. From this, we obtain equations relating the energy density, surface current and isotropic pressure on the null-surface to the jumps and means of geometric quantities.

Title: Tensions between PLANCK and LSS and $H(z)$ data, and alleviation through torsional alternative gravity.

Speaker: Emmanuel Saridakis (National Technical University of Athens, Greece)

Abstract: There is a long standing tension between the geometry, and structure formation and direct Hubbe measurement data. We review the problem and we provide its alleviation through torsional alternative gravity.

Title: Anisotropic Interior Solutions and Equations of State in Hořava Gravity and Einstein-Aether Theory.

Speaker: Daniele Vernieri (Instituto Superior Técnico, Lisboa)

Abstract: I will talk about a reconstruction algorithm able to generate all the static spherically symmetric interior solutions in the framework of Hořava gravity and Einstein-aether theory in presence of anisotropic fluids. I will focus for simplicity on the case of a static aether finding a double infinity of possible viable interior star solutions which present a very rich phenomenology. I will show one illustrative example in more detail and discuss the equations of state relating the density to the radial and tangential pressure..

Title: The recent acceleration of the Universe: a phenomenological approach.

Speaker: Mariam Bouhmadi-López (University of the Basque Country, Spain)

Abstract: We will present several proposals to describe the late-time acceleration of the universe within the framework of general relativity and beyond it. In some of these models, we will see how the cosmological perturbations behave and how well they fit the data. We will as well discuss dark energy related singularities.

Title: Analysing dissipative effects in cosmology.

Speaker: Diego Saez-Chillon Gomez (University of the Basque Country, Spain)

Abstract: In this talk, I will introduce a model of viscous dark matter based on Israel-Stewart theory. Exact solutions and asymptotic solutions are analysed. The confront to observational data is also shown in order to obtain constraints and check the importance of dissipative effects at cosmological scales.

Title: Graviton-photon oscillation.

Speaker: Prado Martín-Moruno (Universidad Complutense de Madrid, Spain)

Abstract: The phenomenon of gravitational waves (GWs) excitation due to the propagation of electromagnetic waves (EMWs) in an electromagnetic field and back again has long been known. After interpreting the propagation of GWs predicted by alternative theories of gravity as if they were moving through a diagravitational medium, we will see how this phenomenon is modified when going beyond General Relativity. The results suggest that graviton-photon oscillation produced by primordial GWs crossing cosmic magnetic fields may lead to footprints of modifications of GR in the sky.

Title: The Geometrical Trinity of Gravity

Speaker: Jose Beltrán Jiménez (University of Salamanca, Spain)

Abstract: General Relativity is commonly ascribed to the curvature of the spacetime. In this talk, I will review alternative formulations in terms of torsion and non-metricity that are equivalent to interpretation as curvature. I will focus on the non-metricity formulation, showing that it is possible to trivialise the connection by a choice of coordinates, which is dubbed Coincident GR. The properties of some modified gravity theories based on this formulation will be briefly discussed.

Title: Torsion Wave Solutions in Metric-affine Gravity

Speaker: Elvis Barakovic (University of Tuzla, Bosnia-Herzegovina)

Abstract: We construct new explicit vacuum solutions of quadratic metric-affine gravity. The approach of metric-affine gravity in using an independent affine connection produces a theory with 10+64 unknowns, which implies admitting torsion and possible nonmetricity. Our spacetimes are generalisations of classical pp-waves, four-dimensional Lorentzian spacetimes which admit a nonvanishing parallel spinor field. We generalize this definition to metric compatible spacetimes with pp-metric and purely axial torsion. We compare these solutions with our previous results and other solutions of classical models describing the interaction of gravitational and neutrino fields..

Title: Teleparallel Gravity: Gravitational Waves to Galaxies and Cosmology

Speaker: Jackson Levi-Said (University of Malta)

Abstract: Teleparallel gravity offers an alternative way to treat gravity without the need for curvature. This can take the form of an equivalence with general relativity but it also offers new ways to modify gravity and study phenomena. In this talk, some recent progress related to gravitational wave polarizations, the galactic rotation curve problem and cosmology will be reviewed. Teleparallel gravity naturally solves some longstanding problems in curvature based gravity and offers an interesting avenue for studying modifications and extensions to gravity.

Title: Healthy conditions for a stable gravity theory and their phenomenological implications.

Speaker: Noemi Frusciante (University of Lisbon)

Abstract: I will present a thorough stability analysis of modified gravity theories in the presence of matter fields. I will use the Effective Field Theory framework for Dark Energy and Modified Gravity to retain a general approach for the gravity sector. Then, I will present the proper viability conditions to guarantee in the scalar sector the absence of ghosts, gradient and tachyonic instabilities. I will show some examples to highlight the relevance of such conditions when constraining model parameters with data. Finally, I will present results about the impact of the no-tachyonic condition in the parameter space of $f(R)$, Generalized Brans Dicke and Horndeski theories. In the cosmological exploration of modified gravity, such condition is seldom taken into account, with more focus given to the popular no-ghost and no-gradient conditions.

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