HEP2023 - 40th Conference on Recent Developments in High Energy Physics and Cosmology, Ioannina, Greece

Wednesday, 5 April 2023 - Friday, 7 April 2023

University of Ioannina (GR)

Book of Abstracts

Contents

Parallel (Theory) / 1

Anomalous and axial Z' contributions to g-2

Author: Pascal Anastasopoulos[1]

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We will study the effects of an anomalous Z' boson on the anomalous magnetic moment of the muon (g-2), and especially the impact of its axial coupling. We mainly evaluate the negative contribution to (g-2) of such couplings at one-loop and look at the anomalous couplings generated at two loops. We find areas of the parameter space, where the anomalous contribution becomes comparable and even dominant compared to the one-loop contribution. We show that in such cases, the cutoff of the theory is sufficiently low, so that new charged fermions can be found in the next round of collider experiments.

Parallel (Theory) / 2

Goldstino condensation

Author: Fotis Farakos[None]

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We investigate the formation of composite states of the goldstino in theories with non-linearly realized supersymmetry and show that the pure Volkov-Akulov model has an instability towards goldstino condensation. We discuss the limitations and implications of our findings for string models involving anti-brane uplifts.

Plenary / 3

Higher-order corrections at the LHC: current status and prospects

Author: Konstantinos Papadopoulos[1]

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The upcoming High Luminosity upgrade of the LHC will provide us with experimental data of unprecedented precision. Making sense of the data and exploiting the machine's full potential will require theoretical predictions of equally high precision. In recent years, the theoretical particle physics community has made a tremendous effort to meet the challenge of performing notoriously difficult perturbative calculations in Quantum Field Theory. The current precision frontier for the QCD-dominated processes studied at the LHC lies at the Next-to-Next-to-Leading-Order (NNLO) corrections for $2 \to 3$ scattering processes. In this talk, I will review the latest developments in higher-order corrections to scattering amplitudes and discuss the prospects in this field of research for the near future.

Plenary / 4

Living on a Supermanifold

Author: Apostolos Pilaftsis[1]

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Latest advances on the formulation of a grand covariant quantum field theory that includes fermions will be presented.

Plenary / **5**

Inflation in Metric-Affine Quadratic Gravity

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In the general framework of Metric-Affine theories of gravity, where the metric and the connection are independent variables, we consider actions quadratic in the Ricci scalar curvature and the Holst invariant (the contraction of the Riemann curvature with the Levi-Civita antisymmetric tensor) coupled non-minimally to a scalar field. We study the profile of the equivalent effective metric theory, featuring an extra dynamical pseudoscalar degree of freedom, and show that it reduces to an effective single-field inflationary model. We analyze in detail the inflationary predictions and find that they fall within the latest observational bounds for a wide range of parameters, allowing for an increase in the tensor-to-scalar ratio. The spectral index can either decrease or increase depending on the position in parameter space.

Plenary / **6**

A Field Theory Approach to Dark Energy and its observational consequences.

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From the perspective of Particle Physics and Field Theory, Dark Energy is a low energy phenomenon. Thus, we expect that field theory in curved space time should be sufficient to understand the physics of Dark Energy and its observational consequences. However, in the context of the Standard Model of Particle Physics obtaining fields with sufficiently low masses that can both be protected technically and be relevant for Dark Energy physics can be a challenge. Pseudo Nambu Goldstone Bosons tied to non-zero Neutrino masses provide an approach to the Dark Energy problem that appears to be very promising. Not only does such an approach solve the traditional problems that Dark Energy was invented to solve but it provides avenues to explore the connected areas of physics, cosmology and astrophysics. As some examples of this, we will discuss the gravitational collapse of dark energy field configurations to form SMBHs (Super Massive Black Holes) with masses comparable to the masses at the centers of galaxies. Further, we will discuss the gravitational waves produced by dark energy fields and show that these gravitational waves can explain the periodicity of the Ice Ages through the amplitude and frequency of the ellipticity variation of earth's orbit created by such Dark Energy Gravitational Waves. Finally, we discuss future directions and point out some of the exciting avenues

that still need further exploration –these explorations will undoubtedly shape our ever expanding understanding of our Universe.

Parallel (Theory) / 9

Black hole solutions In Chern-Simons Gravity with Axion Hair

Author: Nikos Chatzifotis[1]

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Chern-Simons gravity with axions is revisited from the point of view of studying Kerr-like black hole solutions which take into account the back reaction of the axion field onto the spacetime geometry. We extend previous results by giving analytic expressions for slowly rotating black holes, which formally include an all order expansion in the pertinent coupling constant. We investigate potentially observable effects, e.g. the black hole angular-momentum reversal in the near horizon regime by the axion cloud surrounding the black hole, which occurs for sufficiently strong interaction coupling.

References:
[1] N.Chatzifotis, P.Dorlis, N.E.Mavromatos and E.Papantonopoulos,
Phys. Rev. D 105 (2022) no.8, 084051;[arXiv:2202.03496 [gr-qc]].

[2] N.Chatzifotis, P.Dorlis, N.E.Mavromatos and E.Papantonopoulos,
Phys. Rev. D 106 (2022) no.8, 084002;[arXiv:2206.11734 [gr-qc]].

Parallel (Theory) / 11

On Thermal Stability of Hairy Black Holes

Author: Panagiotis Dorlis[None]

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We discuss thermodynamical stability of black hole spacetimes, with the latter viewed as defects in the thermodynamical parameter space. We derive, in a model independent way, the conditions for a hairy black hole with a secondary hair to reach a stable thermal equilibrium with the heat bath, which the black hole is embedded to. As a specific example, we consider black holes with scalar hair in higher-curvature modified gravity theories. If the scalar hair, induced by interactions of matter fields with quadratic-curvature corrections, produces an inner horizon in the deformed geometry, a thermodynamically stable configuration will be reached with the black hole becoming extremal in its final stage. We also speculate that such stable black-hole remnant might induce a minimum length in the quantum spacetime.

Reference:

N. Chatzifotis, P. Dorlis, N.E. Mavromatos and E. Papantonopoulos [arXiv:2302.03980 [gr-qc]].

Parallel (Experiment) / 15

Measurement of azimuthal correlations of jets and determination of the strong coupling in pp collisions at 13 TeV with CMS

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A measurement is presented of the ratio observable $R_{\Delta\phi}$, which is related in a novel way to the azimuthal correlations among jets. It is defined as the fraction of the number of neighboring jets exceeding a minimal transverse momentum of 100 GeV within a 3-jet topology enforced through the allowed azimuthal angular separation of $2\pi/3 < \Delta\phi < 7\pi/8$ with respect to the number of inclusive jets with the same jet transverse momentum interval. The analysis is based on data from proton-proton collisions collected by the CMS experiment at a centre-of-mass energy of 13 TeV, corresponding to an integrated luminosity of 134.4 fb^{-1}. Experimental data are compared to predictions from simulations using Monte Carlo generators that include parton showers, hadronization, and multiparton interactions. Fixed-order predictions of perturbative quantum chromodynamics (QCD) at next-to-leading order, corrected for non-perturbative and electroweak effects, are also compared to the measurement. Within uncertainties, data and theory are in agreement. From this comparison the strong coupling constant at the scale of the Z boson mass is determined to be $\alpha_S(M_Z) = 0.1177^{+0.0116}_{-0.0071}$ using the NNPDF3.1 NLO PDF set, where the errors include the experimental, non-perturbative, PDF, electroweak and scale uncertainties. A test of the QCD predictions for the running of the strong coupling constant $\alpha_S(Q)$ at the TeV region showed no deviation from the expected behaviour.

Parallel (Experiment) / **16**

Multijet cross sections and ratios in pp collisions at 13 TeV with CMS

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A measurement of inclusive differential multijet cross sections and ratios is presented. The analysis is based on data from proton-proton collisions collected by the CMS experiment at a centre-of-mass energy of 13 TeV, corresponding to an integrated luminosity of 59.8 fb^{-1}. The observables R_{mn} are calculated from the corresponding differential multijet cross sections with different multiplicities for m, n. Jets are reconstructed using the anti-k_T clustering algorithm with jet size parameter $R = 0.8$. The analysis sample includes all jets with $p_T > 150$ GeV and absolute rapidity within $|y| < 2.5$ region. The inclusive differential multijet cross sections and their ratios R_{mn} are measured as a function of the average transverse momentum $H_{T,2}/2$ of the two leading jets. Experimental data are compared to predictions from simulations using various Monte Carlo generators.

Plenary / **17**

Dedicated experiments for feebly interacting particles

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The LHC experiments are designed to discover hypothetical particles with prompt decays. In parallel, meta-stable particles are constrained by cosmological observations. Between these two extremes, there is a gap with particles with moderate lifetimes, connecting hidden sectors and the Standard Model through feeble interactions in "portal" models of dark matter, neutrino masses and other scenarios. The detector design and expected sensitivity of dedicated experiments targeting such particles is reviewed. The focus is on MAPP, the MoEDAL Apparatus for Penetrating Particles, currently under installation at the LHC interaction point 8.

Plenary / **21**

The SND@LHC experiment

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Plenary / **22**

Physics potential of future experiments at the FCC

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Plenary / **24**

Silicon detectors: From the early days to the ATLAS and CMS upgrades in the HL-LHC era

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Silicon detectors are used in Nuclear and Particle Physics since the 60-ies. However, the real breakthrough came in the early 80-ies when micrometer-position resolution for charged particle was achieved and their superior performance for tracking down short-lived particles in the Particle Physics experiments demonstrated.

This presentation outlines the historical evolution from strip configurations to hybrid silicon strip and pixel detectors for the ATLAS and CMS upgrades at the High Luminosity upgrade of the Large Hadron Collider (HL-LHC) at CERN. New challenges for silicon sensors are highlighted with respect to radiation hardness. The production delivery of sensors has commenced for the tracker upgrades in the ATLAS and CMS detectors at the HL-LHC and the different design options are presented. The overall delivery period is anticipated to last 4 years to complete the approximately 22000 sensors required. Proposed new technologies as the depleted monolithic active pixel sensors (DMAPS) where the sensor and the readout blocks are integrated in the same silicon bulk are presented. The requirement of precision timing measurements in the HL-LHC, recently has boosted the development of low gain avalanche diodes (LGADs) designed and implemented in a pixel matrix in order to equip the end-cap timing detector layers in ATLAS and CMS. The aim is to improve the pile-up rejection.

Plenary / **30**

Challenges of Future Linear Colliders (CLIC/ILC)

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This talk will address the challenges and necessary technological advances for accelerator and detector optimization, further R&D work on critical technologies within the ILC International Technology Network (ITN), and discuss plans on power, energy and sustainability for future Linear Collider facilities.

Plenary / **33**

CAST and after-CAST

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CAST is astroparticle physics experiment of CERN since 1999, searching mainly for axions. Without having observed as yet this theoretically postulated particle, CAST have further narrowed the phase space for the axion. Today, it is reasonable to say that the rest mass of this tiny particle is probably in the sub-meV range. Following a suggestion (with other 8 colleagues from 7 afiliations) from 2011, the CAST collaboration has converted CAST from an axion helioscope to an axion haloscope, searching for dark matter (DM) axions. The first results were published in 2022 (Nature communications), being competitive with a reference experiment running since ˜2 decades. The axion search was the main activity in CAST. In parallel, we had expanded CAST's horizon searching also for solar chamelons, particles from the dark energy sector. The data analysis in 2023-2024 is aiming to complete the search for streaming DM axions, which imply eventually a better detection sensitivity. The CAST performance was optimized thanks to its people and using state-of-the-art equipment like: recycled XRTelescope(s), microMEGAS, solid state detectors, force sensors and also the magnet recycled from the LHC RD. The motivation to discover axions remains strong; the emerging new detection concepts are impressive (see also contribution to this conference by Abaz Kryemadhi/ Messiah University, USA). The gained experience with CAST allows to address the biggest questions of our time, which seem to be associated with insisting puzzling anomalies also within the solar system. Zwicky's intriguing observation of "dunkle Materie"is suggestive.

Plenary / **34**

Observable primordial gravitational waves from cosmic inflation

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I will review briefly how inflation is expected to generate a stochastic background of primordial gravitational waves (GWs). Then, I will discuss how such GWs can be enhanced by a stiff period following inflation, enough to be observable. I will present examples of this in the contact of hybrid inflation with alpha-attractors, or a period of hyper-kination in Palatini gravity.

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Primordial Black Holes from an Early Matter Phase

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Plenary / **38**

Quantum Instabilities of de Sitter and Minkowski space-times

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Plenary / **40**

Remarks on thermal CFTs and massless Feynman graphs

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Plenary / **41**

Tensions in Cosmology: Are we Approaching New Physics?

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We summarize the famous tensions between various observational datasets and theoretical predictions of the Standard Model of Cosmology, such as the H0 and S8 tensions, that could be a sign that we are approaching New Physics. Then we provide possible solutions, arising from modifications /extensions of the standard lore.

Plenary / **43**

Classical and quantum aspects of a constrained FT

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The classical and quantum properties of systems maybe drastically affected by imposing constraints in their phase space. Desirable properties such as unitarity and renormalizability may not be retained. In this general context we consider a specific model which by construction is also classically integrable. After imposing a constraint we show that at tree level integrability is preserved and particle production or transmutation are not-allowed. In addition, the constrained model remains renormalizable. We compute its beta-function and argue consistency with the expected reduction of the degrees of freedom due to the constraint.

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Topological Defects & Gravitational Waves

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Plenary / **45**

Cosmological models with freeze-in baryogenesis

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In this talk we will discuss models which allows the simultaneous generation of the baryon asymmetry of the Universe along with its dark matter content. We employ the out-of-equilibrium decays of heavy bath states into a feebly coupled dark matter particle and Standard Model charged fermions. These decays lead to dark matter production via the freeze-in mechanism and, assuming that they further violate CP, can generate a viable matter-antimatter asymmetry in the resonant regime. Moreover, we will discuss how the presence of a fluid that temporarily dominates the energy content of the Universe affects the predictions of this scenario. We will show that this additional cosmic component has a significant impact on the predictions of concrete microscopic models, allowing for reheating temperatures which are much lower than those required in the simplest cosmological scenario.

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Entanglement and expansion

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I discuss the entanglement entropy resulting from tracing out local degrees of freedom of quantum harmonic systems, which include free scalar field theory as a continuum limit. It is known that the entanglement entropy of such a system in its ground state is dominated by an area law term. This peculiar feature resembles the famous property of black hole entropy. I summarize the calculation of entanglement entropy for a quantum scalar field in an expanding universe. When field modes become superhorizon during inflation they evolve to increasingly squeezed states. This causes the entanglement entropy to grow continuously as successive modes cross the horizon. The resulting entropy is proportional to the total duration of inflation. It is preserved during a subsequent era of radiation or matter domination, and thus it may be relevant for today's universe. The squeezing of the states of the field modes results in the appearance of a volume term in the entanglement entropy, in violation of the pure area law for a quantum field in its ground state in a static background. These features are demonstrated in a toy model of a scalar field in 1+1 dimensions. Preliminary results in 3+1 dimensions are also presented.

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Searching for dark matter axions via atomic excitations

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Co-authors: Frank Avignone [2]; Richard Creswick [3]; Samuel Cohen [1]

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Axions can be considered as good dark matter candidates. The detection of such light particles an be achieved by observing axion induced atomic excitations. The target is in a magnetic field so that the

m-degeneracy is removed the energy levels can be suitably adjusted. Since the axion is absorbed by the atom the cross section exhibits resonance behavior. Using an axion-electron coupling indicated by the limit obtained by the Borexino experiment, which is quite stringent, reasonable axion absorption rates have been obtained for various atomic targets. The obtained results depend, of course, on the atom considered, through the parameters ϱ (the spin orbit splitting) as well as the δ (the energy splitting due to the magnetic moment interaction). This assumption allows axion masses the tens of μeV within members of the same multiplet, i.e. |J1 , M1 = −J1> ⟶ |J1 , M1 = −J + 1>, J1≠0, and axion masses in the range 1meV-1eV involving transitions of the spin orbit splitting type |J1 , M = −J1> ⟶ |J2 , M2 = −J1 + q>, q = −1, 0, 1, i.e. three types of transition. The axion mass that can be detected is very close to the excitation energy involved, which can vary by adjusting the magnetic field. Furthermore, since the axion is absorbed by the atom, the calculated cross section exhibits resonance behavior, which can be exploited by experiments in minimizing any background events.

Plenary / **50**

Effective Field Theory as a Probe of New Physics at the LHC

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Effective Field theory opens up a new programme of searching for New Physics in the absence of evidence for any new light particles. I will discuss recent progress in theoretical computations for Effective Field Theory and present results of global effective theory interpretations of LHC measurements.

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CMS results

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CMS upgrades

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New Small Wheel System Upgrade of the ATLAS experiment

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The ATLAS collaboration at LHC has endorsed the resistive Micromegas technology, along with the small-strip Thin Gap Chambers (sTGC), for the high luminosity upgrade of the first muon station

in the high-rapidity region, the so called New Small Wheel (NSW) project. After the R&D, the prototyping phase, the first series production Micromegas quadruplets have been constructed and the corresponding Electronics & readout boards at all involved construction sites: in France, Germany, Italy, Russia and Greece. Both Wheels have been installed and commissioned in the ATLAS cavern collecting data during run-3.
The long process of the creation of this complicated project of 2.5M channels will be presented.

Parallel (Experiment) / **57**

Multi-differential measurement of the dijet cross section in proton-proton collisions at sqrt(s) = 13 TeV

Author: Polidamas Georgios Kosmoglou Kioseoglou[1]

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A measurement of the dijet production cross section is reported based on an integrated luminosity of $36.3 fb^{-1}$ of proton-proton collision data collected in 2016 at $\sqrt{s} = 13$ TeV by the CMS detector at the CERN LHC. Jets are reconstructed with the anti-k_T algorithm for distance parameters of $R = 0.4$ and $R = 0.8$ and differential cross sections are measured as a function of the kinematic properties of the two jets with largest transverse momenta. Double-differential (2D) measurements are presented as a function of the largest absolute rapidity $|y|_{max}$ of the two jets and the dijet invariant mass $m_{1,2}$. Triple-differential (3D) measurements are presented as a function of the dijet rapidity separation y* , the total boost y_b of the dijet system, and either $m_{1,2}$ or the average dijet transverse momentum $p_{T\,1,2}$ as the third variable. The measured cross sections are unfolded to correct for detector effects and are compared with fixed-order calculations derived at next-to-next-to-leading order in perturbative quantum chromodynamics. The impact of the 2D and 3D measurements on determinations of the parton distribution functions and the strong coupling constant is investigated, with the inclusion of the 3D cross sections yielding the more precise value of $\alpha_S(m_Z) = 0.1201 \pm 0.0020$.

Plenary / **58**

Detecting Stochastic Gravitational Wave Backgrounds with future space-based observatories

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Future space-borne Gravitational Wave detectors will give us the opportunity to probe for potential stochastic Gravitational Wave signals, originating from high-energy processes in the very early Universe; i.e. from inflation, from phase transitions, from topological defects, or from primordial black holes. However, extracting the interesting signatures from the data will be challenging task. In this talk, I will summarise these challenges, as well as the prospects of future space observatories to detect such signals.

Parallel (Theory) / **59**

T-Model Higgs Inflation In Supergravity

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We propose a modification of no-scale supergravity models which incorporates sgoldstino stabilization and supersymmetry (SUSY) breaking with a tunable cosmological constant by introducing a Kahler potential which yields a kinetic pole of order one. The resulting scalar potential may develop an inflection point close to which an inflationary period can be realized for subplanckian field values consistently with the observational data. For central value of the spectral index ns, the necessary tuning is of the order of 10ˆ-6, the tensor-to-scalar ratio is tiny whereas the running of ns is around -3x10ˆ-3. Our proposal is compatible with high-scale SUSY and the results of LHC on the Higgs boson mass.

Parallel (Theory) / 60

Ending inflation with a bang: Higgs vacuum decay in $R+R^2$ gravity

Author: Andreas Mantziris[1]

Co-authors: Arttu Rajantie [2]; Tommi Markkanen

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According to the current experimental data, the Higgs vacuum appears to be metastable due to the development of a second lower ground state in its potential. Consequently, vacuum decay would induce the nucleation of true vacuum bubbles with catastrophic consequences for our Universe and therefore we are motivated to study possible stabilising mechanisms in the early universe. In our latest investigation (2207.00696), we studied the electroweak metastability in the context of the observationally favoured model of Starobinsky inflation. Following the motivation and techniques from our first study (2011.037633), we obtained constraints on the Higgs curvature coupling ξ, while embedding the SM on the modified gravity scenario $R + R^2$, which introduces Starobinsky inflation naturally. This had significant repercussions for the effective Higgs potential in the form of additional negative terms that destabilize the false vacuum. Another important aspect lay in the definition for the end of inflation, as bubble nucleation is most prominent during its very last moments. Our results dictated that these stronger lower ξ-bounds are very sensitive to the final moments of inflation, where spacetime deviates increasingly from de Sitter.

Plenary / 61

ASIC development for HEP - past and future

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Application Specific Integrated Circuits are vital for the LHC experiments and have involved some of the biggest technology innovations applied in the LHC detectors. Using the history of some of the

principal ASICs used by the CMS experiment at the LHC as a reference point, ASIC developments for the first LHC generation will be discussed, commenting on the challenges and risks and how they were overcome. Currently many ASICs have been and are being developed for experiment upgrades for the HL-LHC. Quite a number of them are still unfinished and they are generally considerably more ambitious than in the first LHC generation. Hence big challenges still remain. Some of them will be discussed, hoping to identify guidelines for success in even more advanced projects in future.

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Recent results of searches for Supersymmetry with the full CMS Run II data set

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Supersymmetry (SUSY) remains one of the most appealing theories beyond the standard model (BSM) of elementary particles, due to its completeness, rich phenomenology, and ability to provide answers to fundamental open questions of modern particle physics and cosmology. The LHC Run II sample of pp collisions at 13 TeV center-of-mass energy collected with the CMS detector is a statistically powerful data set to look for new SUSY signatures and extend previous searches into unexplored regions of the parameter space. A number of recent results from SUSY searches with the full CMS Run II data set are presented and discussed in this contribution.

Parallel (Experiment) / **64**

CMS HGCAL Modules & Assembly Status

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The CMS Collaboration is designing a new high-granularity endcap calorimeter, HGCAL, to be installed as a replacement endcap calorimeter for the High Luminosity LHC era, later this decade. This sampling calorimeter will have approximately six million silicon sensor cells and four hundred thousand scintillator tiles readout with on-tile silicon-photomultipliers. After prototypes and past test beams, the module hardware design has been finalised and CMS is preparing for the mass assembly process. In this presentation, a status of the silicon modules for the HGCAL as well as the assembly process at the National Taiwan University will be given. In addition, hardware projects of the Taiwan Instrumentation and Detector Consortium (TIDC) will be shown.

Parallel (Theory) / **66**

Universal Relations for rapidly rotating neutron stars using supervized machine learning techniques

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Neutron stars are some of the most fascinating stellar objects in the universe, offering unique opportunities to study fundamental physics at supra-nuclear densities. However, their internal structure remains poorly known due to the uncertainties in the equation of state (EoS). In recent years, a lot of work has revealed the existence of universal relations between various observable quantities, such as the star's moment of inertia, the quadrupole moment, etc. These relations are insensitive to the EoS and offer a promising way to infer the fundamental properties of dense matter. At the same time, the fields of multimessenger astronomy and machine learning have advanced significantly, enabling us to discover and validate these relations in a new way. As such, there has been a confluence of research into their combination, and the field is growing. In this work, we developed universal relations for rapidly rotating neutron stars by using supervised machine learning methods such as Linear Regression and Cross Validation, thus proposing a new way of discovering and validating such relations. More specifically, we investigated EoS-insensitive relations for the star's normalized moment of inertia $\bar{I}$, the star's reduced quadrupole deformation $\bar{Q}$, and the star's spin octupole moment $\bar{S}_3$, to name a few. The comprehensive analysis is performed for tabulated hadronic, hyperonic, and hybrid EoS-ensembles that obey the multimessenger constraints and cover a wide range of stiffnesses. The relations suggested could provide an accurate tool to constrain the EoS of the dense nuclear matter when measurements of the relevant observable quantities become available.

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Geometric origin of the dark sector and matter antimatter asymmetry of the Universe

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I discuss the possibility that torsion in the early Universe, which is a feature of several cosmological models, also in the realm of string theory, can provide dark energy which is sufficient to lead to inflation, but also to matter-antimatter asymmetry in the post inflationary Universe, through the axion-like degrees of freedom associated with the torsion. Specifically, I discuss how such axions couple to chiral gravitational anomalies, which can then condense as a consequence of primordial chiral gravitational waves to lead to inflation of running vacuum type, and explain how such axions can acquire masses during the post inflationary epochs so as to provide dark matter candidates. I also speculate on a potential resolution of the current-era cosmological tensions in the context of this framework.

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[arXiv:2012.07971 [hep-ph]];

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"Inflationary physics and trans-Planckian conjecture in the stringy running vacuum model: from the phantom vacuum to the true vacuum," Eur. Phys. J. Plus \textbf{136} (2021) no.11, 1152 doi:10.1140/epjp/s13360-021-02149-6 [arXiv:2105.02659 [hep-th]].

Parallel (Experiment) / 68

Search for New Particles at CERN on the Zooniverse citizen-science platform

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The REINFORCE EU project engages and supports citizens to cooperate with researchers and contribute to the development of new knowledge for science and society. REINFORCE offers four "discovery demonstrators"in different areas of physics. The infrastructure of all demonstrators is based on Zooniverse, the most popular citizen-science platform. The demonstrator titled "Search for new particles at CERN"introduces citizen-scientists in searches for new long-lived particles produced in the high-energy proton-proton collisions at the LHC of CERN recorded by the ATLAS experiment. To make this possible, the demonstrator adopts a three-stage architecture. The first two stages use simulated data to train citizens, but also to allow for a quantitative assessment of their performance and comparison with machine-based algorithms. The third stage uses real data from the ATLAS Open-Data subset, providing two research paths: (a) study of Higgs boson decays to two photons and (b) search for yet undiscovered long-lived particles, predicted by certain Beyond-the-Standard-Model theories. Since the launch of the demonstrator on Zooniverse, it has attracted over 3000 volunteers.

Parallel (Theory) / 70

Compact objects in gravity theories

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We analyse in all generality beyond Horndeski theories of shift symmetry in a static and spherically symmetric spacetime. By introducing four auxiliary functions, we write the field equations in a particularly compact form. We show that assuming additionally parity symmetry renders the system directly integrable giving multiple families of black-hole solutions. These have typically an asymptotically-flat Reissner-Nordstrom behaviour, and emerge in the presence of a canonical kinetic term for the scalar field. In the absence of parity symmetry, we present a general method which allows us to integrate the field equations by choosing the form of only one coupling function and an auxiliary quantity. This method leads to asymptotically flat and AdS black hole solutions with differing properties. We finally discuss disformal transformations within this context as a means of obtaining wormhole and black hole solutions in different theories.

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How Large can the SUSY Contributions to $b \to s\ell^+\ell^-$ Processes be?

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We examine how large the effects in $b \to s\ell^+\ell^-$ transitions in the MSSM with a general flavour structure can be. After carefully analyzing all potentially important supersymmetric contributions, we find that the largest effects arise in case of a light wino, a light smuon and muon sneutrino, a relatively light left stop, maximal mixing among left-handed down-squarks of the $2^{\rm nd}$ and $3^{\rm rd}$ generation, with one light (order 600 GeV) and one decoupled mass eigenstate. While the bound from $B \to X_s\gamma$ can always be avoided by a suitable choice of flavour violating A terms or large μ-term, $B_s - \bar{B}_s$ mixing depends mainly (for fixed squark and Wino masses) on the gluino and the Bino mass. However, also in the latter observable, a cancellation, because of the crossed gluino diagrams, is possible. We find that the effect in $R(K)$ and $R(K^*)$ can be at most of the order of 5\% and correlate this to SUSY searches at the LHC. Concerning the LFU observables where still tensions with the SM predictions exist, like P_5' and the total branching ratios of $B_s \to \phi\mu\mu$ and $B \to K\mu\mu$, only even smaller are possible, due to an unavoidable cancellation between the Wino box diagram and the respective off-shell photon penguin.

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News from the CERN Alumni Network

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An update concerning the Network Activities during the last year will be given with a focus on the Athens Group.

Parallel (Experiment) / **73**

Dimension-8 EFT interpretation for the EWK production of ZZjj in the four-lepton channel

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Vector Boson Scattering (VBS) processes provide a great source of information on the structure of the Quartic Gauge Boson Couplings (QGCs). The Standard Model allows self interactions of the charged vector gauge bosons, although vertices with neutral-only bosons are forbidden. We use Monte Carlo samples containing VBS events with two Z-bosons in association with two jets, and we present preliminary studies for the setting of constraints on anomalous quartic couplings. In these studies we investigate typical observables and we present the expected limits on Asimov Data for the dimension-8 Wilson Coefficients in Eboli Model.

Plenary / **74**

ATLAS highlights

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Parallel (Theory) / 75

Heavier tail likelihoods for robustness against data outliers; Applications to the analysis of Gravitational Wave data

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In recent years we have been witnesses of the blooming of Gravitational Wave Astronomy. In the near future, with the more advanced, as well as the space-based detectors coming online, it is expected to detect events originating from compact binary objects at much higher rates. One of the future data analysis challenges, is performing robust statistical analyses in the presence of detector noise transients, or non-stationarities, which might originate from astrophysical sources. In this work, we propose a heavier-tailed likelihood filter based on the Hyperbolic distribution. We discuss the advantages of this formulation, after applying it to examples taken from synthetic datasets.

Plenary / 76

Gauge field theory vacuum and cosmological inflation without scalar field

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We derive the quantum energy-momentum tensor and the corresponding quantum equation of state for gauge field theory using the effective Lagrangian approach. The energy-momentum tensor has a term proportional to the space-time metric and provides a finite non-diverging contribution to the effective cosmological term. This allows to investigate the influence of the gauge field theory vacuum polarisation on the evolution of Friedmann cosmology, inflation and primordial gravitational waves. The Type I-IV solutions of the Friedmann equations induced by the gauge field theory vacuum polarisation provide an alternative inflationary mechanism and a possibility for late-time acceleration. The Type II solution of the Friedmann equations generates the initial exponential expansion of the universe of finite duration and the Type IV solution demonstrates late- time acceleration. The solutions fulfil the necessary conditions for the amplification of primordial gravitational waves.

Parallel (Experiment) / 77

Simulations studies for the RF performance of the Astroneu II Array

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Astroneu is an array for extensive air shower detection which is developed and operated in the Hellenic Open University campus near the city of Patras, Greece. In the first stage of operation (Astroneu I) it consisted of 9 scintillators detectors and 6 antennas, which were arranged in 3 stations. The Astroneu array is entering the next phase of operation, where 48 particle detectors and 16 RF antennas are about to be installed. In this work we estimate the efficiency of the new antenna array which depends on the topology as well as on various parameters of the air shower, such as the energy, direction of arrival and mass of the primary particle.

Parallel (Experiment) / **78**

Results using data from proton-proton collisions at the LHC collected using the CMS Barrel Muon Trigger electronics for Phase-2

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The Barrel Muon Trigger (BMT) is a part of the upgraded CMS Level-1 Trigger and is the subsystem responsible for searching and reconstructing Muons crossing the barrel region of the detector at Phase-2. Muons crossing the Barrel Muon detector are measured by Drift Tubes and Resistive Plate Chambers. Hits are transmitted to the back end processors via optical links. BMT Layer-1 then uses the hits to generate Trigger Primitives in the form of track segments (track stubs) for each chamber and transmits the results to Layer-2. The Layer-2 processors match them to produce Muon candidates. During the past year, one sector of the barrel was instrumented with Phase-2 electronics, providing the opportunity to perform a BMT slice test in situ with proton-proton collisions data. A description of this system as well as results from studies using these data are presented here.

Parallel (Theory) / **79**

Aspects of Relativistic and Carrollian fluids

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We study Carrollian hydrodynamics on arbitrary backgrounds by employing two distinct but complementary paths. The first one is Carrollian diffeomorphism invariance while the second one consists in analyzing the relativistic fluid equations at small speed of light. The results of the method agree, but the second approach is superior as it effortlessly captures more elaborate situations with multiple degrees of freedom.

Parallel (Experiment) / **80**

An extended outreach project for Astroparticle Physics.

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The μNet project is an extended educational program aiming for the deployment and operation of an extensive school network of educational Cosmic Ray telescopes throughout Greece. In the first year of operation (school term 2022-2023) 20 Cosmic Ray telescopes were installed in the region of Peloponnese, while more than 50 schools and 500 students from all over Greece attended by distance the extended educational program of μNet. The experimental devices, the educational activities, and the developed software tools are briefly covered in this report, along with the main findings and outcomes of the first year of operation of the network.

Parallel (Experiment) / **82**

An ATCA Processor for Level-1 Trigger Primitive Generation and Readout of the CMS Barrel Muon Detectors

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An ATCA processor was designed to instrument the first layer of the CMS Barrel Muon Trigger. The processor receives and processes DT and RPC data and produces muon track segments. Furthermore, it provides readout for the DT detectors. The ATCA processor is based on a Xilinx XCVU13P FPGA, it receives data via 10 Gbps optical links and transmits track segments via 25 Gbps optical links. The processor is instrumented with a Zynq Ultrascale+ SoM connected with the FPGA through high speed links and an SSD which provides for enhanced monitoring and control information. The design of the board and results on its performance are presented, as well as progress on infrastructure developments.

Parallel (Experiment) / **83**

Study of pp->ZZ->2l2v production using the full Run2 data with the ATLAS detector.

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This study presents an analysis of the ZZ->2l2v interaction using the full Run2 data of 139 fb-1 collected by the ATLAS detector at the LHC. The analysis includes a background estimation using a simultaneous fit method and a measurement of the cross section of the inclusive ZZ production, as well as in association with two jets, both differentially and inclusively. The ZZ->2l2v process is an important test of the electroweak sector of the Standard Model, and this study provides precise measurements of the production cross section and differential distributions for this process. The

results are compared with theoretical predictions and can be used to constrain models beyond the Standard Model.

Parallel (Experiment) / 84

EFT re-interpretation of WZ Vector Boson Scattering production

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Vector Boson Scattering in the WZ fully leptonic channel is being studied in ATLAS with the full Run 2 data of 139 fb-1. The importance of the channel for indirect New Physics searches beyond the Standard Model will be presented, and the procedure for an Effective Field Theory interpretation of the existence of quartic gauge couplings will be shown. Limits on anomalous couplings related to dimension-8 operators, which are relevant to the process, will be presented and discussed.

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Memorial for Stavros Katsanevas

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Report from General Secretary of Research & Technology representative to CERN

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Report from the EESFYE Executive Committee

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Report from EESFYE's outreach coordinator

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Round table for EESFYE matters

Parallel (Experiment) / **90**

Gravitational focusing effects on streaming dark matter as a new detection concept

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Cosmological simulations for cold dark matter (DM) suggest that a large number of streams might exist in our Galaxy. The current work includes gravitational focusing (GF) effects on streaming DM constituents by the Sun and the Earth as they approach the Earth bound detectors. For streaming DM, the GF gives rise to spatiotemporal flux enhancements of orders of magnitude above the nominal DM density. Interestingly, due to Earth's rotation the flux enhancements appear as transient signals lasting about 10 seconds repeating daily for days or weeks. This work presents a novel opportunity for DM signal detection and identification. The present simulation can be applied to any kind of invisible matter entering the solar system.

Plenary / **91**

ANNOUNCEMENTS

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