8th ComHEP: Colombian Meeting on High Energy Physics

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Book of Abstracts

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Lepton flavor violation interactions from diphoton effective vertex

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We perform an effective field theory analysis using the charged lepton flavor violation diphoton operators, $\bar{\ell}_i\ell_j\gamma\gamma$. We explored the single and double radiative decays, $\ell_i \to \ell_j\gamma(\gamma)$, $e \to \mu$, $e \to \tau$, and $\mu \to \tau$ conversions in nuclei, and determined which processes can probe $\bar{\ell}_i\ell_j\gamma\gamma$ better. Using the current upper bounds on the radiative decay, $\ell_i \to \ell_j\gamma$, we can find an indirect upper bound on the double radiative decays, three orders of magnitude stronger than the direct bounds from current searches for $\mu \to e$ transitions, and four orders of magnitude better than current bounds for $\tau \to \ell\gamma\gamma$. We also find that the best limits for $\bar{\ell}_i\ell_j\gamma\gamma$ operator are provided by $\ell_i \to \ell_j\gamma$ processes, while the best future sensitivities come from $\mu \to e$ conversion in aluminum.

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Prueba de la mecánica cuántica por medio de la oscilación de neutrinos utilizando la desigualdad de Leggett-Garg

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Se estudió el fenómeno de oscilación de neutrinos y su cuanticidad por medio de la desigualdad de Leggett-Garg, fundamentada bajo el concepto de macrorealismo, el cual establece que un sistema macroscópico con dos estados posibles se encontrará en uno de esos estados en un momento dado, sin encontrarse nunca en una superposición de los mismos, eje central de la mecánica cuántica. El fenómeno de oscilación de neutrinos es importante en este contexto debido a que brinda la posibilidad de estudiar fenómenos cuánticos como la probabilidad de supervivencia de un sabor de neutrino en sistemas de distancias macroscópicas brindadas por experimentos como MINOS, NOvA, Daya Bay y RENO. Se encontró una clara violación en términos del factor de oscilación L/E de la probabilidad de supervivencia de neutrinos para el sabor muónico y antineutrino electrónico, los resultados suponen que existe un valor característico para cada sabor de neutrino a partir del cual no se satisface la desigualdad.

The phenomenon of neutrino oscillation and its quantumness was studied by means of the Leggett-Garg inequality, based on the concept of macrorealism, which establishes that a macroscopic system with two possible states will be in one of those states at a given moment, never being in a superposition of them, the central axis of quantum mechanics. The phenomenon of neutrino oscillation is important in this context because it provides the possibility of studying quantum phenomena such as the survival probability of a neutrino flavor in systems of macroscopic distances provided by experiments such as MINOS, NOvA, Daya Bay and RENO. A clear violation was found in terms of the oscillation factor L/E of the survival probability of neutrinos for the muon flavor and electron antineutrino, the results imply that there is a characteristic value for each neutrino flavor from which the inequality is not satisfied.

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Leptogenesis within a scotogenic model

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I will present a rather generic scotogenic model to provide a solution to neutrino masses, dark matter, and the baryon antibaryon asymmetry, while accommodating the current tension on the anomalous magnetic moment of the muon. The viable region of the parameter space is determined through a Markov Chain Monte Carlo numerical code, and satisfies both dark matter observables and lepton flavor violation constraints. Then, I will present a solution to the baryon antibaryon asymmetry via leptogenesis within this scotogenic model.

5

Classification for Alternative 3-3-1 models with exotic electric charges

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We report the most general classification of 3-3-1 models with $\beta = \sqrt{3}$. We found several solutions where anomaly cancellation occurs among fermions of different families. These solutions are particularly interesting as they generate non-universal heavy neutral vector bosons. Non-universality in the SM fermion charges under an additional gauge group generates Charged Lepton Flavor Violation (CLFV) and Flavor Changing Neutral Currents˜(FCNC); we discuss under what conditions the new models can evade constraints coming from these processes. In Addition, we also report LHC constraints.

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Flavor and LHC constraints on minimal Z' models

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We report several anomaly-free Z' models and their corresponding LHC and low-energy constraints. We also discuss the possibility of explaining some experimental anomalies using a Z' model.

8

Analysis of the WIMP, SIMP and FIMP mechanisms of dark matter production in the early universe

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We present an analysis of the mechanisms of dark matter production in the early universe. There are many different models that try to explain such production. In this short talk we focus on three of these mechanisms. The first and the most recognized is the Weakly Interacting Massive Particles or WIMP model, which we work on by applying the Boltzmann equation to study the behavior of the WIMP relics in the thermal bath in the early universe. This analysis is done by finding an approximate solution of the equation analytically, and then numerically, using Python programming. We then use this same process adapting the calculations to characterize the Feebly Interacting Massive Particles or FIMP and Strongly Interacting Massive Particles or SIMP.

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JUNO's sensitivity to supernova neutrino initial spectra extraction under the framework Earth matter effects.

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JUNO will be an underground detector, filled with 40 ktn of liquid scintillation and boasting excellent resolution. It will enable simultaneous studies of great importance in the fields of neutrino and supernova physics. An intriguing area of research is the potential observability of Earth matter effects on the energy spectrum of neutrinos originating from core-collapse supernovae (CCSN) within our galaxy. This is especially relevant for supernovae occurring at distances less than 1 kpc. The observation of such effects would offer an alternative mechanism for determining the neutrino mass ordering. The presentation will delve into the most crucial aspects of extracting the initial energy spectrum in the presence of flavor conversions (Mikheyev-Smirnov-Wolfenstein effect) in both the star's mantle and terrestrial matter.

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Bremsstrahlung-induced Gravitational Waves in Monomial Potentials during Reheating

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We discuss the production of primordial gravitational waves (GW) from radiative inflaton decay during the period of reheating, assuming perturbative decay of the inflaton either into a pair of bosons or fermions, leading to successful reheating satisfying constraint from Big Bang nucleosynthesis. Assuming that the inflaton ϕ oscillates in a general monomial potential V(ϕ)∝ϕˆn, which results in a time-dependent inflaton decay width, we show that the resulting stochastic GW background can have optimistic detection prospects, especially in detectors that search for a high-frequency GW

spectrum, depending on the choice of n that determines the shape of the potential during reheating. We also discuss how this GW energy density may affect the measurement of ΔNeff for bosonic and fermionic reheating scenarios.

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Exploring the U(1) gauged Scotogenic Model within compressed mass spectrum scenarios at the LHC.

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n this talk we present a variation of the Scotogenic Model that extends the gauge group by a global U(1) symmetry, and a scalar singlet that induces Spontaneous Symmetry Breaking to explain the origin of both Majorana masses and Lepton number violation. Then, we make a brief analysis of the viable parameter space that satisfies the conditions for fermionic dark matter, which can be considered in a compressed mass spectrum with the lightest scalar state of the Z2 odd doublet. Finally, we will make a brief analysis of the collider observables and how they compare with the current experimental constraints given by both ATLAS and CMS experiments.

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Calibration of the NN Jet Vertex Tagger using Z to mu mu events in the ATLAS detector

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This work seeks to mitigate the increased pileup effects in Run 3 on the ATLAS detector by deriving efficiency scale factors and their corresponding uncertainties for pileup jet tagger: NN JVT. This is determined by looking at Z (ee/mumu)+jet events. This PU jet tagger has been tuned recently so further development of the software to allow for efficient determination of scale-factors is essential. As well as harmonisation of the calibration software. This work focus on R22 Run-2 and Run-3.

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Self-Interacting Dark Matter Extension to the Standard Model with and Astrophysics phenomenology

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As a possible extension to the standard model, a *leptophilic* U(1) gauge boson that **violates lepton universality** and a fermionic **self-interacting dark matter** that couples to this new gauge boson can explain recent anomalies in flavour physics (like (g-2)mu) and small scale structure problems of cold dark matter (like the core-cusp problem). We discuss the parameter space in which the dark sector of the model can account for those observables.

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Modelamiento de un WCD en Geant4 para medir la humedad del suelo

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Los rayos cósmicos son partículas que llegan desde el espacio exterior y bombardean constantemente la Tierra en todas las direcciones. Están compuestos por protones, partículas alfa y el resto son núcleos pesados. Al interactuar con la atmósfera (oxígeno y nitrógeno), producen cascadas de partículas secundarias, entre las que se encuentran los neutrones, que podemos clasificar de la siguiente manera: (a) neutrones de alta energía $(11MeV < E < 10GeV)$; (b) neutrones rápidos, con energías entre $100KeV < E < 11MeV$, generados por la interacción de neutrones de alta energía con la atmósfera; (c) neutrones epitérmicos $(0,5eV < E < 100KeV)$, producidos por la moderación de los neutrones rápidos mediante colisiones con núcleos atómicos; y finalmente, los neutrones térmicos, generados por colisiones elásticas de los neutrones epitérmicos con los átomos blancos que están en equilibrio térmico con el entorno. El rango de energía está entre $(0,025eV < E < 0,5eV)$, y las colisiones más probables se producen con átomos de masa similar, por ejemplo, átomos de hidrógeno.

La abundancia de neutrones epitérmicos es inversamente proporcional a la humedad del suelo. Este fenómeno puede utilizarse para construir detectores de neutrones de rayos cósmicos con el fin de monitorear el nivel de humedad del suelo. Existen varios tipos de detectores utilizados para monitorear la humedad del suelo mediante el método de conteo de neutrones epitermicos. Sin embargo, el más ampliamente utilizado es el detector de gas de Helio-3. Este tipo de detector ha experimentado un aumento significativo en su uso en aplicaciones como la seguridad nacional de los países, además de medir la humedad del suelo. Como resultado, se ha producido una crisis en el suministro de Helio-3 y su precio ha aumentado significativamente.

Para competir con los detectores de gas, se están evaluando diferentes tipos de sistemas de detección de neutrones. Un ejemplo de estos sistemas son los detectores de centelleo mezclados con un agente de captura de neutrones que permite su detección. También se han realizado pruebas con detectores Cherenkov de agua para su uso en la detección de neutrones, ya que están fabricados con materiales económicos, no tóxicos y de fácil acceso.

En este trabajo se realizan ajustes relacionados con la geometría del detector, la composición de los materiales y el volumen activo del detector Cherenkov de agua, con el propósito de mejorar la capacidad de detección de neutrones epitérmicos provenientes del suelo. En cuanto al volumen activo del detector, está compuesto por agua pura y diferentes concentraciones de un aditivo, como por ejemplo, el NaCl. Luego de inyectar un flujo de partículas secundarias a diferentes alturas, los ajustes se llevaron a cabo mediante simulaciones en Geant4 para obtener los histogramas de carga y energía.

La adición del aditivo, los ajustes geométricos y las modificaciones en los materiales mejoran la capacidad de detección de neutrones del detector Cherenkov. Los resultados obtenidos son de interés para el desarrollo de detectores de neutrones y su aplicación correspondiente en la medición de la humedad del suelo. El uso de un dopante como el NaCl, que consiste en un compuesto económico y de fácil acceso, permite utilizar el WCD como una herramienta complementaria en el estudio de fenómenos relacionados con los neutrones epitermicos.

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Placing Bounds on the Seesaw with Photons

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The Dimension-5 Seesaw Portal is a Type-I Seesaw model extended by $d = 5$ operators involving the sterile neutrino states, leading to new interactions between all neutrinos and the Standard Model neutral bosons. In this work we focus primarily on the implications of these new operators at the GeV-scale. We first revisit LEP constraints on the new interactions. Second, we turn to heavy neutrino pair production from Higgs decays, where the former are long-lived and disintegrate into a photon and a light neutrino. We perform a detailed recast of the search, which relies on the arrival time t_γ and pointing variable $|\Delta z_\gamma|$. Using Higgs production with an associated lepton, we place bounds on the effective operators.

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Search for flavor-changing neutral currents in rare top decays

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Models beyond the Standard Model with extra scalars have been highly motivated by the recent discovery of a Higgs boson. The Two Higgs Doublet Model Type III considers the most general case for the scalar potential, allowing mixing between neutral CP-even and CP-odd scalar fields. This work presents the results of the study on the t ⟶ cγ decay at one loop level if neutral flavor changing is generated by top-charm-Higgs coupling given by the Yukawa matrix

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Study of the $K\bar{K}$ $S-$wave amplitude near threshold in the $D^+ \to K^-K^+K^+$ decay

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The description of scalar mesons has been a persistent challenge in the field of light meson spectroscopy over the past several decades. Notably, the investigation of scalar states, such as the $a_0(980)$ and the $f_0(980)$, has been of significant interest due to the limited understanding of their properties. Amid these ongoing challenges, the study of three-body decays of charmed mesons, employing Dalitz plot analysis, has emerged as a valuable tool for probing the nature of these states.

Within this context, the doubly-Cabibbo suppressed decay $D^+ \to K^-K^+K^+$ stands out as a promising channel for conducting investigations at LHCb. This decay process offers a unique opportunity to gain insights into the $K\bar{K}$ $S-$wave amplitude, a fundamental component in determining branching fractions and couplings of scalar states to their final decay products. Additionally, this amplitude holds relevance for measurements of CP-violation in B_s meson decays.

The main focus of this presentation is to provide an update on the latest findings regarding the $K\bar{K}$ $S-$wave amplitude in the $D^+ \to K^-K^+K^+$ decay channel. The data employed in this study were collected using the LHCb detector during the period spanning from 2016 to 2018, from proton-proton collisions. This dataset corresponds to an integrated luminosity of 5.6 fb^{-1} and was acquired at a center-of-mass energy of 13 TeV.

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String theory and black holes through AdS/CFT: Fast review

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Abstract

The theories of the Standard Model and General Relativity do not provide all the answers to the current open problems of theoretical high-energy physics. On the other hand, string theory constitutes a very fertile theoretical framework where it is possible to find several answers and build physics beyond the standard model. Furthermore, it is the most compelling candidate to become the quantum theory of gravity. In this work we make a first approach to the theory of bosonic strings, where we show some important results incorporated into black holes, in the context of holographic duality.

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Dynamics of confined monopoles and similarities with confined quarks

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We study the annihilation of a pair of ‘t Hooft-Polyakov monopoles due to confinement by a string. We analyze the regime in which the scales of monopoles and strings are comparable. We compute the spectrum of the emitted gravitational waves and find it to agree with the previously calculated pointlike case for wavelengths longer than the system width and before the collision. However, we observe that in a head-on collision, monopoles are never recreated. Correspondingly, not even once the string oscillates. Instead, the system decays into waves of Higgs and gauge fields. We explain this phenomenon by the loss of coherence in the annihilation process. Due to this, the entropy suppression makes the recreation of a monopole pair highly improbable. We argue that in a similar regime, analogous behavior is expected for the heavy quarks connected by a QCD string. There too, instead of restretching a long string after the first collapse, the system hadronizes and decays in a high multiplicity of mesons and glueballs. We discuss the implications of our results.

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Updated Big Bang Nucleosynthesis Bounds on Long-lived Particles from Dark Sector

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As electromagnetic showers may alter the abundance of Helium, Lithium, and Deuterium, we can place severe constraints on the lifetime and amount of energy injected by long-lived particles decaying into dark matter. Considering up-to-date measurements of the light element abundances that point to Yp = 0.245 ± 0.003,(D/H) = (2.527 ± 0.03) × 10−5,(7Li/H) = 1.58+0.35 −0.28 × 10−10, (6Li/7Li) = 0.05, and the baryon-to-photon ratio obtained from the Cosmic Microwave Background data, η = 6.14 × 10−10, we derive upper limits on the fraction of electromagnetic energy produced by long-lived particles. Our findings apply to decaying dark matter models and non-thermal processes between 102 and 1010 seconds in the early universe

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Toward a search for axionlike particles at the LNLS

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Axionlike particles (ALPs) appear in several dark sector studies. They have gained increasing attention from the theoretical and experimental community. In this work, we propose the first search for

ALPs to be conducted at the Brazilian Synchrotron Light Laboratory (LNLS). In this work, we derive the projected sensitivity of a proposed experiment for the production of ALPs via the channel eþe− → aγ. We show that such an experiment could probe ALP masses between 1–55 MeV, and ALP-electron couplings down to gaee ¼ 2–6 × 10−4 GeV−1 depending on the energy beam, thickness of the target, and background assumptions. Therefore, this quest would cover an unexplored region of parameter space for experiments of this kind, constitute a promising probe for dark sectors, and potentially become the first Latin-American dark sector detector.

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Study of heavy neutral leptons in displaced vertex in proton pto-ton collisions

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In the present work, Monte Carlo simulation methods were employed using the MADGRAPH software. A range of masses was tested for a fourth type of neutral lepton, HNL, symmetrically coupled with the three generations of neutrinos in the standard model. Additionally, different orders of magnitude for the coupling of the HNL with the neutrinos were tested. The reconstruction of the HNL signal is highly sensitive to variations in the coupling. The faithful reconstruction of the W boson mass was also shown to be important for applying a correct weighting of the jets that are taken into consideration.

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Anomaly-free Model with an extra Abelian gauge Dark Symmetry and Dirac Type II Seesaw

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One of the most intriguing problems of the SM is the masslessness of neutrinos, which is contradicted by the experimental evidence. It has been established that neutrinos have a small mass, but different from zero, therefore the first experimental proof of new physics beyond the SM has been achieved. Also, it is very important mencionate that cosmology requires a heavy neutral stable particle that is suited to be a viable dark matter candidate. Therefore, we need a viable dark matter candidate and an explanation for neutrino masses.
We propose a model to obtain the small neutrino masses and dark matter candidate by extending the visible content of the Standard Model (SM) with a hidden sector composed of one scalars singlet S, two charged Dirac chiral fermions under dark symmetry, the lightest of which is the possible candidate for dark matter, and at least two right-handed singlet neutrinos $(\nu_R 1, \nu_R 2)$. These right-handed neutrinos are charged under a new symmetry U$(1)_D$. In addition, it is necessary to add a heavy scalar doublet to play the role of messenger between the visible sector (SM) and the "hidden" sector.

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Singlet-doublet Dirac fermion dark matter from Peccei-Quinn symmetry

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Weakly Interacting Massive Particles (WIMPs) and axions are arguably the most compelling dark matter (DM) candidates in the literature. Here, we consider a model where the PQ symmetry solves the strong CP problem, generates radiatively Dirac neutrino masses, and gives origin to multicomponent dark sector. Specifically, scotogenic Dirac neutrino masses arise at one-loop level. The lightest fermionic mediator acts as the second DM candidate due to a residual Z2 symmetry resulting from the PQ symmetry breaking. The WIMP DM component resembles the well-known singlet-doublet fermion DM. While the lower WIMP dark mass region is usually excluded, our model reopens that portion of the parameter space (for DM masses below . 100 GeV). Therefore, we perform a phenomenological analysis that addresses the constraints from direct searches of DM, neutrino oscillation data, and charged lepton flavor violating (LFV) processes. The model can be tested in future facilities where DM annihilation into SM particles is searched for by neutrino telescopes.

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Jet reconstruction analysis and difference between HLT and online jets

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Performance of the High level trigger reconstructing jets and how the results are compared to offline reconstructed jets. The main focus of the talk will be the vertex reconstruction, how it can be improved and what are the main reasons it usually fails.

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The minimal scenario for singlet fermion dark matter

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We propose and study a new and simple extension of the Standard Model in which the dark matter is a singlet Dirac fermion. The only other particle present in the model is a singlet scalar that mixes with the Higgs boson and couples to the dark matter. The model is based on a Z6 discrete symmetry that is spontaneously broken by the vev of the scalar, which generates the dark matter mass. We show that the model is phenomenologically viable and that it can be tested in current and future experiments.

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Machine learning approach for VBF identification with the final 4-muon state

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The strength of the coupling of the Higgs boson with other fermions and bosons has been extensively studied during the first two runs of the LHC. In this paper we study the production of the Higgs boson with 4-muon final state, i.e., Vector Boson Fusion (VBF). VBF is the process of two quarks, each emitting a Z vector boson, which then merge to create a Higgs boson. Three machine learning (ML) models are constructed: a gradient boosting based model, an Auto-ML based model and a Deep Learning model to discriminate Higgs boson events from non-Higgs boson events. The results of these models are compared with those obtained by making linear cuts.

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Decaimientos del bosón Zˆ0→eμ, eτ, μτ en el Modelo Mínimo Supersimétrico sin Paridad R

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Las interacciones de corrientes neutras en leptones de distintas familias son discutidas en el presente trabajo. Estos procesos están suprimidos dentro del Modelo Estándar (ME) debido a que la interacción débil es quiral. Sin embargo, se han establecido las cotas experimentales (más recientes) para los procesos de decaimiento del bosón Z^0 en $e\mu, e\tau, \mu\tau$ en la colaboración ATLAS, obteniendo achos de decaimiento BR$(Z^0 \to e\mu) < 7.5 \times 10^{-7}$, BR$(Z^0 \to e\tau) < 5.0 \times 10^{-6}$ y BR$(Z^0 \to \mu\tau) < 6.5 \times 10^{-6}$, respectivamente, con nivel de confianza del 95%. Se analizan estos procesos en una extensión mínima al ME denominado Modelo Mínimo Supersimétrico sin Paridad R (MMSS sin Paridad R), siendo éste un número que distingue partículas del ME de sus compañeros supersimétricos. Se discute la base del ME, su contenido de partículas, haciendo énfasis en la parte asociada con la Interacción Electrodébil, mostrando las propiedades de transformación de los campos bosónicos y su generación de masa por medio del mecanismo de Higgs. Se presenta la conservación del número leptónico en procesos dentro del ME. Se introduce el MMSS, su contenido de partículas y se contruye el Lagrangiano de interacción que viola Paridad R. Se toma este Lagrangiano y, a partir de este, se identifican los términos que permiten las interacciones de corrientes neutras y se construyen los respectivos diagramas de Feynman, con lo que posteriormente se calculan las amplitudes de los procesos, que contienen la dinámica y cuyo modulo al cuadrado nos da la probabilidad. Con la información anterior se calculan los anchos de decaimiento (BR) de los procesos para realizar las respectivas conclusiones sobre los resultados obtenidos.

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Constraining a Z' boson with $\mu\tau$ LFV coupling from ANTARES and IceCube data

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Recently the neutrino experiments ANTARES and IceCube have released new constraints to the non-standard neutrino interaction (NSI) parameter $\epsilon^d_{\mu\tau}$ (flavor off-diagonal). To the light of this new data, in this work, we study the new physics implications on the parameter space of a simplified Z' model with lepton flavor violating ($\mu\tau$) couplings. For a Z' boson with a mass heavier than the τ lepton, our results show that ANTARES and IceCube can provide additional constraints to such a new physics scenario with $\mu\tau$ couplings, when compared to bounds from low-energy flavor physics. Moreover, these neutrino experiments can exclude a similar region than ATLAS experiment, showing the potential to provide complementary information to the one obtained from direct searches at the Large Hadron Collider. The impact of the expected sensitivity at DUNE and Belle II experiments is also studied.

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The BCFW bridge construction of Representative Graphs

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In the context of scattering amplitudes in gauge theories, we construct using the Amplituhedron formalism the on-shell diagrams for the N=4 Super yang mills theory in the planar limit using the recursion relation BCFW starting with the 3-point amplitudes.

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Tensions between theory and experiment on final states interaction with neutrinos

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Accurate modeling of neutrino final state interactions with target nuclei using neutrino detectors is an open field of research. Experiments such as MINERvA, T2K, and NOvA had shown discrepancies between their simulations and their data, which implies that the leading theoretical models embedded in the simulations are not encoding the full physics of the interactions. In particular, long-baseline neutrino oscillation experiments are currently developing various analysis techniques to bridge the gap between the theoretical models and the experimental results through the tuning of the models to better represent the data. The tuning emphasizes shifts in parameters with influence in the regions of energies to which the experiments are sensitive. In this talk we discuss the latest techniques deployed during the tuning processes done over neutrino cross-section simulators used by some long-baseline neutrino oscillation experiments.

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Analysis and simulation of low-energy Michel electrons in Proto-DUNE

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Measurements of low-energy electrons produced by electron neutrino interactions and cosmic rays are crucial for neutrino oscillation measurements, the detection of supernova bursts and searches for beyond the standard model physics at neutrino experiments. In particular, electrons from cosmic muons that decay at rest, called Michel electrons, have well-known energy spectra below 50 MeV. They are therefore important for understanding the detector response to low-energy electrons. In this talk, we will discuss the simulation and analysis of Michel electrons in the Deep Underground Neutrino Experiment (DUNE) vertical drift prototype.

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Characterization of charged pions in neutrino events

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The latest results of neutrino experiments have shown a difficulty in the modeling and reconstruction of the final states, especially those produced by charged pions, where there are strong differences between what is predicted by the models and what is obtained. A better understanding and more accurate characterization of these interactions and decays can contribute significantly to improve the theoretical models and the techniques of particle identification. This talk will present the importance and problems in the identification of charged pions for neutrino events in the Nova experiment at Fermilab, as well as the discussion of possible strategies that can be implemented to contribute with improvements in such analysis.

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Bremsstrahlung on solar neutrino detection at SuperChooz

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In the different neutrino experiments, especially those of long-line baseline, the identification and subsequent reconstruction of the events has been a problem due to the lack of high-resolution detectors, which implies that it is difficult to differentiate between processes with similar topologies. The LiquidO project proposes an opaque scintillating liquid that confines light and allows for high sensitivity when identifying interaction processes at both high and low energies. The idea of this talk is to show a quick review of LiquidO technology and its implementation in the future SuperChooz neutrino detector.

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Fitting and scale uncertainty analysis of the NRQCD long-distance matrix elements in inclusive χ_c states production from B meson decays.

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Charmonium production has been modeled using NRQCD factorization. It is necessary to test the theoretical precision of the factorization formula along with the estimation of the short-distance dynamics through the fitting with the experimental data. The present talk presents a brief review of the literature's theoretical predictions of charmonium production applied to the decay mode $B \to H(c\bar{c})X$ and shows the fitting of the long-distance matrix elements with experimental data considering simultaneously an approach to estimate the theoretical uncertainties thought variating the NRQCD and QCD renormalization scales.

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Jet Performance studies on Dark jet resonance searches

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The present work aims to carry out a comparative study of jet reconstruction algorithms when employed to analyze events originating from a dark QCD model. Specifically, it focuses on two definitions used in the ATLAS experiment: LCTopo Trimmed, which has been established as the standard for jet reconstruction, and UFOCSSK SoftDrop, a more sophisticated method expected to become the new standard. The impact of calibration and grooming algorithms on the agreement between the reconstructed quantities and those at the truth level is investigated. The results highlight the importance of calibration, with definitions like EMPFlow and LCTopo Trimmed showing positive agreement between reconstruction levels and truth. In contrast, other definitions exhibited some degree of deviation. In particular, the UFOCSSK algorithms without grooming and with Trimming showed discrepancies due to the presence of low p_T components that were effectively removed only by UFOCSSK SoftDrop.

The analysis of variables such as the dijet system's mass shows that calibration and grooming algorithms have a significant impact on the final event distribution. Grooming algorithms slightly improved the location of the resonance of the dark sector mediator in the LCTopo-based definitions. However, in the UFOCSSK algorithms, each grooming algorithm shifted the resonance to different positions, with Trimming being the least effective, resulting in greater dispersion. Metrics reflecting pile-up resistance, such as the average dijet mass as a function of the number of primary vertices and the mass response as a function of true p_T, are examined. Overall, the transition from LCTopo Trimming to UFOCSSK SoftDrop is depicted as a positive enhancement for the search for resonances in dark QCD.

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Late-time cosmology in a model of modified gravity with an exponential function of the curvature

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An analysis of the late-time evolution of the Universe for an f(R)-gravity model built from an exponential function of the scalar curvature is presented. The corresponding field equations, written in terms of a suited statefinder function are solved numerically, allowing to study the evolution of interesting cosmological parameters, which present values (at z = 0), are shown to be compatible with Planck 2018 observations and the ΛCDM–model values. Finally, considering updated measurements from the dynamics of the expansion of the Universe, H(z), we perform a statistical analysis to constrain the free parameters of the model, finding a particular set of values that fit the data well and predict acceptable values for the cosmological and statefinder parameters at present time. We conclude that this f(R)-gravity model is consistent with the considered observational data, and a viable alternative to explain the late-time acceleration of the Universe.

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Advances in the ATLAS Forward Proton Detector and Global Alignment Studies

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This presentation offers a comprehensive overview of the ATLAS Forward Proton (AFP) detector within the ATLAS experiment at CERN. Positioned some millimeters from the proton-proton collision point at the LHC, the AFP detector comprises silicon-based trackers and a time-of-flight system strategically placed 210 meters away from the ATLAS interaction point. The silicon tracker facilitates precise momentum measurements, while the time-of-flight system effectively mitigates background interference from multiple proton-proton collisions. The AFP physics program focuses on probing soft and hard diffractive events at low luminosities ($\mu \approx 1$). Furthermore, we present systematic uncertainty results for global alignment using data from 2017 (Run 2), comparing it with the latest data from 2022 (Run 3). Global alignment, defined as the distance between the AFP edge and the beamline, serves as a crucial metric for ensuring the precision and reliability of the detector's performance.

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Probing a Z′ with non-universal fermion couplings through top quark fusion, decays to bottom quarks, and machine learning techniques

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We present a new feasibility study on the production of a Z′ boson at the LHC, through top anti-top fusion, with family non-universal couplings, considering proton-proton collisions at 13 TeV and 14 TeV. Such a hypothesis is well motivated theoretically and it can explain observed differences between SM predictions and experimental results, as well as being a useful tool to further probe recent results in searches for new physics considering non-universal fermion couplings. We work under two simplified phenomenological frameworks where the Z′ masses and couplings to the SM particles are free parameters, and consider final states of the Z′ decaying to a pair of b quarks. The analysis is performed using machine learning techniques to maximize the sensitivity. Despite being a well motivated physics case in its own merit, such scenarios have not been fully considered in ongoing searches at the LHC.

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Two Texture Zeros for Dirac Neutrinos in a Diagonal charged lepton basis

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A study of the two zero textures for the Dirac neutrino mass matrix
M_ν in a basis where the charged leptons are diagonal is carried through. Current neutrino oscillation data are used in our analysis.
Phenomenological implications of M_ν on the leptonic CP violation and neutrino mass spectrum are explored.

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Abelian gauge extensions with Higgs mixing

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The effect of Higgs Mixing is calculated for any Abelian gauge extension of the standard model and the effects in possible Dirac dark fermion dark matter candidates are discussed

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Scalar bosons and the muon g-2 anomaly

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The muon anomalous magnetic moment g-2 deviates by more than three sigmas from the corresponding standard model (SM) prediction. It is possible that this experimental anomaly is a consequence of physics beyond the SM.
We calculate the radiative corrections to g-2 due to a neutral exotic scalar field and compare it with the current literature. We use this result to calculate the allowed regions in the parameter space at a 68% confidence level (i.e., 1 sigma).

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Bootstrapping Quantum Mechanics

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Bootstrapping is an emerging numerical method that is used to calculate the eigenvalue of the Hamiltonian for some non-relativistic Quantum systems. The approach consist on using the hermitian property of the hamiltonian and the other operators to select the correct values of the energy of the system. We will show a basic introduction to this method, and applied it in the hydrogen atom and the harmonic oscillator.

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Quo vadis particle physics?

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Registration

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Jet clustering with a scale-invariant filtered tree

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The beauty of the Higgs boson

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Recent highlights from the CMS Experiment

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Dark Matter Complementarity

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Searches for dark sector in jets with the ATLAS detector

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Compton scattering: electron/laser interactions. From precision at FCC-ee, to low-energy applications

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Coherent elastic neutrino-nucleus scattering

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Neutrino oscillation experiments

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Phenomenology of light gauge bosons and dark matter

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Calculando Amplitudes de dispersi´on para todas las Masas y Espines

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El presente trabajo sobre el formalismo de los espinores
de helicidad y las propiedades del Little Group de Wigner, con el objetivo de construir amplitudes de dispersi´on tanto en el caso de part´ıculas sin masa, revisando ejemplos de la teor´ıa de Yukawa y la QED, como en el de part´ıculas masivas. Esto se realiz´o a partir del estudio de las amplitudes de tres puntas como pieza fundamental, permitiendo as´ı que a trav´es de relaciones de recursividad se construyan las de orden superior, evitando calcularlas de las reglas de Feynman de la teor´ıa. Adicional a esto, se estudiaron algunos l´ımites interesantes que se obtienen de estas relaciones de recurrencia y se encontraron similitudes entre las amplitudes masivas y sin masa a trav´es de los mismos espinores. Finalmente, se verific´o la validez y potencia de estos m´etodos On-Shell al realizar el c´alculo de amplitudes para diferentes procesos altamente conocidos.

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Oscillation tomography study of Earth's composition and density with atmospheric neutrinos

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Knowledge of the Earth's interior composition is highly relevant to many geophysical and geochemical problems. Neutrino oscillations are modified in a non-trivial way by the effects of matter. They can provide valuable and unique information not only on the density but also on the chemical and isotopic composition of the deep regions of the planet. In this paper, we re-examine the possibility of performing an oscillation tomography of the Earth with atmospheric neutrinos and antineutrinos to obtain information on the composition and density of the outer core and the mantle, complementary to that obtained by geophysical methods. Particular attention is paid to the D′′ layer just above the core-mantle boundary and to the water (hydrogen) content in the mantle transition zone. Our analysis is based on a Monte-Carlo simulation of the energy and azimuthal angle distribution of μ-like events generated by neutrinos. Taking as reference a model of the Earth consisting of 55 concentric layers with constant densities determined from the PREM, we evaluate the effect on the number of events due to changes in the composition and density of the outer core and the mantle. The variations are implemented so that the constraint imposed by the Earth's total mass and its moment of inertia are verified.

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Reunión Red Colombiana de Altas Energías