IberiCos 2025

Monday 14 April 2025 - Wednesday 16 April 2025

Book of Abstracts

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Session 8 - Gravity / 3

Electromagnetic wormholes

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I will discuss how the effective geometry seen by photons propagating on a non-trivial electromagnetic background within Born-Infeld theory corresponds to an asymmetric wormhole. I will explain some interesting properties of the generated geometry such as the behaviour of null geodesics. Interestingly, the wormhole effective geometry arises for the background fields created by a charged particle, a monopole and a dyon. The identical effective geometry for these three objects can be understood in terms of the duality invariance of Born-Infeld geometry.

Session 6 - Early Universe / 4

Echoes of the Higgs: Gravitational Waves and the Fate of the Electroweak Vacuum

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We explore a minimal scenario where the Standard-Model Higgs is responsible for reheating the Universe after inflation and produces a significant background of gravitational waves. The characteristic features of such signal can be directly correlated to the classical stability of the electroweak vacuum, thus offering a novel connection between the inflationary scale and the top quark mass at energies scales inaccessible by current particle accelerators.

Session 8 - Gravity / 5

Study of Gravastar in Einstein-Gauss-Bonnet Gravity

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The present work investigates a new model of the gravastar in a framework of 5-Dimensional (5D) Einstein-Gauss-Bonnet (EGB) grav- itational theory. Adopting the approach of Mazur and Mottala, we divide the geometry of the stellar spherical object into three differ- ent portions, as follows (i) interior portion (ii) intermediate spherical thin shell and (iii) exterior portion. The interior portion contains dark energy having negative pressure. The thin shell region is made up of ultra-relativistic plasma where pressure and energy density are directly proportional. The exterior portion is completely vacuumed. By considering these assumptions, a set of stable and non-singular exact solutions for a gravastar has been investigated. In our model, graphical behavior shows that the obtained solution is physically rea- sonable and interesting.

Session 4 - Modified Gravity & Dark Energy / 7

A New Gravitational Instanton in Conformal Invariant Gravity

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A new exact time-dependent Kerr-like black hole solution is found on a Randall-Sundrum brane world spacetime. The solution is also valid on the Wick-rotated Euclidean counterpart space, so represents equally well a gravitational instanton, i.e. a bump in spactime. Because the r-dependent part is determined by a first order differential equation, one conjectures that the solution is a self-dual solution comparable with the Eguchi-Hanson solution. The zero's and poles of the spacetime are determined by a quintic polynomial. To describe the Hawking particles, one uses the antipodal boundary condition on a complex Klein-bottle hypersurface $\mathbb{C}^1 \times \mathbb{C}^1$. We used the Hopf fibration to get S^2 as the black hole horizon, where the centrix is not in a torus but in the Klein bottle. The twist fits very well with the antipodal identification of the point on the horizon. No "cut-and-paste" is necessary, so the Hawing particles remain pure without instantaneous information transport.
A local observer passing the horizon will not notice a central singularity in suitable coordinates.
The black hole paradoxes are also revisited in our new black hole model.
A connection is made with the geomeric quantization of $\mathbb{C}^1 \times \mathbb{C}^1 \sim S^3$, by considering the symplectic 2-form.
The model can be easily extended to the non-vacuum situation by including a scalar field. Both the dilaton and the scalar field can be treated as quantum fields when approaching the Planck area.
keywords[Kerr black hole, conformal invariance, brane-world models, Klein surface, antipodicity, Hawking radiation, instantons]

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Session 5 - Compact objects & Cosmology / 8

Are supermassive black holes primordial?

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Black holes with masses between a million and a billion solar masses are seen in the centres of many galaxies, even at high redshift. Their origin remains unknown and hard to explain, raising the possibility that these black holes are primordial rather than astrophysical. I will discuss the motivation for this scenario and the difficulty in finding a working model of the early universe (e.g. inflation) which can generate them. In particular, I will discuss the CMB spectral distortions which tightly constrain non-standard initial conditions on the relevant length scale for supermassive black holes. This talk is primarily based on https://inspirehep.net/literature/2781654 and https://inspirehep.net/literature/2781818 with Lesgourgues and Sharma.

Session 3 - Modified Gravity & Dark Energy / 10

Temperature-redshift relation in energy-momentum-powered gravity models

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There has been recent interest in the cosmological consequences of energy-momentum-powered-gravity models, in which the matter side of Einstein's equations includes a term proportional to some power, n, of the energy-momentum tensor, in addition to the canonical linear term. Previous works have suggested that these models can lead to a recent accelerating universe without a cosmological constant, but they can also be seen as phenomenological extensions of the standard ΛCDM, which are observationally constrained to be close to the ΛCDM limit. Here we show that these models violate the temperature-redshift relation, and are therefore further constrained by astrophysical measurements of the cosmic microwave background temperature. We provide joint constraints on these models from the combination of astrophysical and background cosmological data, showing that this power is constrained to be about $|n| < 0.01$ and $|n| < 0.1$, respectively in models without and with a cosmological constant, and improving previous constraints on this parameter by more than a factor of three. By breaking degeneracies between this parameter and the matter density, constraints on the latter are also improved by a factor of about two.

Session 3 - Modified Gravity & Dark Energy / 13

The ESPRESSO Redshift Drift Experiment – High-fidelity spectra of the Lyman forest of QSO J052915.80-435152.0

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The elusive cosmological redshift drift —predicted by General Relativity as a direct signature of the universe's accelerated expansion —remains one of the most ambitious goals in observational cosmology. In this study, we take the first steps toward detecting this effect using the Lyman-α forest

of bright quasars as tracers of the expanding cosmos. Focusing on the brightest quasar, J052915.80-435152.0, we present results from two high-resolution, high signal-to-noise (SNR) spectral epochs observed with ESO's ESPRESSO instrument. These observations serve as the initial benchmarks for a decades-long experiment to monitor the redshift drift.

By comparing the two epochs through a model-based approach, we assess the precision of velocity measurements achievable at the current SNR, providing a reality check on theoretical expectations. Our analysis reveals a null drift in the Lyman-α forest, with a measured velocity shift of $\Delta v = -0.32 \pm 4.55\ \mathrm{m\,s^{-1}}$ over a timespan of 0.8 years. This corresponds to a cosmological drift rate of $\dot{v} = -0.36 \pm 5.31\ \mathrm{m\,s^{-1}\,yr^{-1}}$, or a redshift drift of $\dot{z} = (-0.55 \pm 7.5) \times 10^{-8}\ \mathrm{m\,s^{-1}\,yr^{-1}}$, where the expected signal in a ΛCDM cosmology is $\dot{v} = -0.47\ \mathrm{cm\,s^{-1}\,yr^{-1}}$, clearly undetectable at the current stage. The achieved precision is slightly below expectations, highlighting key challenges in achieving ultimate sensitivity.

Extrapolating from these results, we estimate that detecting the cosmic redshift drift at 99% significance will require a long-term campaign of 5000 observational hours over 50 years using an ELT/ANDES-class spectrograph. This work marks a critical first step in a generational experiment to measure one of the most profound indicators of our universe's evolution.

Session 8 - Gravity / 14

Wormhole effective mass and gravitational waves by binary wormhole

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We considered the generation of gravitational waves by the binary system associated with a wormhole. In the Newtonian limit, the gravitational potential of a wormhole requires the effective mass of the wormhole taking into account radial tension effects. This definition allows us to derive gravitational wave production in homogeneous and heterogeneous binary systems. Therefore, we studied gravitational waves generation by orbiting wormhole–wormhole and wormhole–black hole binary systems before coalescence. Cases involving negative mass require more careful handling. We also calculated the energy loss to gravitational radiation by a particle orbiting around the wormhole and by a particle moving straight through the wormhole mouth, respectively.

Session 9 - Observational Cosmology / 15

Illustrating the consequences of a misuse of sigma_8 in cosmology

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The parameter σ_8, which represents the root-mean-square (rms) mass fluctuations on a scale of $R_8 = 8h^{-1}$ Mpc (where h is the reduced Hubble parameter), is commonly used to quantify the amplitude of matter fluctuations at linear cosmological scales. Derived quantities, such as $S_8 = \sigma_8(\Omega_m^0/0.3)^{0.5}$, are also frequently employed. However, the dependence of R_8 on h complicates direct comparisons of σ_8 values obtained under different assumptions about H_0, since σ_8 in such cases characterizes the

amount of structure at different physical scales. This issue arises both when comparing σ_8 values from fitting analyses of cosmological models with differing H_0 posteriors, and when contrasting constraints from experiments that employ different priors on the Hubble parameter. As first noted by Ariel G. Sánchez in Phys. Rev. D 102, 123511 (2020), quantifying the growth tension using σ_8 or S_8 can introduce substantial biases and couple the growth and Hubble tensions in an intricate and uncontrolled way. To address these challenges, Sánchez proposed an alternative parameter, σ_{12}, defined as the rms mass fluctuations at a scale of 12 Mpc, which is independent of h. Although Sánchez's work was published five years ago and other authors have since highlighted the limitations of σ_8, much of the cosmological community –including large collaborations – continues to rely on this parameter rather than adopting σ_{12}, seemingly due only to historical considerations. In this work, we illustrate the biases introduced by the use of σ_8 through some clear examples, aiming to motivate the community to transition from σ_8 to σ_{12}. We show that the bias found in models with large values of H_0 is more prominent. This artificially complicates the search for a model that can efficiently resolve the Hubble tension without exacerbating the growth tension. We argue that the worsening of the growth tension in these models is much less pronounced than previously thought or may even be nonexistent.

Session 4 - Modified Gravity & Dark Energy / 16

Diffusion Models for Emulating the Large-Scale Structure of the Universe in Modified Gravity Cosmologies

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The next generation of galaxy surveys will provide unprecedented data, leading to accurate tests of gravity on cosmological scales. To fully exploit the nonlinear information encoded in the large-scale structure of the Universe, we propose to leverage cutting-edge deep learning algorithms, such as diffusion models, to efficiently generate 3D density fields conditioned on cosmological parameters. This approach is capable of fast and accurate emulation of cosmic volumes, while maintaining consistency with summary statistics and achieving a low computational cost comparable to state-of-the-art N-body simulations of modified gravity cosmologies. We demonstrate that trained diffusion models can be used to derive robust and accurate constraints on cosmological parameters, offering an efficient alternative for cosmological analysis with the same accuracy as traditional methods.

Session 8 - Gravity / 17

Penrose and super-Penrose energy extraction from a Reissner-Nordström black hole spacetime with a cosmological constant through the Bañados-Silk-West mechanism

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The Penrose process consists of transferring energy from a black hole to infinity. This process can be studied in a combined description with the Bañados-Silk-West (BSW) mechanism, which uses collisions of ingoing particles at the event horizon of a black hole to locally produce large amounts

of energy. In this talk, the blending of the Penrose process with BSW mechanism is described for a d dimensional extremal Reissner-Nordström black hole spacetime with negative, zero, or positive cosmological constant, i.e., for an asymptotically anti-de Sitter (AdS), flat, or de Sitter (dS) spacetime. In an extremal Reissner-Nordström black hole background, in the vicinity of the horizon, several types of radial collisions between electrically charged particles can be considered. The most interesting one is between a critical particle, with its electric charge adjusted in a specific way, and a usual particle. This gives a divergent center of mass frame energy locally, which is a favorable but not sufficient condition to extract energy from the black hole. To find if energy can be extracted in such a collisional Penrose process, one must consider a collision in general between ingoing particles 1 and 2, from which particles 3 and 4 emerge, with the possibility that particle 3 can carry energy far out from the black hole horizon. One finds that the mass, energy, electric charge, and initial direction of motion of particle 3 can have different values, depending on the collision internal process. However, the different possible values lie within some range. Moreover, the energy of particle 3 can, in some cases, be arbitrarily high but not infinite, which characterizes a super-Penrose process. It is also shown that particle 4 has negative energy, as required in a Penrose process. For zero cosmological constant the results do not depend on the number of dimensions, but they do for nonzero cosmological constant, which also introduces differences in the lower bound for the energy extracted.

Session 3 - Modified Gravity & Dark Energy / 18

Testing hyperconical modified gravity in galaxies and clusters with distinct datasets

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This work explores the viability of Hyperconical Modified Gravity (HMG) as a relativistic alternative to the Modified Newtonian Dynamics (MOND) in explaining the dynamics of galaxy clusters, radial accelerations and galaxy rotation curves. By using five datasets (including high-resolution X-ray data and weak-lensing observations), we test HMG's predictions for hydrostatic equilibrium in galaxy clusters and flat rotation curves in galaxies. Our results show that HMG successfully accounts for the observed dynamics in the analysed gravitational systems even beyond 500 kpc and reproduces flat rotation curves on scales of 1 Mpc, outperforming MOND in some cases. These findings suggest that HMG offers a promising framework for understanding gravitational anomalies without invoking dark matter, though further research is needed to refine the model and extend its applicability.

Session 4 - Modified Gravity & Dark Energy / 19

The hybrid cosmology in the scalar-tensor representation of $f(\mathcal{G},T)$ gravity

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The $f(\mathcal{G},T)$ theory of gravity is recast in terms of the ϕ and ψ fields within the scalar-tensor formulation, where $\mathcal{G}$ is the Gauss-Bonnet term and T denotes the trace of the energy-momentum tensor. The general aspects of the introduced reformulation are discussed and the reconstruction of

the cosmological scenarios is presented, focusing on the so-called hybrid evolution. As a result, the scalar-tensor $f(\mathcal{G},T)$ theory is successfully reconstructed for the early and late time approximations with the corresponding potentials. The procedure of recovering the $f(\mathcal{G},T)$ theory in the original formulation is performed for the late time evolution and a specific quadratic potential. The scalar-tensor formulation introduced herein not only facilitates the description of various cosmic phases but also serves as a viable alternative portrayal of the $f(\mathcal{G},T)$ gravity which can be viewed as an extension of the well-established scalar Einstein-Gauss-Bonnet gravity.

Session 7 - Astroparticle Physics / 20

N-body Simulations for LiMRs cosmology

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Over 80–85% of the matter in the universe is dark matter (DM), with most of it classified as Cold Dark Matter (CDM), composed of collisionless, heavy particles. However, there is no fundamental reason to assume that the dark sector consists of only one type of particle. Recently, the existence of Light Massive Relics (LiMRs), which act like hot dark matter, has received renewed attention. These particles, being relativistic at decoupling, modify N_{eff} at CMB and also impact LSS across all scales at late times.

To investigate the effects of LiMRs on nonlinear structure formation, we conduct cosmological N-body simulations using a 3-fluid model that includes CDM, SM neutrinos, and LiMRs. Our simulations are initialized at a redshift of 99, ensuring the validity of linear theory. We modify this power spectrum using a code called Py-RePS to generate accurate and precise initial conditions for the 3-fluid simulations. These modified initial conditions are then used to run N-body simulations with N-GenIC and the Gadget-3 code, enabling us to resolve structure formation down to non-linear scales with high accuracy.

Our goal is to explore the impact of LiMRs(both thermal and non-thermal) on various cosmological observables, including the matter power spectrum and small-scale structures. By leveraging high-precision N-body simulations, we aim to place constraints on the physical properties of LiMRs and enhance our understanding of the role of light relics in cosmic structure formation.

Session 10 - Observational Cosmology / 21

Quantifying BAO tension and its implications for late-time solutions to the Hubble crisis

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Several studies in the literature have found a discrepancy between Baryon Acoustic Oscillation (BAO) measurements derived from two distinct methodologies, i.e. the two-dimensional (2D, angular) and the three-dimensional (3D, anisotropic) BAO. Since these probes play a key role in building the inverse distance ladder, this inconsistency affects discussions on the Hubble tension and

its theoretical solutions. With the aid of type Ia Supernovae (SNIa) and through a largely model-independent approach, we reinterpret this discrepancy in terms of a BAO tension and study the effects of replacing the angular components of the 3D BAO data from BOSS/eBOSS with the recent data from DESI Y1. The tension is found to be at ~2⊠ and ~2.5⊠, respectively, when the SNIa of the Pantheon+ compilation are used, rising to ~4.6⊠ with DESY5. In view of these results, we apply a calibrator-independent method to test the robustness of the distance duality relation, finding no evidence of its violation. Remarkably, we show how 2D and 3D BAO leave an imprint on completely different scales when studying the late-time phenomenology required to solve the Hubble crisis, assuming that standard physics holds before recombination.

Session 4 - Modified Gravity & Dark Energy / 22

Understanding Lcdm and Constraining Modified gravity using stacked galaxy clusters' caustics

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We perform a stacking analysis of galaxy cluster velocity phase space using the caustic technique. By stacking 128 clusters, we create four robust stacked clusters with excellent agreement between caustic masses and binned medians. We model the gravitational potential using the NFW profile, validating the ΛCDM mass-concentration relation. Implementing the Chameleon screening model, we find constraints on modified gravity parameters consistent with ΛCDM, yielding stringent upper limits of $|f_{\mathrm{R0}}|$
$lesssim 4 \times 10^{-6}$ at 95% C.L. for $f(\mathcal{R})$ gravity.

Session 6 - Early Universe / 23

Preheated inflation

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We develop and analyse a novel mechanism based on Warm Little Inflaton models that allows for production of scalar particles χ during the slow-roll regime due to a narrow parametric resonance. We show that an appreciable energy density of χ particles can be generated through this mechanism without it becoming the dominant contribution to the Friedmann equation, thus preserving the underlying inflationary paradigm. The backreaction on the inflaton is obtained, and its effects on several CMB observables are computed. The spectrum of induced gravitational waves is also determined. We obtain a modification of the curvature power spectrum which includes features that may fall within the range of future observations, as well as a substantial contribution to the tensor power spectrum.

Session 7 - Astroparticle Physics / 24

A multiple QCD axion

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The QCD axion is a well-motivated candidate for new physics and a primary focus of an ambitious global experimental program. It offers a compelling solution to both the strong CP and the dark matter problems within a narrow region of its parameter space, known as the QCD axion band. Nevertheless, rich theoretical frameworks lead us to expect that the axion is not the only exotic scalar produced in Nature, as it is often produced alongside several axion-like particles (ALPs).

In this talk, I will discuss the impact of a non-minimal scalar sector in the properties of the QCD axion and its role in addressing the strong CP problem. I will show that - due to an enlarged misalignment between the flavor and mass basis - the strong CP problem can be solved in a new displaced band, with the displacement determined by the number of ALPs in the theory. This setup can therefore open radically new regions of signal for QCD axions.

Motivated by these results, I will present a UV model that generates such multiple axions in the context of extra spacetime dimensions and I will discuss some implications to fifth force searches, cosmology and astrophysics.

Session 10 - Observational Cosmology / 25

The revival of galaxy-quasar correlations for cosmology

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Weak gravitational lensing has flourished into one of the most competitive fields in cosmology, based on two main pillars, namely cosmic shear and galaxy-galaxy lensing. However, there is a third pillar that is usually overlooked as an observable in itself: cosmic magnification, the statistical correlation in the sky between the position of foreground galaxies and the number counts of background sources. In particular, the study of galaxy-quasar correlations in the sky due to weak lensing magnification has been abandoned for 20 years owing to the success of galaxy-galaxy lensing. In this talk, we present out work aiming to revive this field by leveraging the much larger amount of high-quality data available at present.

In particular, we work with lenses from the Sloan Digital Sky Survey, both from spectroscopic large-scale structure catalogs like the CMASS and LOWZ samples and from photometric samples with reliable redshifts. Regarding background quasars, we employ both the spectroscopic all-sky Quaia catalog and a photometric one with reliable redshifts from a cross-match between the Pan-STARRS1 (PS1) and WISE surveys. All cross-correlation possibilities are studied to assess the impact of the number density of objects as well as the reliability of the redshift determinations. The quasar samples are binned in magnitude to separate the positive and negative contributions to cosmic magnification.

The most robust signal is clearly measured using the photometric lens sample, highlighting the importance of a high number density of lenses. Both background quasar catalogs agree on the common magnitude ranges, but the PS1-WISE sample allows us to go to much deeper magnitude and leverage the negative-correlation regime, which involves a much higher number density of quasars and thus produces a more stable signal. The signal behaves as expected with respect to quasar magnitude, transitioning from a positive to a negative angular correlation when going from brighter to fainter quasars and extending up to 100-200 arcmin (tens Mpc). Additionally, in some specific cases, a large-scale excess correlation appears, which was already observed in a previous work using background submillimeter galaxies and its relationship to the specifics of the lens sample is studied. All in all, the measurements presented in this work exemplify the importance of galaxy-quasar correlations

for cosmology, since the observable is shown to be very sensitive to both the cosmological matter density and clustering amplitude parameters.

Session 10 - Observational Cosmology / 26

Cosmic insights from galaxy clusters: Exploring magnification bias on sub-millimetre galaxies

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Magnification bias, an observational effect of gravitational lensing in the weak regime, allows the cosmological model to be tested through angular correlations of sources at different redshifts. This effect has been observed in various contexts, particularly with sub-millimetre galaxies (SMGs), offering valuable astrophysical and cosmological insights.

The study aims to investigate the magnification bias effect exerted by galaxy clusters on SMGs and its implications for astrophysical and cosmological parameters within the Lamda-CDM model. Magnification bias was explored by quantifying the cross-correlation function,which we then utilised to derive constraints on cosmological and astrophysical parameters with a Markov chain Monte Carlo algorithm.

Two distinct galaxy cluster samples were used to assess result robustness and understand the influence of sample characteristics. Cluster samples show higher cross-correlation values than galaxies, with an excess at larger scales suggesting contributionsfrom additional large-scale structures. The parameters obtained, while consistent with those of galaxies, are less constrained due to broader redshift distributions and limited cluster statistics. Results align with weak lensing studies, hinting at slightly lower sigma 8 and Omega matter values than Planck's cosmic microwave background data, emphasising the need for enhanced precision and alternative low-redshiftuniverse tests.

While this method yields constraints that are compatible with the Lamda-CDM model, its limitations include broader redshiftdistributions and a limited number of lenses, resulting in less constrained parameters compared to previous galaxy studies. Nonetheless, our study underscores the potential of using galaxy clusters as lenses for magnification bias studies, capitalising on their elevated masses and thus providing a promising avenue to test current cosmology theories. Further progress can be made by expanding the lens sample size.

Session 10 - Observational Cosmology / 27

Cosmography via Stellar Archaeology of stacked SDSS Legacy ETGs

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This work uses Lick indices to derive an independent, cosmology-free measurement of the Hubble parameter H(z), focusing on massive, passive galaxies at low redshift (z<0.4) from SDSS Legacy data. Unlike prior studies based on Full Spectral Fitting (FSF) or the D4000 spectral feature, we adopt a novel combined Lick index approach. Two Stellar Population Synthesis models are employed: Thomas, Maraston & Johansson (2011) and the updated model from Knowles et al. (2021). A critical analysis of systematic effects is presented, highlighting the importance of index selection and the superiority of stacked spectra (from galaxies grouped by velocity dispersion and redshift) over single-galaxy spectra. We introduce a new method to model velocity dispersion effects in the Knowles framework.

We observe oscillatory redshift trends for certain Balmer and iron indices, affecting the inferred t(z). Relations for the evolution of galaxy age, metallicity, and α/Fe with mass are obtained and compared with literature results. Central to this study are H(z) estimates derived using a cosmographic H(z;H_0,q_0,j_0...) approach, covering the redshift range up to 0.4. Besides the H(z) estimation we recover posterior probabilities for the cosmographic parameters, among which we have H_0. Without the introduction of Gaussian priors or refining the data selection by removing bad quality sets of data, we find $H_0 = 76.7^{+8.7}_{-6.2}$ km s^{-1} Mpc^{-1}. When some outliers are cut out and Gaussian priors on q_0 and j_0 introduced, the posterior of H_0 contracts down to $70.95^{+3.45}_{-3.40}$ km s^{-1} Mpc^{-1}.

These findings highlight the utility of Lick indices in providing H(z) measurements while emphasizing the need to mitigate systematic uncertainties, and pave the way for an extension of our work at higher redshift, fully exploiting the BOSS and eBOSS data and future spectra at z>1.0.

Session 8 - Gravity / 28

Two nonlinear electromagnetic generalizations of the Kerr-Newman-AdS-NUT Black holes.

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We present two nonlinear electromagnetic black hole solutions belonging to the Kerr-Newman-AdS-NUT family, referred to as cubic potential and quartic potential. These solutions are characterized by mass, angular momentum, electric and magnetic charge, the NUT parameter, the cosmological constant, and a nonlinear parameter. We provide the necessary electromagnetic potentials to generate these solutions, which satisfy the alignment conditions. We analyze the energy conditions and observe that the nonlinear parameter induces a significant negative pressure. According to Einstein's equations, this negative pressure contribution can be interpreted as mimicking the presence of a cosmological constant on the geometric side. Additionally, we present a Lagrangian in terms of the potentials and the trace of the energy-momentum tensor.

Session 8 - Gravity / 29

Energy extraction from electrostatic black holes.

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This work explores the extraction of energy from electrostatic black holes through the decay or splitting of electrically charged particles. We establish the energetic criteria for viable extraction, deriving a general expression for the efficiency that depends on black hole and particle parameters. Focusing on Reissner-Nordström (RN) and Reissner-Nordström-de Sitter (RNdS) black holes, we analyze scenarios with non-vanishing particle angular momentum. Notably, the RNdS case reveals two distinct energy extraction regions: the generalized ergosphere and a cosmological ergosphere induced by the cosmological horizon. Under specific conditions, these ergospheres merge, enabling energy extraction throughout the whole region between the event and cosmological horizons.

Session 10 - Observational Cosmology / 30

Study of the physical properties of strong gravitational lens candidates in the sub-mm through SED analysis

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Submillimeter galaxies (SMGs) are a population of high-redshift, dust-obscured galaxies with high star-formation rates and a steep number of counts, making them crucial for understanding galaxy formation and evolution. This study investigates the physical properties of 68 candidate gravitationally lensed SMGs at $z > 1.2$ from the Herschel-ATLAS catalog, along with their associated lenses at lower redshifts. Lens selection is performed based on the close proximity of the H-ATLAS sources to elliptical galaxies in the AllWISE catalog, identified using a WISE color-color diagram classification. Our primary objective is to examine the potential magnification of the background SMGs and to evaluate the effectiveness of this selection method for identifying new lenses. To achieve this, we perform SED fitting on the ultraviolet to far-infrared emission of the candidates using the CIGALE fitting code, analyzing the lens and the SMG components separately to derive statistical conclusions about their properties

Session 7 - Astroparticle Physics / 31

Constraining dark matter candidates using gravitational strong lensing

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The nature of dark matter is one of the most important unsolved questions in science. Some dark matter candidates do not have sufficient nongravitational interactions to be probed in laboratory or accelerator experiments. It is thus important to develop astrophysical probes which can constrain or lead to a discovery of such candidates. I illustrate this using state-of-the-art measurements of strong gravitationally-lensed quasars to constrain four of the most popular sterile neutrino models, and also report the constraints for other independent methods that are comparable in procedure. I will also discuss exciting improvements in measurements with up-and-coming instruments. Finally,

I will explore the extension of these calculations to various dark matter models, by looking at the properties of structure formation.

1 Zelko, Nierenberg and Treu 2024, MNRAS, https://ui.adsabs.harvard.edu/abs/2023arXiv231117140Z/abstract
2 Zelko et al. 2022, PRL, https://ui.adsabs.harvard.edu/link_gateway/2022PhRvL.129s1301Z/PUB_HTML

Session 3 - Modified Gravity & Dark Energy / 32

Observational constraints on vector-like dark energy

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The canonical cosmological model to explain the recent acceleration of the universe relies on a cosmological constant, and most dynamical dark energy and modified gravity model alternatives are based on scalar fields. Still, further alternatives are possible. One of these involves vector fields: under certain conditions, they can lead to accelerating universes while preserving large-scale homogeneity and isotropy. We report quantitative observational constraints on a model previously proposed by Armendáriz-Picón and known as the cosmic triad. We consider several subclasses of the model, which generically is a parametric extension of the canonical ΛCDM model, as well as two possible choices of the triad's potential. Our analysis shows that any deviations from this limit are constrained to be small. In particular the preferred present-day values of the matter density and the dark energy equation of state are fully consistent with those obtained, for the same datasets, in flat ΛCDM and w_0CDM. The constraints mildly depend on the priors on the dark energy equation of state, specifically on whether phantom values thereof are allowed, while the choice of potential does not play a significant role since any such potential is constrained to be relatively flat.

Session 6 - Early Universe / 34

Schwinger Current in de Sitter Space

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We study classical background electric fields and the Schwinger effect in de Sitter space. We show that having a constant electric field in de Sitter requires the photon to have a tachyonic mass proportional to the Hubble scale. This has physical implications for the induced Schwinger current which affect its IR behaviour. To study this we recompute the Schwinger current in de Sitter space for charged fermions and minimally coupled scalars imposing a physically consistent renormalization condition. We find a finite and positive Schwinger current even in the massless limit. This is in contrast to previous calculations in the literature which found a negative IR divergence. We also obtain the first result of the Schwinger current for a non-minimally coupled scalar, including for a conformally coupled scalar which we find has very similar behaviour to the fermion current. Our results may have physical implications for both magnetogenesis and inflationary dark matter production.

Session 5 - Compact objects & Cosmology / 35

Implications of cosmologically coupled black holes for pulsar timing arrays

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It has been argued that realistic models of (singularity-free) black holes (BHs) embedded within an expanding Universe are coupled to the large-scale cosmological dynamics, with striking consequences, including pure cosmological growth of BH masses. In this pilot study, we examine the consequences of this growth for the stochastic gravitational wave background (SGWB) produced by inspiraling supermassive cosmologically coupled BHs. We show that the predicted SGWB amplitude is enhanced relative to the standard uncoupled case, while maintaining the $\Omega_{\rm gw} \propto f^{2/3}$ frequency scaling of the spectral energy density. For the case where BH masses grow with scale factor as $M_{\rm bh} \propto a^3$, thus contributing as a dark energy component to the cosmological dynamics, $\Omega_{\rm gw}$ can be enhanced by more than an order of magnitude. This has important consequences for the SGWB signal detected by pulsar timing arrays, whose measured amplitude is slightly larger than most theoretical predictions for the spectrum from inspiraling binary BHs, a discrepancy which can be alleviated by the cosmological mass growth mechanism.

Session 5 - Compact objects & Cosmology / 37

Probing fundamental physics using compact astrophysical objects

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It is well known that alternative theories to the Standard Model allow and sometimes require fundamental constants, such as the fine-structure constant, α, to vary in spacetime. We demonstrate that one way to investigate these variations is through the Mass-Radius relation of compact astrophysical objects, which is inherently affected by α variations. We start by considering the model of a polytropic white dwarf, which we perturb by adding the α variations for a generic class of Grand Unified Theories. We then extend our analysis to neutron stars, building upon the polytropic approach to consider more realistic equations of state, discussing the impact of such variations on mass-radius measurements in neutron stars. We present some constraints on these models based on current data and also outline how future observations might distinguish between extensions of the Standard Model.

Session 4 - Modified Gravity & Dark Energy / 38

Unveiling Cosmic Dynamics through f(Q) Gravity

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In the quest to understand the accelerated expansion of the universe, f(Q) gravity offers a promising alternative to General Relativity (GR) by incorporating non-metricity into the gravitational framework. Unlike GR, which relies on spacetime curvature, f(Q) gravity modifies the Einstein-Hilbert action by replacing the Ricci scalar R with a function f(Q), where Q represents the non-metricity scalar. This study utilizes the Friedmann-Lemaître-Robertson-Walker (FLRW) model to explore how f(Q) gravity affects key cosmological parameters, including the Hubble parameter, energy density, isotropic pressure, and equation of state. By deriving and analyzing the modified Friedmann equations, we examine the role of non-metricity in shaping cosmic evolution. Our findings indicate that f(Q) gravity can effectively model the universe's accelerated expansion, potentially providing new insights into dark energy. These results underscore the potential of f(Q) gravity as a viable framework for addressing outstanding questions in cosmology. Future research could expand upon this work by exploring more complex f(Q) models, paving the way toward a comprehensive theory of gravity that aligns with both observational data and theoretical advancements.

Session 7 - Astroparticle Physics / 40

Strong CMB bounds on ALPS form strings

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Axion-like particles (ALPS), radiated from a network of cosmic strings, may be a large part of Dark Matter (DM). In the era of precision cosmology, it is possible to characterize the effect of such particles - which almost scale invariant distribution function spans many orders of magnitudes in momentum - on the observables. In this work, we employ the CLASS code and Planck 2018 data to place bounds on the abundance and on other distinctive parameters of ALPS from strings. We focus on the mass range $10^{-20} - 10^{-15}$ eV, and we find the strongest constraint on the ALP decay constant f_a if the ALP mass is between $10^{-20} - 10^{-18}$ eV, where we are able to improve the overabundance of DM bound on f_a by more than a factor of 3. As a result, ALPS from strings cannot account for more than one-tenth of DM at three sigma if m_a is between $10^{-20} - 10^{-18}$ eV.

Session 2 - Phase Transitions & Topological Defects / 41

Domain wall evolution beyond quartic potentials: The Sine-Gordon and Christ-Lee potentials

Authors: Carlos Martins[None]; José Ricardo Correia[None]; Manuel Rosa[None]; Ricarda Heilemann[None]

Domain walls are the simplest type of topological defects formed at cosmological phase transitions, and one of the most constrained. These analyses typically assume a quartic double well potential, but this model is not fully representative of the range of known or plausible particle physics models. Here we study the cosmological evolution of domain walls in two other classes of potentials. The Sine-Gordon potential allows several types of walls, interpolating between different pairs of minima (which demands specific numerical algorithms to separately measure the relevant properties of each type). The Christ-Lee potential parametrically interpolates between sextic and quartic behavior. We use multiple sets of simulations in two and three spatial dimensions, for various cosmological epochs and under various choices of initial conditions, to discuss the scaling properties of these networks. In the Sine-Gordon case, we identify and quantify deviations from the usual scaling behavior. In the Christ-Lee case, we discuss conditions under which walls form (or not), and quantify how these outcomes depend on parameters such as the energy difference between the false and true vacua

and the expansion rate of the Universe. Finally, we briefly comment on the possible cosmological implications of our results.

Session 1 - Phase Transitions & Topological Defects / 42

Gravitational waves from a curvature-induced phase transition of a Higgs-portal dark matter sector

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Our latest study (2407.18845) investigates the possibility of generating gravitational waves (GWs) from a curvature-induced phase transition of a non-minimally coupled scalar field acting as dark matter, with a portal interaction to the Higgs field. This analysis is conducted within a dynamical spacetime framework, specifically during the transition from inflation to kination, while also examining the potential for triggering Electroweak symmetry breaking through this mechanism.

A comprehensive exploration of inflationary scales is carried out, considering both positive and negative values of the non-minimal coupling. The study further accounts for phenomenological and observational constraints on the Beyond Standard Model (BSM) couplings, ensuring consistency when the scalar field serves as spectator dark matter. Notably, kination enhances the GW amplitudes, significantly restricting the viable parameter space. While the resulting GW spectra typically reside at high frequencies for standard high-scale inflation, certain regions of parameter space allow for potential detection in future experiments, offering a testable link between early universe dynamics, dark matter physics, and gravitational wave cosmology.

Session 7 - Astroparticle Physics / 43

Deviations from the von Laue Condition: Implications for the On-Shell Lagrangian of Particles and Fluids

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According to the von Laue condition, the volume integral of the proper pressure inside isolated particles with a fixed structure and finite mass vanishes in the Minkowski limit of general relativity. We explore this condition considering a simple illustrative example: non-standard static global monopoles with finite energy, for which the von Laue condition is satisfied when the proper pressure is integrated over the whole space. We demonstrate, however, that the absolute value of this integral, when calculated up to a finite distance from the center of the global monopole, generally deviates from zero, and that this deviation is bounded by the energy located outside the specified volume (under the assumption of the dominant energy condition). Furthermore, we establish that the maximum deviation from unity of the ratio between the volume averages of the on-shell Lagrangian and the trace of the energy-momentum tensor cannot exceed three times the outer energy fraction. Additionally, we show that, as long as the dominant energy condition holds, these constraints generally apply to real particles with fixed structure and finite mass. We argue that, except

in extremely dense environments with energy densities comparable to that of an atomic nucleus, the volume average of the aforementioned ratio for atomic nuclei should remain extremely close to unity. Finally, we discuss the implications of our findings for the form of the on-shell Lagrangian of real fluids. This is often a crucial element for accurately describing fluid dynamics in the presence of non-minimal couplings to other matter fields or gravity.

Session 10 - Observational Cosmology / 44

Hidden Patterns in the Local Universe: Cosmic Coincidence or New Physics?

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The current era of astronomical surveys is revolutionizing our understanding of the Universe, revealing unprecedented details on both large and local scales. While redshift catalogues capture cosmic structures on vast scales, precise distance surveys shed new light on the galaxies closest to the Milky Way.
Our research focuses on emerging patterns unveiled by improved distance accuracy that defy straightforward explanations within the standard cosmological model. One striking example is the "Council of Giants," a ring of massive galaxies encircling the Local Group, first proposed by McCall (2014). In our recent study (Olex et al., 2024), we confirm the existence of this structure using modern observations and our new AI-based method for pattern search in cosmological data (called HINORA). Meanwhile, recent works (e.g., Peebles, 2023) suggest the existence of additional planar structures in the Local Universe, potentially linked to exotic phenomena like cosmic strings.
To verify whether these patterns could arise naturally in a ΛCDM framework, we applied our HINORA methodology to cosmological simulations. In this talk, I will present our preliminary findings, exploring whether such structures emerge by chance or, on the contrary, signify new physics. These results not only challenge established paradigms but also underscore the importance of high-precision surveys in probing the fundamental nature of the Universe.

Session 6 - Early Universe / 45

Testing inflationary models with de Sitter Swampland Conjectures

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The de Sitter Swampland Conjectures are used to test some inflationary models compatible with CMBdata. We find that warm inflationary models, with one or more scalar fields, and the Claplygin-inspired models for some class of potentials satisfy the de Sitter Swampland Conjectures. Inflationary models in the context of theories of gravity that couple non-minimally curvature and matter are shown to be inconsistent with the de Sitter Swampland Conjectures.

Session 9 - Observational Cosmology / 46

Cosmological implications of the TDiff invariant models

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The symmetry group of general relativity is the group of diffeomorphisms (Diff), which means that the form of the physical equations remains invariant under general coordinate transformations. We discuss the cosmological implications of breaking the Diff invariance down to transverse diffeomorphisms (TDiff) invariance in the matter sector. We show that even simple cases, like a minimally coupled TDiff scalar theory with purely kinetic terms, represent an interesting alternative to the LCDM and provide new ways to deal with the cosmological tensions.

Session 3 - Modified Gravity & Dark Energy / 47

Is cosmological data suggesting a nonminimal coupling between matter and gravity?

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We analyse the late-time cosmological effects of a modified theory of gravity with a non-minimal coupling between curvature and matter. By evolving the cosmological parameters that match the cosmic microwave background data until their values from direct late-time measurements, we will show how to obtain an agreement between different experimental methods without disrupting their individual validity. We use type Ia supernovae data from the Pantheon+ sample and the recent 5-year Dark Energy Survey (DES) data release along with baryon acoustic oscillation measurements from the Dark Energy Spectroscopic Instrument (DESI) and extended Baryon Oscillation Spectroscopic Survey (eBOSS) to constrain the modified model's parameters and to compare its fit quality to the Flat-ΛCDM model. We find moderate to strong evidence for a preference of the nonminimally coupled theory over the current standard model for all dataset combinations.

This talk is based on the work conducted in JCAP06(2024)025 (arXiv:2403.11683) and in Phys.Dark Univ. 48 (2025) 101861 (arXiv:2412.09348).

Session 1 - Phase Transitions & Topological Defects / 48

Catastrophic events in domain wall evolution

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The collapse of domain wall networks in the early universe could have left observable signatures in the form of gravitational waves and primordial black holes. This motivates a detailed study of

the dynamics of these topological defects. In this talk, I will discuss how their effective description can predict singularities in the worldvolume of the walls and how this catastrophic evolution is reproduced in field theory simulations.

Session 6 - Early Universe / 49

Current constraints on cosmological scenarios with very low reheating temperatures

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If reheating occurs at sufficiently low temperatures (below 20 MeV), neutrinos–assuming they are populated only through weak interactions–do not have enough time to reach thermal equilibrium before decoupling. We present an updated analysis of cosmological models with very low reheating scenarios, including a more precise computation of neutrino distribution functions, leveraging the latest datasets from cosmological surveys. At the 95% confidence level, we establish a lower bound on the reheating temperature of $T_{\rm RH} > 5.96$ MeV, representing the most stringent constraint to date.

Session 4 - Modified Gravity & Dark Energy / 50

Testing Gravity with cross-correlations of CMB and LSS

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The accelerated expansion of the Universe is canonically attributed to the Dark Energy (DE), encapsulated in the Lambda factor in the Einstein field equations of gravity, but its nature is still not understood. While observations supply strong evidence in favor of the standard model of cosmology Lambda-CDM, a plethora of different modified gravity models (MG) can still arise and describe gravity and DE in another way than a Lambda-constant. In our work, we exploit the Effective Field Theory (EFT) framework which allows us to describe gravity and DE in a general way, encompassing single-field models. The strength of this approach is that we can describe not only general features of gravity but also recover model-dependent results through a mapping procedure. Upon this theoretical setting, we combine CMB and galaxy-clustering observables to discriminate between Lambda-CDM and MG/DE models. One of our main aims is to specifically assess the constraining power of cross-correlations between different probes from wide galaxy surveys, like Euclid, and the high sensitivity maps of the microwave sky delivered by Planck.

Session 10 - Observational Cosmology / 51

Varying fundamental constants cosmography

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Cosmography is a model-independent phenomenological approach to observational cosmology, relying on Taylor series expansions of physical quantities as a function of the cosmological redshift or analogous variables. A recent work [Martins et al. Phys. Lett. B827 (2022) 137002] developed the formalism for a cosmographic analysis of astrophysical and local measurements of the fine-structure constant, α, and provided first constraints on the corresponding parameters. Here we update the earlier work, both by including more recent measurements of α and by extending it to the proton-to-electron mass ratio, the proton gyromagnetic ratio, and various combinations of the three enabling the addition of the corresponding measurements to the analysis. We place stringent model-independent constraints on the first two terms of these cosmographic series, ranging from the parts per billion to the parts per million level. We illustrate the benefits of this approach with two specific applications: cosmographic constraints on a broad class of Grand Unified Theories in which varying fundamental constants unavoidably occur, and a discriminating test between freezing and thawing dark energy models.

Session 7 - Astroparticle Physics / 52

Small instanton-induced flavor invariants and the axion potential

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Small instantons can enhance the axion mass, due to an appropriate modification of QCD in the ultraviolet (UV), in a way where the axion still solves the strong CP problem. However, besides increasing the axion mass, small instantons can also enhance any CP violation present in the theory, which can shift the minimum of the axion potential, putting the the axion solution strong CP problem at risk. In this talk, I will first introduce the use of flavour invariants to capture CP violation in the Standard Model Effective Field Theory (SMEFT) and how they naturally arise in the instanton computation. Finally, I will present how the invariants can be used to make statements about CP-violation in small instanton scenarios. Besides this, I will also explore these effects to the rest of the axion interactions, namely in regards to the couplings with fermions.

Session 3 - Modified Gravity & Dark Energy / 53

Comparing Dark Energy Models in Extended Theories of Gravity

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The wide range of modified gravity theories proposed to address the limitations of General Relativity (GR) presents a challenge in distinguishing between them. In particular, the Geometric Trinity of Gravity - comprising General Relativity, based on curvature; Teleparallel Gravity, which relies on torsion and Symmetric Teleparallel Gravity, which is formulated in terms of nonmetricity- are dynamically equivalent. This raises fundamental questions about the underdetermination of the geometric nature of spacetime and whether observational distinctions between these frameworks are possible.

Since these theories are phenomenologically equivalent to GR, obtaining deviations from it requires considering extended versions, where the Lagrangian is an arbitrary function of the corresponding geometric invariants: $f(R)$, $f(T)$ and $f(Q)$.

We compare these three classes of modified gravity theories by evaluating which of them are compatible with a CDM expansion history using a reconstruction approach.
Our main objective is to determine which of these theories can account for cosmic acceleration without invoking a cosmological constant.
We show that for these theories, an exact CDM behavior can only be reproduced with a cosmological constant. This motivated extending the analysis to more general theories that incorporate boundary terms and matter couplings.

Session 2 - Phase Transitions & Topological Defects / 54

Analytical Methods for Realistic Cosmic Strings and Superstrings

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The CVOS model is a thermodynamical framework designed to describe the evolution of a network of current-carrying cosmic strings, where energy loss due to loop formation is incorporated phenomenologically. In this work, I investigate the stability of these configurations by analytically manipulating and examining the microscopic equations of the model. Subsequently, I analyze the evolution of the loops through numerical simulations in various regimes—namely, the linear, Kaluza–Klein, and Witten scenarios—and compare their behaviors. The different cases exhibit substantially distinct features, providing deeper insight into the small-scale dynamics of the network.

Session 2 - Phase Transitions & Topological Defects / 55

Structure Formation From Cosmic Domain Wall Collapses

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A series of symmetry-breaking phase transitions in the early universe is expected to have caused the formation of networks of sheet-like topological defects called domain walls, whose collapse could leave observable imprints in current-day massive non-linear structures. We use the parameter-free version of the velocity-dependent one-scale model to provide an estimate of their decay energy, which is expected to act as a seed for density perturbations of the background matter field. We calculate the current mass of the resulting non-linear objects depending on collapse redshift and wall tension, and thus show that domain walls can be responsible for the formation of objects with masses up to those of current-day galaxy clusters. Based on this, we estimate the maximal fraction of such objects and confirm that the contribution of standard domain walls to structure formation is always subdominant. Networks of walls based on a biased scalar field potential, however, are subject to much less stringent observational constraints, allowing for a significantly larger collapse energy. Based on our analysis, we are able to show that the collapse of such biased wall networks can provide a significant contribution to structure formation, and, in particular, a mass excess at high redshifts of z ≥ 9 as suggested by JWST data.

Session 2 - Phase Transitions & Topological Defects / 56

Preliminary evaluation of GVOS model parameters on the asymptotic solutions for current carrying cosmic strings networks evolution

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Cosmic strings arise naturally in both unifying theories and superstring inspired inflation models, in which case the fundamental strings formed in the very early universe may have stretched to macroscopic scales.
To better understand the underlying physical mechanisms and how the macroscopical properties of such networks evolve, analytical developments are needed. In this work, we have explored the generalised velocity-dependent one-scale model for current-carrying cosmic strings, and in particular studied how three phenomenological parameters introduced to model the loop chopping efficiency, the possible overall biases from additional degrees of freedom and an eventual bias between charge and current, impact the allowed asymptotic solutions of the network.
This analysis also reveals the expansion rates that are compatible with each solution branch, and the conditions under which it would be possible to have charge and current solutions that are not erased through the universe expansion, and their relation to the phenomenological parameters that characterize the network.

Session 7 - Astroparticle Physics / 57

How much is the lifetime of an oscillon affected by coupling to another field?

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Oscillons are long-lived localized solitons of a real scalar field with potential flatter than quadratic. They are considered to be formed through parametric resonance during preheating after inflation and can play an important role in the early universe because of their long lifetime. However, their lifetime can be greatly affected by the parametric resonance if there is coupling of the inflaton field to other fields. We consider an oscillon coupled with another real scalar field and use both semi-analytical method and numerical simulation to investigate the evolution and lifetime of the oscillon. We find that the oscillon life time can be greatly shortened depending on the coupling strength.

Session 1 - Phase Transitions & Topological Defects / 58

Gravitational Waves from compressional and vortical modes in strong first order phase transitions

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Multiple extensions of the Standard Model of particle physics predict the existence of first order phase transitions occurring in the early Universe, leading to an imprint in the stochastic background of gravitational waves. When the transition occurs at the electroweak scale, this imprint will be in the expected range of LISA.
In this talk we explore the gravitational wave production of strong first order phase transitions, seeking to understand the role of fluid non-linearities and their impact on the expected signal. To do so, we employ large scale simulations of two transitions: one preceded by a detonation, another by a deflagration. We then study the evolution of vortical and compressional modes, how they are intrinsically related and what their respective impacts are on the expected gravitational wave background signal. We also demonstrate saturation of the gravitational wave power spectra due to non-linear decay of flow.

Session 3 - Modified Gravity & Dark Energy / 60

Quintessence approximations

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We introduce new simple analytical approximations for quintessence solutions covering both tracking (asymptotically inverse power-law potentials) and thawing slow-roll models. From an observational perspective the remarkable accuracy of the approximations makes numerical calculations superfluous when assessing observational constraints. We will then discuss ongoing work on generalisations for thawing hilltop models.

Session 2 - Phase Transitions & Topological Defects / 61

Analytical approximations to the stochastic gravitational wave background from cosmic strings with friction

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Cosmic strings can be produced during phase transitions in the very early universe. They are particularly interesting objects since they emit gravitational waves contributing to the stochastic gravitational wave background (SGWB). This gives us possibility to connect gravitational waves experiments to unknown physics scenarios of the very distant past. In the early stages of cosmic string network evolution we expect frequent interactions of cosmic strings with particles of the surrounding plasma. Usually in the literature the contribution to the SGWB from these friction-dominated regimes is neglected. In our work, however, we show that, for a significant part of parameter space, the inclusion of friction leads to a prominent signature in the ultra-high frequency range of the spectrum. More than that, this signature should be sensitive to the particular underlying high energy physics scenarios, depending not only on the fields that constitute the string but also on the particle contents of the early universe. In order to ease an investigation of the signature's dependence on free parameters we developed analytical approximations to the SGWB created by cosmic strings during the friction era for the most relevant cases.

Session 4 - Modified Gravity & Dark Energy / 62

Homogeneous solutions to the Einstein-matter equations at a conformal gauge singularity

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I will present expansions of the metric and its derivative near a conformal gauge singularity (also known as isotropic singularities) for Bianchi I symmetric massless solutions of the Einstein-Vlasov and Einstein-Boltzmann system with a magnetic field. We will discuss how this can be related to our universe. This is work in collaboration with Ho Lee, John Stalker and Paul Tod.

Session 9 - Observational Cosmology / 63

JWST observations and state of cosmic anomalies

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Observations from the James Webb Space Telescope (JWST) have unveiled an unexpectedly high abundance of massive galaxies at early times, further challenging ΛCDM predictions. I will discuss our pioneering solutions for these tensions and their implications for the future of cosmology.

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Registration

65

TBA

66

TBA

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Primordial Black Holes and the Early Universe

Primordial black holes, which could have formed after inflation, can have significant implications for the history of the early Universe. Such a population of black holes, which may have differing mass and spin, can undergo evaporation due to Hawking radiation at different points in time. In this talk, I will review the potential impact of this evaporation on various cosmological observables, including the creation of matter-antimatter asymmetry, dark radiation, gravitational waves and dark matter.