CoCo 2021: Cosmology in Colombia

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Book of Abstracts

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Recent results from the Dark Energy Survey

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I will present the cosmological results from the Dark Energy Survey analysis of data collected over three years, the so-called DES-Y3 data. These results arise from studying three combinations of two-point angular correlation functions (the so-called 3x2pt analysis) involving the distribution of galaxies and the distortions in their images due to weak gravitational lensing, as well as the detection of the baryon acoustic oscillation (BAO) feature.

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Emptiness vs. Incompleteness: Selection effects on Cosmic Void BAO

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In the context of the study of large-scale structure of the Universe, we analyze the response of cosmic void clustering to selection effects, such as angular incompleteness due to observational systematics and radial selection functions. We find for the case of moderate (<20%) incompleteness: that void sample selection based on a constant radius cut yields robust measurements. This is particularly true for BAO-reconstructed galaxy samples, where large-scale void exclusion effects are mitigated. We also find for the case of severe (up to 90%) incompleteness, a stronger void exclusion effect that can affect the clustering on large scales even for post-reconstructed data, when using the constant cut. For these cases, we introduce void radius selection criteria depending on the (local) observed tracer density that maximizes the BAO peak signal to noise ratio. This selection prevents large exclusion features from contaminating the BAO signal. An accurate estimation of the void distribution is necessary to obtain unbiased clustering measurements with either criterion when dealing with severe incompleteness, such as can be found at the edges of the radial selection function. Moreover we finally verify, with large simulated data sets including lightcone evolution, that both void sample definitions (local and constant) yield unbiased BAO scale measurements. In conclusion, cosmic voids can be used as robust tracers for clustering measurements, even in the case of (moderately) unknown systematics.

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Probing the effects of primordial black holes on 21-cm EDGES signal along with interacting dark energy and dark matter - baryon scattering

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21cm radio signal has emerged as an important probe in investigating the dark age of the Universe (recombination to reionization). In the current analysis, we explore the combined effects of primordial black holes (PBH), cooling off of the baryonic matter due to dark matter (DM) - baryon collisions and interaction of dark matter - dark energy (DE) fluid on the 21cm brightness temperature. The variation of brightness temperature shows remarkable dependence on DM mass (m_χ) and the dark matter - baryon scattering cross-section (σ_0). Bounds in m_χ - σ_0 parameter space are obtained for different possible PBH masses and for different interacting dark energy (IDE) models. These bounds are estimated based on the observed excess (-500^{+200}_{-500} mK) of 21cm brightness temperature by EDGES experiment. Eventually, bounds on PBH mass is also obtained for different values of dark matter mass and for different IDE model coupling parameters. The compatibility of the constraints of the IDE models, in the estimated bounds are also addressed.

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Banks Zaks Cosmology

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We study the thermodynamical behavior of Banks-Zaks theory close to its infrared fixed point in a cosmological setting. Due to the anomalous dimension, the resulting pressure and energy density deviate from radiation and result in various cosmological scenarios. For the specific range of parameters, unparticles alone results in an exponentially contracting universe followed by a non-singular bounce and an exponentially expanding universe. Simultaneously, the consideration of unparticles on the top of the perfect fluid gives different interesting cosmological solutions such as cyclic solutions, single bounce, and De-Sitter(dS) bounce. We also argue about the possibility of late-time cosmic acceleration caused by unparticles.

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Axion Dark Matter in the Time of Primordial Black Holes

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We investigate the production of QCD axion dark matter in a nonstandard cosmological era triggered by primordial black holes (PBHs) that fully evaporate before the onset of BBN. Even if PBHs cannot emit the whole axion dark matter abundance through Hawking radiation, they can have a strong impact on the dark matter produced via the misalignment mechanism. First, the oscillation temperature of axions reduces if there is a PBH dominated era, and second, PBH evaporation injects entropy to the standard model, diluting the axion relic abundance originally produced. The axion window is therefore enlarged, reaching masses as light as $\sim 10^{-8}$ eV and decay constants as large as $f_a \sim 10^{14}$ GeV without fine tuning the misalignment angle. Such small masses are in the reach of future detectors as ABRACADABRA, KLASH, and ADMX, if the axion couples to photons.

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Early Dark Energy models

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In this work, we present two models to describe early dark energy, with a non-negligible contribution in the radiation-domination epoch. Such type of early contributions to the Hubble parameter is extremely promising to tackle the ongoing Hubble tension. With this motivation, we explore the redshift evolution of their state equations and evaluate the best fits for the models' free parameters, with different cosmological datasets and samplers. We extensively discuss the feasibility of these models and foreseeable proxies that they can be submitted through the cosmological history of the Universe.

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Astrophysical solutions in the generalized SU(2) Proca theory

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The scalar-tensor theory introduced by Horndeski has a sound and firm basis since it avoids the Ostrograski's instability. The generalized SU(2) Proca Theory, which is a vector-tensor theory where the vector content enjoys a SU(2) global symmetry, has been built following Horndeski's spirit. Such a theory exhibits interesting properties that make it a candidate to describe the primordial inflationary period while satisfying the restriction on the gravitational waves speed. At astrophysical scales, the theory needs to be validated. Here we study the spherically-symmetric case using the 't Hooft-Polyakov magnetic monopole ansatz. We found equilibrium configurations constructed from only the metric tensor and the vector field mentioned above. These configurations constitute particle-like solutions which are regular at the origin and asymptotically flat. The objects we have found are boson stars which could eventually contribute to the dark matter content of the universe.

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Asymmetric dark matter from scatterings

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We study possible particle-antiparticle asymmetry in the dark sector in two distinct scenarios. In both the scenarios dark matter (DM) scatterings play defining role in deciding the asymmetry as well as the density. In the first case, we demonstrate a general semi-annihilation of DM particles, leading to maximal asymmetry in DM sector (Ref :JHEP 08 (2020), 149). In the second case, We find an interesting interplay of the DM self-scatterings and annihilations in generating the present DM density, and possible particle-antiparticle asymmetry in the DM sector. The role of DM self-scatterings in determining its present density and composition is a novel phenomenon. The simultaneous presence of the self-scatterings and annihilations is required to obtain a non-zero asymmetry, which otherwise vanishes due to unitarity sum rules (Ref : arXiv : 2103.14009).

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NANOGrav Collaboration: The search for signs of modified gravity with PTAs

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NANOGrav (the North American Nanohertz Observatory for Gravitational Waves) exploits the high-precision timing of an array of Galactic millisecond pulsars (MSPs) in a bid to unveil timing deviations induced by gravitational waves (GWs). A GW transiting an Earth–pulsar line of sight distorts the intervening spacetime, causing pulses to arrive before or after their expected times of arrival (TOAs). Crucially, such a GW will affect all pulsars in the Galaxy, imprinting a correlated (quadrupolar) influence on the TOAs that allows NANOGrav and other pulsar timing arrays (PTAs) to effectively synthesize a kiloparsec-scale GW detector. On the other hand, modified gravity theories are expected to play an important role in these gravitational physics scenarios beyond the standard model, both in particle physics and cosmology, where through the latter scenario, they can be tested. In this paper I will present in very general lines the work that we carried out in the NANOGrav collaboration (specifically in the detection and astrophysics working groups - DWG, AWG), and also some preliminary results of the search for modified gravity signs with the Pulsar data Timing Arrays (PTA's). Finally I will give some insights about the LISA consortium and future second and third generation experiments such as Einstein Telescope (ET), DECIGO and Cosmic Explorer (CE), among others.

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Ajuste de parámetros cosmológicos mediante distancias de luminosidad de supernovas tipo Ia.

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Los métodos cosmografícos son una técnica independiente de los modelos cosmológicos, que es utilizada para reconstruir la expansión de Hubble del Universo con bajos corrimientos al rojo.
En este trabajo se hace un análisis cosmográfico, considerando ajuste lineal, cuadrático y cúbico, de las distancias
de luminosidad de supernovas tipo Ia. Para ello se toman los datos de corrimiento al rojo y distancia de luminosidad
de supernovas tipo Ia (SNIa) reportadas en el catálogo Pantheon. Se expande la distancia de luminosidad a primero, segundo
y tercer orden para obtener el mejor ajuste del parámetro de Hubble, parámetro de desaceleración y jerk.
Se obtienen ajustes a bajo y alto corrimiento al rojo, y se reportan las gráficas comparativas para dichos corrimientos
al rojo. En el método se considera la minimización de la función de error $\chi 2$ basada en los algorítmos convencionales.

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Dirac algorithm and counting of degrees of freedom for the complete Maxwell-Proca theory in flat spacetime

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Recently, theories based on multiple vector fields have been proposed, involving not only the dynamical character, as commonly demanded, but also the interaction between them; however, it is a topic that has not brought enough attention in the construction of alternative theories of gravity until a few years ago. Furthermore, in the construction of theories with multiple fields, the interactions between the involved fields are restricted or just allowed between fields of the same type. Due to the lack of knowledge of a theory that introduces the interactions between massive and massless fields of spin one, the complete Maxwell-Proca theory was recently proposed. In this theory not only the dynamics of the Maxwell and Proca fields are included, as previously stated, but also the interactions between them. Nevertheless, it is important to keep in mind that such a procedure must guarantee the absence of instabilities and remove the non-physical degrees of freedom that can be introduced due to interactions between the fields. This is the reason why the aplication of the Dirac algorithm in the complete Maxwell-Proca theory is imperative to guarantee the propagation of the appropriate number of degrees of freedom and, from this, to find the conditions to be imposed on the theory to achieve the consistent description with a physical system. We emphasize that the theory is built on Minkowski spacetime and its description is valid for any number of interacting Maxwell and Proca fields.

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Phantom-like dark energy from quantum gravity

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We analyse the emergent cosmological dynamics corresponding to the mean field hydrodynamics of quantum gravity condensates, in the tensorial group field theory formalism. We focus in particular on the cosmological effects of fundamental interactions, and on the contributions from different quantum geometric modes. The general consequence of such interactions is to produce an accelerated expansion of the universe, which can happen both at early times, after the quantum bounce predicted by the model, and at late times. Our main result is that, while this fails to give a compelling inflationary scenario in the early universe, it produces naturally a phantom-like dark energy dynamics at late times, compatible with cosmological observations. By recasting the emergent cosmological dynamics in terms of an effective equation of state, we show that it can generically cross the phantom divide, purely out of quantum gravity effects without the need of any additional phantom matter. Furthermore, we show that the dynamics avoids any Big Rip singularity, approaching instead a de Sitter universe asymptotically.

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Model-building Cosmic Inflation and Dark Energy

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Cosmic Inflation explains the initial conditions of the history of the Universe and generates the density perturbations which lead to the formation of structures in the Universe, such as galaxies. Dark Energy can be thought of as a substance responsible for a late-time inflationary period, in which the Universe has entered relatively recently. In this talk I will discuss inflation and dark energy, with some prominent examples of models and their observables. Then I will discuss quintessential inflation, which connects the two, focusing on the latest developments.

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Rippling 3-Riemannian structure describing gravity with dark matter effects

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In an attempt to solve the missing mass problem, the paper introduces a probabilistic three-dimensional structure which is locally described by energy density, time density and a Riemannian metric. This proposition has its roots in the results of general relativity and quantum theory. On large scale, source mass binds energy density which causes curvature in the Riemannian manifold of space measure leading to variations in length and time scales. Additional gravitational effects are predicted for a source mass which are caused by the flow of bounded energy density and is proposed as a candidate for 'dark matter'model. The paper makes testable predictions some of which may have already been observed as 'dark matter'or 'dark energy'.

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Protochime: First steps towards a gravitational dark matter detector

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The existence of dark matter is firmly established from various observations in Cosmology, Astrophysics, and Particle physics. However, most experiments trying to discover the building blocks of dark matter assume additional channels that allow interactions with baryonic matter, as pure gravitational effects are extremely difficult to detect. This assumption, however, is not yet backed by astrophysical evidence and has not resulted in any detection of a dark matter particle.

The Windchime Project aims to be the first experiment to probe dark matter in both the Planck mass regime and the ultralight regime for direct gravitational purposes only. The first prototype of this experiment, Protochime, was developed by an international collaboration between Colombia (Universidad Nacional de Colombia) and the United Stated (Purdue University) and is already capable of producing rudimentary but purely gravitational constraints in some BSM models. In this talk, an overview of The Windchime Project is disclosed, along with a description of Protochime and its first results.

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Comprehensive Analysis of a Non-Singular Bounce in f(R, T) Gravitation

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The work is devoted to the study of bouncing cosmology in f(R, T) modified gravity where we presume $f(R, T) = R + 2\lambda T$, with R the Ricci scalar, T the trace of energy momentum tensor and λ the model parameter. We present here a novel parametrization of Hubble parameter which is apt in representing a successful bouncing scenario undergoing no singularity. We proceed to present a complete analysis of the proposed bouncing model by studying the evolution of primordial curvature perturbations, energy conditions and stability against linear homogeneous perturbations in flat space-time. We also delineate bouncing cosmology for the proposed model by employing Quintom matter. The present article further communicate for the first time that violation of energy-momentum materialize for both the contracting and expanding universes except for the bouncing epoch with energy flow directed away and into the matter fields for the contracting and expanding universe respectively. We further present a thorough investigation about the feasibility of the proposed bouncing scenario against first and generalized second law of thermodynamics. We found that the proposed bouncing scenario obeys the laws of thermodynamics for the constrained parameter space of λ. The manuscript conclude after investigating the viability of the proposed bouncing model in non minimal f(R, T) gravity where $f(R, T) = R + \chi RT$.

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Extended SU(2) Proca theory

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In this work, we explore the construction of a vector-tensor theory with a SU(2) global symmetry in the vector sector as a proposal for a modified theory of gravity. We start with a general Lagrangian containing terms involving symmetric and antisymmetric combinations of the covariant derivatives of the field. Then, we study the degeneracy of the full theory to determine whether it can be healthy or not. Thus, we find relations among some of the free functions in the theory to guarantee the degeneracy. We find that there are several ways in which the kinetic matrix can be turned degenerate. Finally, we take the scalar limit to check whether the resulting theory is also degenerate and present the set of linear combinations that are degenerate both at the vector and the scalar levels.

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New opportunities for axion dark matter searches in nonstandard cosmological models

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We study axion dark matter production from a misalignment mechanism in scenarios featuring a general nonstandard cosmology. Before the onset of Big Bang nucleosynthesis, the energy density of the universe is dominated by a particle field ϕ described by a general equation of state ω. The ensuing enhancement of the Hubble expansion rate decreases the temperature at which axions start to oscillate, opening this way the possibility for axions heavier than in the standard window. This is the case for kination, or in general for scenarios with ω >1/3. However, if ω <1/3, as in the case of an early matter domination, the decay of ϕ injects additional entropy relative to the case of the standard model, diluting this way the preexisting axion abundance, and rendering lighter axions viable. For a misalignment angle 0.5< $\theta_i < \pi/\sqrt{3}$, the usual axion window becomes expanded to 4×10^{-9} eV m_a 2×10^{-5} eV for the case of an early matter domination, or to 2×10^{-6} eV m_a 10^{-2} eV for the case of kination. Interestingly, the coupling axion-photon in such a wider range can be probed with next generation experiments such as ABRACADABRA, KLASH, ADMX, MADMAX, and ORGAN. Axion dark matter searches may therefore provide a unique tool to probe the history of the universe before Big Bang nucleosynthesis.

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Cosmological constraints with the Effective Fluid approach for Modified Gravity

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Cosmological constraints of Modified Gravity (MG) models are seldom carried out rigorously. First, even though general MG models evolve differently (i.e., background and perturbations) to the standard cosmological model, it is usual to assume a ΛCDM background. This treatment is not correct and in the era of precision cosmology could induce undesired biases in cosmological parameters. Second, neutrino mass is usually held fixed in the analyses which could obscure its relation to MG parameters. In a couple of previous papers we showed that by using the Effective Fluid Approach we can accurately compute observables in fairly general MG models. An appealing advantage of our approach is that it allows a pretty easy implementation of this kinds of models in Boltzmann solvers (i.e., less error-prone) while having a useful analytical description of the effective fluid to understand the underlying physics. This paper illustrates how an effective fluid approach can be used to carry out proper analyses of cosmological constraints in MG models. We investigated three MG models including the sum of neutrino masses as a varying parameter in our Markov Chain Monte Carlo analyses. Two models (i.e., Designer f(R) [DES-fR] and Designer Horndeski [HDES]) have a background matching ΛCDM, while in a third model (i.e., Hu & Sawicki f(R) model [HS]) the background differs from the standard model. In this way we estimate how relevant the background is when constraining MG parameters along with neutrinos' masses. We implement the models in the popular Boltzmann solver CLASS and use recent, available data (i.e., Planck 2018, CMB lensing, BAO, SNIa Pantheon compilation, H 0 from SHOES, and RSD Gold-18 compilation) to compute tight cosmological constraints in the MG parameters that account for deviation from the ΛCDM model. For both the DES-fR and the HS model we obtain log10 b < -8 at 68% confidence when all data are included. In the case of the HDES model we find a somewhat weaker value of log10 Jc > -5 at 68% confidence. We also find that constraints on MG parameters are a bit weakened when compared to the case where neutrinos' masses are held fixed in the analysis.

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Small Field Polynomial Inflation

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In this talk, we will present a renormalizable polynomial inflation model, focusing on the small field scenario. We show that the CMB data can be fitted perfectly with a perturbated inflection-point. In particular, the running of the spectral index is predicted to be $\alpha \simeq -1.43 \times 10^{-3}$, which could be tested by next generation CMB experiment. We also analyze reheating through perturbative inflaton decays to either fermionic or bosonic final states via a trilinear coupling. We obtain a full parameter space by considering BBN constraint on reheating temperature and radiative stability of the inflaton potential. We find that the inflationary scale within the parameter space can be as low as $H_{\rm inf} \sim 1$ MeV, or as high as $\sim 10^{10}$ GeV. Similarly, the reheating temperature can lie between its lower bound of ~ 4 MeV and about 4×10^{8} (10^{11}) GeV for fermionic (bosonic) inflaton decays. Our model is renormalizable and very simple, and can thus serve as the inflationary sector of some well motivated BSM scenarios.

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Conformally and Disformally Coupled Vector field Models of Dark Energy

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Scalar fields coupled to dark matter by conformal or disformal transformation gives rise to a general class of scalar-tensor theories which leads to a rich phenomenology in a cosmological setting. While this possibility has been studied comprehensively in the literature for scalar fields, the vector case has been hardly treated. We build models of vector fields coupled conformally and disformallyto dark matter and study their cosmological implications by dynamical system analysis. In doing so, we derive explicitly the general covariant form of the coupling term that can be applied for general vector-tensor theories. For concreteness, the standard Proca theory with a vector potential is taken to describe dark energy. Despite this minimal realization for the vector-tensor theory, the parameter space is considerably enriched compared to the uncoupled case to provide new emerging scaling solutions, and renewed stable attractor points to drive the late-time accelerated expansion of the universe. Numerical calculations are performed to see the impact of the conformal and disformal couplings in the cosmological background evolution.

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Varying Higgs VEV in Cosmology and an Axionic Solution

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The ΛCDM model provides an excellent fit to the CMB data. However, a statistically significant tension emerges when its determination of the Hubble constant H_0 is compared to the local distance-redshift measurements. The axi-Higgs model, which couples ultralight axions to the Higgs field, offers a specific variation of the ΛCDM model. It relaxes the H_0 tension as well as explains the ^{7}Li puzzle in Big-Bang nucleosynthesis, the S_8 tension with the weak-lensing data, and the observed isotropic cosmic birefringence in CMB. In this letter, we demonstrate how the H_0 and S_8 tensions can be resolved simultaneously, by correlating the axion impacts on the early and late universe. In a benchmark scenario selected for experimental tests soon, the analysis combining the CMB+BAO+WL+SN data yields $H_0 = 71.1 \pm 1.1$˜km/s/Mpc and $S_8 = 0.766 \pm 0.011$. Combining this (excluding the SN(supernovae) part) with the local distance-redshift measurements yields $H_0 = 72.3 \pm 0.7$˜km/s/Mpc, while S_8 is almost unchanged.

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Gravitational waves and Baryogenesis from ultralight PBHs

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Hawking radiation (HR) causes ultralight primordial black holes (PBHs) ($10^9 g$) to entirely evaporate and produce all of the particles in a given theory, regardless of their other interactions. Successful baryogenesis via leptogenesis predicts the mass scale of RH neutrinos as well as black holes if right-handed (RH) neutrinos are also created from PBH evaporation. We show that a network of cosmic strings naturally give rise to a strong stochastic gravitational-wave (GW) signal at the sensitivity level of pulsar timing arrays (PTA) and LIGO5, given that the lepton number violation (generation of RH neutrino masses) in the theory is a result of a gauged *U(1)* breaking followed by the formation of PBHs. A break in the GW spectra occurs around MHz frequency due to a short period of black hole dominance in the early universe, for which baryon asymmetry is independent of initial PBH density. As a result, GW detectors with higher frequencies are required to observe the break together with the regular GW signal caused by graviton emission via HR. The NANOGrav PTA's recent discovery of a stochastic common spectrum process (interpreted as GWs) across a large number of pulsars conflicts with PBH baryogenesis for large cosmic string loops ($\simeq 0.1$).

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A Simplified Dark Matter Model for Muon g-2 with Scalar Lepton Partners at the TeV Scale

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The E989 experiment at the Fermi National Laboratory (FNAL) reported a 4.2-sigma discrepancy between the measured magnetic dipole moment of the muon, and the prediction from the Standard Model (SM). Addressing this anomaly could require a proper accounting of QCD hadronic vacuum polarizations, or it might be a signal of new physics. In this talk, we shall take the latter approach and propose a minimal BSM framework, inspired by the MSSM. The extra particles and ingredients in our scheme are: (i) a Majorana fermion, which we shall refer to as the bino; (ii) left- and right-handed scalar particles, analogous to the sleptons, that couple, respectively, with the SU(2) second generation lepton doublet and right handed muon; (iii) a gaugino-like interaction between the bino, the sleptons, and the muon; and (iv) mixing with the left- and right-handed smuons through a trilinear coupling with the SM Higgs. The BSM contribution to this g-2 anomaly then proceeds at one loop level. Analogous with the R-parity in the MSSM, the model is invariant under a $\mathbb{Z}_2$ symmetry in which the SM/BSM states are even/odd. The bino, being the lightest BSM particle that is neutral under SM interactions, is a good DM candidate. We demonstrate that, in order to satisfy the g-2 anomaly, the viable mechanism for bino DM to reproduce the observed DM relic density is through coannihilations, which requires the next lightest BSM particle to be nearly degenerate with the bino; depending on the Higgs-slepton trilinear coupling, the bino mass can be as high as ˜TeV. Meanwhile, noting that the expected direct detection signal is mainly driven by anapole DM-nucleon interactions, we show that limits from future generation detectors are sensitive only for relative mass splittings below the percent level. Apart from the phenomenological constraints on this scenario, we have obtained limits from theoretical considerations. We show that more stringent limits on our framework, while respecting g-2 and the relic density limit, can be obtained from requiring a long-lived metastable electroweak vacuum than from perturbative unitarity.

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Cosmological analysis of Barrow holographic dark energy model considering the Granda-Oliveros infrared cutoff

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Motivated by the work of Saridakis, in this talk we report the phenomenology of Barrow holographic dark energy using the Granda-Oliveros infrared cutoff. The latter is a holographic dark energy model based on the recently proposed Barrow entropy, which arises from the modification of the black-hole surface due to quantum-gravitational effects, quantified by a new parameter Δ. In order to analyze this new scenario we also consider a flat, homogeneous and isotropic universe, modeling it's content as a perfect fluid. We extract a differential equation for the evolution of H^2 and calculate the quantities associated with dark energy models. We show that this scenario can reproduce an accelerated expansion and describe the universe's thermal history, with the sequence of matter and dark energy eras. Additionally, we show that the new Barrow exponent Δ significantly affects the dark energy equation of state, and according to it's value it can lead it to lie in diferentes regimes.

CoCo / **30**

Numerical study of the 1D Schrödinger-Poison equation for Ultra light Cold Dark Matter

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The large scale structures on the universe are best described by the cold dark matter model which only fails on sub-galaxy scales known as the small scale crisis. There has been recently proposed a model of dark matter, where cold dark matter is modeled by a complex scalar field, which follows a Schrödinger equation with a non-linear potential which satisfies a Poisson equation. This Schrödinger-Poisson equation (SP-equation) approximates the results of the standard cold dark matter model on large scales and, on small scales, exhibits some properties that could help to solve some problems on the small scale crisis. We propose an approach for the numerical integration of the SP equation in 1D, where we combine a matrix representation in a B-splines basis with the a Crank-Nicholson time-evolution integrator. As preliminary results we present the Husimi distributions obtained within this approach. With their help it is possible to identify the transition from the linear to the non-linear regime and we start to elucidate the halo formation.

CoCo / **31**

FUNCION DE CORRELACION DE DOS PUNTOS EN EL FORMALISMO PERTURBACIONES - HALO

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La formación de estructuras a gran escala en el universo es un área de gran interés científico en cosmología, en cuyo estudio diversas herramientas estadísticas ayudan a evaluar los modelos analíticos que describen el origen y evolución de estructuras. Para ello se presente la estimación de la función de correlación de dos puntos en el campo de materia sobre los resultados de la simulación BolshoiP a fin de comparar tales estimaciones con lo predicho por la teoría no lineal de perturbaciones aplicada al modelo del halo llamado \emph{formalismo perturbaciones - halo}(FPH), implementado por Mead et. al. (2015).\\
Los resultados de las estimaciones de la función de correlación de dos puntos que se obtuvieron son consistentes con lo reportado en la literatura en los cuatro estimadores empleados. En contraste con los resultados del modelo FPH se observan puntos donde el espectro de potencias obtenido a partir de la función de correlación es sobrestimado, particularmente a redshift mayores a 1 y bajas escalas.

CoCo / **32**

Implementación de Algoritmos de Aprendizaje Automático en la Clasificación de Exoplanetas

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En este trabajo se implementan diferentes algoritmos de aprendizaje supervisado y no supervisado en la clasificación de exoplanetas usando la base de datos de los archivos de exoplanetas de la NASA.

Los dos atributos usados para la clasificación de exoplanetas son el radio y la masa de los mismos, los cuales nos permiten clasificarlos en 4 categorías: Gigantes Gaseosos, Tipo Neptuno, Super Tierras y Terrestres. Se presentan los resultados de la implementación de los diferentes algoritmos, en los cuales se encuentra que los asociados al aprendizaje supervisado muestran mejores métricas de rendimiento.

CoCo / **33**

Non-minimally Coupled Vector Boson Dark Matter

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We consider a simple abelian vector dark matter (DM) model, where {\it only} the DM $(\widetilde{X}_\mu)$ couples non-minimally to the scalar curvature $(\widetilde{R})$ of the background spacetime via an operator of the form $\sim \widetilde{X}_\mu\,\widetilde{X}^\mu\,\widetilde{R}$. By considering the standard freeze-out scenario, we show, it is possible to probe such a non-minimally coupled DM in direct detection experiments for a coupling strength $\xi \sim \mathcal{O}\left(10^{30}\right)$ and DM mass $m_X < 55$ TeV, satisfying Planck observed relic abundance and perturbative unitarity. We also discuss DM production via freeze-in, governed by the non-minimal coupling, that requires $\xi < 10^5$ to produce the observed DM abundance over a large range of DM mass depending on the choice of the reheating temperature. We further show, even in the absence of the non-minimal coupling, it is possible to produce the whole observed DM abundance via 2-to-2 scattering of the bath particles mediated by massless gravitons.

CoCo / **34**

DM capture in WDs

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We discuss the capture of dark matter in white dwarfs (WD), the most abundant stellar remnants, as complementary to terrestrial searches. We consider the capture of DM due to interactions with either ion or the degenerate electron component of WDs. We account for the stellar structure, star opacity, realistic nuclear form factors, and temperature effects to discuss the capture rate. In the case of ions we use a Maxwell Boltzmann distribution while for the degenerated electrons, we require a formalism that properly incorporates Pauli blocking and a relativistic treatment for electrons. We also discuss the dark matter evaporation rate. The DM interactions can be constrained by comparing the heating rate, due to the presence of DM in the star nucleus, with observations of cold WDs. We have calculated the capture rate and applied this technique to observed WDs in the Messier 4 (M4) globular cluster to set bound on DM interactions.

CoCo / **35**

Quintessential inflation: A tale of emergent and broken symmetries

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Inflation and dark energy share many essential properties. I will describe how these two eras can be easily unified into a common framework based on emergent scale invariance. I will present the associated cosmological history and discuss how the inclusion of non-minimally coupled spectator fields may lead to the spontaneous symmetry breaking of internal symmetries and its eventual restoration at the onset of radiation domination. This sequence of events comes together with a rich phenomenology involving the automatic reheating of the Universe and the generation of short-lived topological defects able to produce an observable gravitational wave background.

CoCo / **36**

The hitchhiker's guide to ghost freedom

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It is over 150 years since Ostrogradski noticed that higher-order Lagrangians generically lead to instabilities that render theories inconsistent and unphysical. Today, we call these ghosts. I will show that ghosts appear even in first-order Lagrangians and I will present a user-friendly method to spot them in such a simple scenario. I will briefly comment on higher-order extensions, including gravity.

CoCo / **37**

Imprint of the seesaw mechanism on feebly interacting dark matter and the baryon asymmetry

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We show that the type-I seesaw, responsible for generating the light neutrino mass, itself is capable of accommodating one of the three right-handed neutrinos as a freeze-in type of dark matter (DM) where the required smallness of the associated coupling is connected to the lightness of the (smallest) active neutrino mass. It turns out that (a) the non-thermal production of DM having mass $\leq \mathcal{O}(1)$ MeV (via decays of W, Z bosons, and SM Higgs) consistent with relic density as well as (b) its stability determine this smallest active neutrino mass uniquely $\sim \mathcal{O}(10{-}12) eV$. On the other hand, the study of flavor leptogenesis in this scenario (taking into account the latest neutrino data and Higgs vacuum stability issue) fixes the scale of two other right-handed neutrinos.