7th ComHEP: Colombian Meeting on High Energy Physics

Monday 28 November 2022 - Friday 2 December 2022

Book of Abstracts

Contents

LHC results / 1

Quarkophobic W' for LHC searches

Authors: Alfredo Gurrola[1]; Jose Ruiz[2]

[1] *Vanderbilt University (US)*

[2] *Universidad de Antioquia (CO)*

Corresponding Authors: alfredo.gurrola@cern.ch, jose.ruiz@cern.ch

We consider a simplified model where a W' boson is added to the standard model with negligible couplings to quarks, but generic couplings to leptons and electroweak bosons. We study the implications of such a model for LHC searches. Consequently, we propose an LHC search through the vector boson fusion topology which would have sensitivity for such a new particle with the current proton-proton collisions's energy and available luminosity.

Theory and Phenomenology / 2

Representaciones de Álgebras de Lie graduadas.

Author: Juan Camilo Guzman Martinez[1]

Co-author: Roberto Enrique Martinez Martinez

[1] *Universidad Nacional de Colombia, sede Bogotá*

Corresponding Authors: juacguzmanmar@unal.edu.co, remartinezm@unal.edu.co

Se construye el algebra de Líe del grupo de Poincare para extenderlo a álgebras de Lie graduada adicionando generadores fermionicos. Se estudiarán representaciones irreducibles minimales de estas álgebras y los respectivos súpercampos para construir densidades lagrangianas invariantes bajo las álgebras graduadas.

QCD and Heavy Flavours / 3

A holographic bottom-up description of light nuclide spectroscopy and stability

Authors: Miguel Angel Martín Contreras[1]; Alfredo Vega[None]; Saulo Diles[2]

[1] *Universidad de Valparaíso*

[2] *Universidade Federal do Pará*

Corresponding Authors: alfredo.vega@uv.cl, smdiles@ufpa.br, miguelangel.martin@uv.cl

This work explores a holographic proposal to describe light nuclide spectroscopy by considering extensions to the well-known bottom-up AdS/QCD proposals, the hardwall and softwall models. We also propose an alternative description inspired by the Woods-Saxon potential. We find the static dilaton associated with this potential in this Wood-Saxon-like model. We compute the nuclide spectra finding that, despite their pure AdS/QCD origin, hardwall and softwall, as monoparametric models, have good accuracy and precision since the RMS error is near 11% and 4 % respectively. In the case of the Wood-Saxon model, the RMS was around 1%. We also discuss configurational entropy as a tool to categorize which model is suitable to describe nuclides in terms of stability. We found that configurational entropy resembles a stability line, independent from nuclear spin, for

symmetric light nuclides when considering softwall and Wood-Saxon-like models. For the hardwall case, configurational entropy, despite increasing with the constituent number, depends on the nuclear spin. Thus, the Woods-Saxon-like model emerges as the best choice to describe light nuclide spectroscopy in the bottom-up scenario.

Theory and Phenomenology / 4

Chern-Simons on the Null Plane

Author: German Ramos[None]

Corresponding Author: gramoszge@gmail.com

We present a canonical quantization for Chern-Simons on the Null Plane coordinates using the Dirac procedure and the Faddeev-Jackiw procedure. The constraint structure when using null-plane coordinates is considered and the gauge generators are derivated.

QCD and Heavy Flavours / 5

The Triplet vector boson model: flavor and collider constraints.

Authors: Eduardo Rojas[None]; José Herman Muñoz[1]; Miguel Cabarcas[2]; Nestor Quintero Poveda[3]

[1] *Universidad del Tolima*

[2] *Universidad Santo Tomás*

[3] *Universidad Santiago de Cali*

Corresponding Authors: josecabarcas@usantotomas.edu.co, nestor.quintero01@usc.edu.co, eduro4000@gmail.com, jhmunoz@ut.edu.co

The triplet vector boson (TVB) is a simplified new physics model involving massive vector bosons transforming as a weak triplet vector, which it has been proposed as a combined explanation for the anomalous $b\to s\mu^+\mu^-$ and $b\to c\tau^-\tau$ data (the so-called B-meson anomalies). In this work, we carry out an updated view of the TVB model, including the Belle II perspectives. We perform a global fit to explore the allowed parameter space by the most current $b\to s\mu^+\mu^-$ and $b\to c\tau^-\tau$ data by considering all relevant low-energy flavor observables. Our results are confronted with the most recent LHC constraints. We also incorporate in our study the first measurement of the ratio $R(\Lambda c)=BR(\Lambda b\to\Lambda c\tau^-\tau)/BR(\Lambda b\to\Lambda c\mu^-\mu)$ very recently obtained by LHCb. In particular, we show that the TVB model can provide an explanation for the B meson anomalies; however, this framework is in strong tension with LHC bounds. With respect to future flavor measurements at Belle II, our results suggest that a small new physics window would be allowed to explain the $b\to c\tau^-\tau$ data in agreement with LHC constraints solely. Furthermore, the implications of our phenomenological analysis of the TVB model to some known flavor parametrizations are also discussed.

Neutrinos theory / 6

Neutrino masses at two-loop in multi-component dark matter Z5 model

Authors: BRALLAN ORLANDO TABORDA TORO[1]; Oscar Zapata[None]

[1] *Student*

Corresponding Authors: brallan.taborda@udea.edu.co, oalberto.zapata@udea.edu.co

We proposed a radiative seesaw model where the neutrino masses are generated at two loops. We analyzed the phenomenology of the Z5 model for two-component dark matter and neutrino masses. The Z5 symmetry allows interactions that give rise to processes between dark matter particles that affect their relic densities and their detection, which we studied in detail. In a first approach we considered the scalar sector to be the dark matter candidates, and then we studied the case of a neutrino and scalar as dark matter candidates.

Neutrinos theory / **7**

Thermal leptogenesis in the type-I Dirac seesaw extension to the DFSZ axion model for dark matter

Author: Brayan Elian Castiblanco Ortigoza[1]

Co-author: Dr. Carlos José Quimbay Herrera [1]

[1] *Universidad Nacional de Colombia*

Corresponding Authors: cjquimbayh@unal.edu.co, bcastiblancoo@unal.edu.co

The type-I Dirac seesaw extension is made to the DFSZ axion model, where light active neutrinos are Dirac particles and acquire mass through the canonical seesaw mechanism after the Peccei-Quinn and electroweak symmetry breaking, finding that neutrino mass can be approximated to $m_\nu \sim v f_a / _{UV}$, result which relates the three energy scales involved in the model: the mass of the heavy sterile Dirac fermions introduced ($_{UV}$), Peccei-Quinn spontaneous symmetry breaking scale given by the axion coupling constant (f_a), and the electroweak scale (v). As a consequence, it was found that $10^3 f_{a\ UV}$, hence neutrino Yukawa coupling associated to the QCD axion, which is candidate to dark matter, is highly suppressed (up to 10^{-10}) in comparison to the Higgs. Dirac neutrino effective mass matrix is computed explicitly, whose components depend on active-sterile mixing parameters, the latter being new sources of CP violation. Therefore, the CP asymmetry factor and the baryon-antibaryon density are computed for the unflavoured leptogenesis, linking neutrino physics, QCD axion, and cosmological parameters into a same theoretical model.

Neutrinos theory / **8**

Neutrino Masses and Majoron production in the type 1 Seesaw Mechanism

Authors: Carlos Andres Florez Bustos[1]; Gustavo Ardila[None]; Werner Rodejohann[2]

[1] *Universidad de los Andes (CO)*

[2] *Max Planck Institut für Kernphysik*

Corresponding Authors: andres.florez@cern.ch, ga.ardila10@hotmail.com

In this talk we introduce the neutrino mass problem of the Standard Model of particle physics. Then, we analyze how to generate these masses by introducing right-handed Majorana singlets in the type 1 Seesaw mechanism framework. Afterwards, we explain the origin of these masses through the spontaneous symmetry breaking of a global U(1) symmetry, which introduces a new scalar singlet with a massive Goldstone mode, referred to as the Majoron. We conclude the talk by showing some preliminary results regarding the production of both Majorons and Heavy neutrinos at different experiments.

Comunicación y diversidad / **9**

Comunicando la Materia Oscura

Author: JESSICA VELASQUEZ MUNERA[1]

Co-author: Jose Ruiz [2]

[1] *Grupo de Fenomenología e Interacciones Fundamentales, Instituto de Física, Universidad de Antioquia*

[2] *Universidad de Antioquia (CO)*

Corresponding Authors: jose.ruiz@cern.ch, jessica.velasquez1@udea.edu.co

La búsqueda de materia oscura en aceleradores de partículas es un tema del cual se tiene muy poco material divulgativo, el objetivo de este proyecto es crear una estrategia de divulgación de este tema enfocada a personas sin formación en áreas afines a la astrofísica. Se realizó un estudio del tema y se buscaron referencias para determinar cuál debía ser el contenido, en qué orden se debía presentar y qué metodología se debía usar. El producto divulgativo que se realizó fue una serie de infografías en las cuales se abarcan las siguientes temáticas: el modelo estándar, materia oscura, aceleradores de partículas y cómo se realiza la búsqueda de materia oscura en aceleradores de partículas. Se eligieron estos temas y este orden para garantizar que los espectadores tengan los elementos suficientes para poder comprender la temática central del proyecto.

Dark Matter / Cosmology / Astroparticles / **10**

Model for Dirac neutrino masses with two-component dark matter and extra gauge Abelian symmetry

Authors: DAVID ALEJANDRO SUAREZ ROLDAN[None]; DIEGO ALEJANDRO RESTREPO QUINTERO[None]

Corresponding Authors: david.suarezr@udea.edu.co, restrepo@udea.edu.co

We propose a model with a multicomponent and multiflavor dark matter which allows the realization of an effective operator for Dirac neutrino masses. Furthermore, it has an extra Abelian gauge symmetry that is spontaneously broken and generates masses for particles in the dark sector and it is responsible for the stablity of dark matter candidates. We explore the parameter space of the model and we analyze the impact of the constraint of the relic abundance of the candidates of dark matter.

QCD and Heavy Flavours / **11**

Measurement of the B^+ differential cross section as a function of transverse momentum and multiplicity density in pPb collisions at $\sqrt{s_{NN}} = 8.16$ TeV

Authors: Camilo Jose Torres Castano[1]; Jhovanny Andres Mejia Guisao[1]

[1] *Universidad de Antioquia (CO)*

Corresponding Authors: cjose.torres@udea.edu.co, jmejiagu@cern.ch

We present the first observation of the B^+ meson production suppression in high-multiplicity respect to low multiplicity pPb collisions at $\sqrt{s_{NN}} = 8.16$ TeV with data collected by the CMS detector during 2016 and corresponding to an integrated luminosity of 175 nb^{-1}. The measurement uses exclusive decay channel $B^+ \to J/\psi\ K^+$. The inclusive results show a good agreement with theoretical calculations from the FONLL within uncertainties. The cross section ratio measurements

scaled by the charged-particle multiplicity density, from low to high multiplicity, shows a significant decrease on the p_T dependence with increasing charged-particle multiplicity density. Results may indicate interplays of beauty quark energy loss, diffusion effects models in high multiplicity events, and gluon saturation models in lower multiplicity events.

QCD and Heavy Flavours / **12**

Study of Bs0 -> φφφ via charmonium resonances

Author: Cindy Catalina Moreno Sarria[1]

Co-authors: Sergey Barsuk [2]; Valeriia Zhovkovska [2]; Vsevolod Yeroshenko [2]

[1] *Universidad Nacional de Colombia (CO)*

[2] *Université Paris-Saclay (FR)*

Corresponding Authors: cindy.catalina.moreno.sarria@cern.ch, valeriia.zhovkovska@cern.ch, sergey.barsuk@cern.ch, vsevolod.yeroshenko@cern.ch

Multiple fits were done with the run 2 of the LHCb data, to extract signal of $B_s^0 \to \phi\phi\phi$ events via charmonia resonances. First, 3D fits in the bins of the B_s^0 invariant mass were computed to get the estimated number of true $\phi\phi\phi$ events. With a new histogram with the resulting signal for each bin, a fit was applied, to extract the B_s^0 signal. After this fit, from the triggered data of 1972 events, it returned 321.26 ± 49.3 events in the signal yields. This procedure also was applied in the bins of the Dalitz plot of the three body decay $B_s^0 \to \phi\phi\phi$ to then apply a fit of a η_c resonance. However due to the low number of events, the yields and uncertainties didn't converged correctly.

LHC experiments / **13**

Experimental setup for high precision laser polarisation determination

Authors: Aurelien Martens[1]; Santiago Rodriguez Mendoza[None]

[1] *Université Paris-Saclay (FR)*

Corresponding Authors: aurelien.martens@cern.ch, sarodriguezme@unal.edu.co

In the context of high precision electron polarimetry for future e+e- colliders, a tool to precisely monitor laser polarisation in real time to the per-mille level is needed. We propose to investigate the capabilities of photo-elastic modulators to that purpose

Theory and Phenomenology / **14**

Alternative 3-3-1 models: a comprehensive analysis

Author: Yithsbey Giraldo Usuga[1]

Co-authors: Eduardo Rojas ; Richard Benavides ; WILLIAM ANTONIO PONCE GUTIERREZ

[1] *Universidad de Nariño*

Corresponding Authors: ribebenavides@gmail.com, yithsbey@gmail.com, eduro4000@gmail.com, william.ponce@udea.edu.co

We systematically review how anomaly-free 3-3-1 models, with and without exotic electric charges, can be constructed using as a basis closed sets of fermions that include each of the particles and antiparticles of all electrically charged fields. Our analysis reproduces not only the models known in the literature, but also shows the existence of several more independent models for one and three families not considered so far. A phenomenological analysis of the new models is performed, in which the lower bounds at 95% CL on the gauge boson masses are presented.

Theory and Phenomenology / **15**

Scalar coupling evolution in a non-perturbative QCD resummation scheme

Author: John David Gómez Aguirre[None]

Co-author: Adriano Natale

Corresponding Author: johndgomez77@gmail.com

I will talk about the Standard Model scalar coupling (λ) evolution in a particular QCD resummation scheme, where the QCD coupling becomes infrared finite due to the
presence of a dynamically generated gluon mass, leading to the existence of a non-perturbative infrared fixed point. We discuss how this scheme can be
fixed taking recourse to phenomenological considerations in the infrared region. The QCD β function associated to this non-perturbative
coupling when introduced into the SM renormalization group equations increases the λ values at high energies.

Neutrinos theory / **16**

Five texture zeros in the lepton sector

Author: Richard Benavides[None]

Co-authors: Alejandro Rico ; Alex Tapia ; David Vanegas ; José Muñoz ; Luis Muñoz

Corresponding Authors: dvanegas@udemedellin.edu.co, ribebenavides@gmail.com, jose.munoz25@eia.edu.co, atapia@udemedellin.edu.co, fisimaxwell@gmail.com, lamunozh@gmail.com

We have assumed special structures for the charged and neutral mass matrices in
the lepton sector, inspired by structures for the up and down quark mass matrices that result by assuming a certain number of symmetrical zeros in their entries named texture zeros. A prediction of the lepton mixing matrix results from the rotation matrices that diagonalize the mass matrices in the neutral and charged lepton sectors. The use of texture zeros reduces the number of spurious parameters to explain observations in this sector.

Neutrino experiments / **17**

DUNE and the Liquid Argon Software (LArSoft) an overview

Authors: DEYWIS MORENO[None]; JOSE DAVID TAMARA JARAMILLO[1]

[1] *Universidad Antonio Nariño*

Corresponding Authors: jose.tamara@uan.edu.co, deymoreno@uan.edu.co

The deep underground neutrino experiment (DUNE) is a neutrino observatory and nucleon decay detector under construction, designed to give answers to modern physics problems like: the neutrino hierarchy and matter-antimatter asymmetry. To do that, in DUNE will be possible to perform precise measurements of neutrino oscillation parameters, in addition DUNE will be able to detect and measure electron neutrino fluxes from a core-collapse supernova within our galaxy and proton decay. In this talk a brief description of the experiment will be presented then a review of the Liquid Argon Software (LArSoft) is given, this framework is an important tool in the simulation and reconstruction of different phenomena across liquid argon time projection chambers. The basic steps for the reconstruction and simulation of events using LarSoft are shown and their main functionalities. Finally, the broad context of application of LarSoft in the DUNE experiment is addressed and some simulation examples will be discussed.

Dark Matter / Cosmology / Astroparticles / **18**

Bases de la Teoría Cuántica de Campos en Espacios Curvos: Creación de Partículas

Authors: Daniela Ávila Durán[None]; Diego Gallego[1]

[1] *Universidad Pedagógica y Tecnológica de Colombia.*

Corresponding Authors: daniela.avila02@uptc.edu.co, diego.gallego@uptc.edu.co

En el presente trabajo se muestran rudimentos básicos de la teoría cuántica de campos en el espacio-tiempo plano a espacio-tiempos curvos, donde se plantea la no unicidad del vacío y se muestra un ejemplo particular simple en el cual se evidencia esto.

Basado en: P. C. W. Davies N.D. Birrel. *Quantum fields in curved space.* Cambridge Monographs on Mathematical Physics, 1984.

Dark Matter / Cosmology / Astroparticles / **19**

Gauged Lepton number

Author: DIEGO ALEJANDRO RESTREPO QUINTERO[None]

Corresponding Author: restrepo@udea.edu.co

A model of gauged lepton number with scotogenic Dirac neutrino masses and dark baryogenesis

QCD and Heavy Flavours / **20**

Approaching the lepton flavour universality violation in B meson decays using a leptoquark model

Author: Nicolas Gomez Cruz[None]

Co-authors: Andrés Fernando Castillo Ramirez [1]; Diego Milanes Carreno [2]

[1] *Universidad Nacional de Colombia*

[2] *Universidad Nacional de Colombia (CO)*

Corresponding Authors: damilanesc@unal.edu.co, nigomezcr@unal.edu.co, afcastillor@unal.edu.co

Recent measurements on semi-leptonic decays of the B meson suggest a violation of lepton universality. This goes against the Standard Model prediction where none of its interactions distinguish lepton flavours. A posible explanation for this anomaly lies in the context of Beyond Standard Models. In this talk a model with new physics will be presented, which makes use of leptoquarks - hypothetical particles mediating interactions between quarks and leptons - and it will be shown how it can account for lepton violation in semi-leptonic decays.

Dark Matter / Cosmology / Astroparticles / **21**

Restricciones físicas para la existencia de agujeros de gusano desde la teoría de la relatividad general

Authors: Diego Mauricio Gallego Mahecha[1]; Julian Cortez[1]

[1] *Universidad Pedagogica y Tecnologica de Colombia*

Corresponding Authors: julian.cortez@uptc.edu.co, diego.gallego@uptc.edu.co

En este trabajo se estudian las restricciones físicas impuestas por la teoría de la relatividad general de Einstein para la existencia de soluciones tipo agujero de gusano. Se hace un análisis partiendo de las condiciones energéticas usadas comúnmente en relatividad general, junto con las restricciones impuestas por la ecuación de Raychaudhuri [1], relacionada también con las condiciones energéticas mencionadas. Se espera llegar al hecho de que es necesario considerar materia "exótica" para la existencia de agujeros de gusano, reproduciendo así el análisis realizado en [2] y siguiendo el trabajo recopilatorio de la tesis de maestría de Catalina Miritescu, *Traversable wormholes* [3]. Para este análisis tomamos la solución propuesta por Visser [4], la cual consiste en unir dos espacios de Schwarzschild cuyos horizontes han sido removidos. Se encuentra que esta solución requiere una densidad de energía superficial negativa para su existencia.

Referencias:
[1] Amalkumar Raychaudhuri. "Relativistic cosmology. I". En: Physical Review 98.4 (1955), pag. 1123
[2] Michael S Morris y Kip S Thorne. "Wormholes in spacetime and their use for interstellar travel: A
tool for teaching general relativity". En: American Journal of Physics 56.5 (1988), pags. 395-412.
[3] Catalina-Ana Miritescu. "Traversable Wormhole Constructions". Tesis de maestría. Imperial CollegeLondon, 2020.
[4] Matt Visser. "Traversable wormholes from surgically modified Schwarzschild spacetimes". En: Nuclear Physics B 328.1 (1989), pags. 203-212.

Neutrino experiments / **22**

The importance of characterizing charged pions in neutrino interactions

Author: Juan David Villamil Santiago[None]

Corresponding Author: juan.david.villamil.santiago@cern.ch

Recent results from neutrino experiments studying neutrino interactions show that final state interactions are not fully explained by current theoretical models. In this regard, pion production in final state interactions is at the center of the discrepancies between theoretical models and experimental data. Hence, a characterization based on data of pion production and interactions in long-baseline

neutrino experiments would contribute significantly to hadron identification, and therefore, to better tune the theoretical models embedded in the Monte Carlo simulations used by neutrino experiments to carry on their analyses. Currently, neutrino experiments such as MINERvA, T2K, and NOvA, published various improvements in the tuning of the nuclear theoretical models coded in their simulations based on their data. However, there are standing difficulties in hadron identification, which could be sorted if constraints from pion classification become available. This talk portraits the importance of developing better pion identification algorithms, and summarizes the ideas that could contribute to the improvement in pion identification.

QCD and Heavy Flavours / 23

Addressing the B meson anomalies within the minimal U_1 leptoquark model

Authors: Nestor Quintero Poveda[1]; Miguel Cabarcas[2]; José Herman Muñoz[3]; Eduardo Rojas[None]

[1] *Universidad Santiago de Cali*

[2] *Universidad Santo Tomás*

[3] *Universidad del Tolima*

Corresponding Authors: eduro4000@gmail.com, josecabarcas@usantotomas.edu.co, jhmunoz@ut.edu.co, nestor.quintero01@usc.edu.co

Very recently the LHCb experiment released the first measurement of the ratio $R(\Lambda_c)$. Moreover, the BABAR experiment reported a new result of the leptonic decay ratio of Upsilon meson $\Upsilon(3S)$, namely, $R_{\Upsilon(3S)}$. Both measurements are below their corresponding Standard Model predictions (deficit), deviating by \sim 1.1\sigma~1.1σ and \sim 1.8\sigma~1.8σ, respectively. In addition, the LHCb recently presented the first search of the LFV decay $B^0 \to K^{*0}\mu^{\pm}\tau^{\mp}$. Motivated by these new data, in this work we study their impact on the phenomenology of the singlet vector leptoquark (U_1) model addressing the hints of lepton flavor universality violation in the semileptonic decays of BB mesons (BB meson anomalies), by carrying out a global fit analysis. In general, we found that a minimal version of the U_1 model with a mass of 1.8 TeV can successfully explain the BB meson anomalies, while being compatible with all other flavor observables and LHC bounds. Interestingly, our study shows that the new observables generate strong tension, leading to non-trivial effects on the global fit. Future improvements at the LHCb and Belle II experiments would help to understand their complementarity. Moreover, we also analyze the impact of the expected sensitivity on flavor observables at Belle II to provide a further test of the U_1 model. Finally, we study the minimal assumptions under which the U_1model could, in addition, provide a combined explanation of the anomalous magnetic moment of the muon.

QCD and Heavy Flavours / 24

Preliminary results for the Dalitz plot analysis of the $D^+ \to K-K+K+$ decay using the Multi-meson model

Authors: Alberto Correa Dos Reis[1]; Diego Milanes Carreno[2]; Juan Sebastian Ordonez Soto[2]

[1] *CBPF - Centro Brasileiro de Pesquisas Físicas (BR)*

[2] *Universidad Nacional de Colombia (CO)*

Corresponding Authors: juan.sebastian.ordonez.soto@cern.ch, alberto.correa.dos.reis@cern.ch, damilanesc@unal.edu.co

This work presents the selection of the $D^+ \to K-K+K+$ candidates and progress in the amplitude analysis of this decay using the Multi-meson model (Triple-M), a model based on an effective chiral Lagrangian. The study is based on a sample of *pp*-collision data, collected at a centre-of-mass energy of 13 TeV with the LHCb detector between 2016 and 2018. The results of the amplitude analysis

using the latest version of the Multi-meson model are expected to give hints towards a more solid theoretical understanding of heavy-meson decays into three mesons. In particular, the $K+K-$ scattering amplitudes for the combinations of spin (0,1) and isospin (0,1) of the two-body system may be obtained from a Dalitz plot fit using the decay amplitude derived with the Triple-M.

Neutrino experiments / 25

Tensions between theory and experiment on final states interaction with neutrinos

Author: Camilo Cortés Parra[1]

Co-authors: Enrique Arrieta Diaz [2]; Juan David Villamil Santiago [1]

[1] *Universidad Nacional de Colombia*

[2] *Universidad del Magdalena*

Corresponding Authors: jdvillamils@unal.edu.co, camacortespar@unal.edu.co, arrieta1@fnal.gov

Modeling neutrino final state interactions with target nuclei within neutrino detectors is an open research field. Experiments such as MINERvA, T2K and NOvA found discrepancies on their simulations with their data, which implies that the current theoretical models 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 theory and experiments through the tuning of the theoretical models, embedded in their simulations, to their data, emphasizing the regions of energies in which they operate. Further theoretical work is expected in the future to explain the findings of neutrino experiments on this regard. In this talk we summarize the latest analysis techniques coded in neutrino cross-section simulators used by some long-baseline neutrino oscillation experiments, focusing on the final state interactions tunings done over the GENIE 3.2 simulation.

LHC results / 26

Feasibility studies for searches enhanced by machine learning methods of leptoquarks with preferencial couplings to third generation fermions at the LHC.

Authors: Alfredo Gurrola[1]; Carlos Andres Florez Bustos[2]; Cristian Rodriguez[3]; Joel Jones-Perez[None]

[1] *Vanderbilt University (US)*

[2] *Universidad de los Andes (CO)*

[3] *Universidad de los Andes*

Corresponding Authors: alfredo.gurrola@cern.ch, c.rodriguez45@uniandes.edu.co, andres.florez@cern.ch, jones.j@pucp.edu.pe

In recent years, the observations reported by LHCb, Babar, and Belle experiments of the apparent anomalies in B-meson decays, together with the possible anomaly on the magnetic angular momentum of muons reported by the Muon $g-2$ experiment at Fermilab, indicate that, perhaps, lepton flavour universality is violated in the SM, in turn being a window to search new physics.

Of the new models that intent to extend the SM to explain violation of lepton flavour universality, several of them introduce new particles with preferential couplings to third generation fermions. Some of the most popular models include the hypothetical production of heavy mass particles in particular we concéntrate on Leptoquarks (LQ). In this project, we seek to conduct feasibility studies for the LHC associated with the production of these new hypothetical particles through different production mechanism and with preferential couplings to third generation fermions. These studies

are conducted using different simulation packages to emulate the LHC conditions and the statistical analysis will use Machine Learning (ML) methods.

QCD and Heavy Flavours / **27**

Implementation of trigger lines for luminosity measurements in run 3

Authors: Andres Gomez[1]; Diego Milanes Carreno[2]; Patrick Spradlin[3]

[1] *Universidad Nacional de Colombia*

[2] *Universidad Nacional de Colombia (CO)*

[3] *University of Glasgow (GB)*

Corresponding Authors: patrick.spradlin@cern.ch, anmgomezmo@unal.edu.co, damilanesc@unal.edu.co

The biggest particle accelerators quantify the number of interactions with luminosity, the proportionality factor between the number of events per second and the cross section. For Run 3, LHCb experiment uses Allen software for High Level Trigger 1 (HLT1) developed on Graphics Processing Units (GPUs). The implementation of new trigger lines for luminosity measurements requires the development and testing over Monte Carlo samples before its integration to LHCb software. Here, we show some code and results of new trigger lines in the Allen project.

Dark Matter / Cosmology / Astroparticles / **28**

Delimitación de las dimensiones del operador escalar en 4D CFT

Author: Ayda Milena Bernal[1]

Co-author: Diego Gallego [2]

[1] *Universidad Pedagógica y Tecnológica de Colombia*

[2] *Universidad Pedagógica y Tecnológica de Colombia.*

Corresponding Authors: diego.gallego@uptc.edu.co, ayda.bernal@uptc.edu.co

En el presente trabajo se estudian las generalidades de la teoría conforme (CFT) como, por ejemplo, el algebra conforme, las funciones de correlación, los límites de unitaridad y la expansión del producto operador (OPE). Elementos con los que se abordaran argumentos teóricos, incluyendo el cómo establecer limites en las dimensiones del operador escalar en cuatro dimensiones de las CFT´s.

Basado en Riccardo Rattazzi y col. "Bounding scalar operator dimensions in 4D CFT". En: Journal of High Energy Physics 2008.12 (2008).

LHC results / **29**

Searches of new physics in the final state $B\tau\nu$ in pp collisions

Authors: Carlos Andres Florez Bustos[1]; Jose Ruiz[2]; Tomas Atehortua Garces[2]

[1] *Universidad de los Andes (CO)*

[2] *Universidad de Antioquia (CO)*

Corresponding Authors: jose.ruiz@cern.ch, andres.florez@cern.ch, tomas.atehortua@udea.edu.co

The $R_{D^{(*)}}$ anomaly is one of the most intriguing experimental results in particle physics. Experiments as BaBar, Belle and LHCb have measured a consistent tension with the standard model. In this work we study a consequence of different solutions to this tension as a sequential W' boson, EFT and leptoquark. Such models, are not only able to explain the $R_{D^{(*)}}$ anomaly but also to produce distinctive signatures at the LHC. We proposed a search for the signature $\mathrm{b}, \tau, p_T^{miss}$ maximizing the statistical significance with regard to standard model backgrounds as $W^{\pm}$ + jets, Z^0 + jets and $t\bar{t}$. We finally show how the different models require a differentiated selection criteria and the exclusion that can be achieved.

QCD and Heavy Flavours / 30

Search for B_c to Phi K+ decay using LHCb experiment Run 2 data

Author: Jonnatan Pereira[1]

Co-authors: Diego Milanes Carreno [1]; Sergey Barsuk [2]; Vsevolod Yeroshenko [2]; Valeriia Zhovkovska [2]

[1] *Universidad Nacional de Colombia (CO)*

[2] *Université Paris-Saclay (FR)*

Corresponding Authors: jonnatan.pereira.betencur@cern.ch, damilanesc@unal.edu.co, vsevolod.yeroshenko@cern.ch, valeriia.zhovkovska@cern.ch, sergey.barsuk@cern.ch

There is no Bc annihilation decay experimentally observed to date. The B_c -> Phi K+ decay can proceed via annihilation of anti-b and c quarks into a W intermediate boson or, alternatively, involving final-state rescattering effects. Observation of the B_c -> Phi K+ decay will provide a new insight on the B_c meson properties and will allow a new independent determination of the V_cb CKM matrix element. The analysis is performed using LHCb experiment data from Run 2 at 13 TeV center of mass energy. Phi meson is reconstructed via decays to two charged kaons. The B+ decay to Phi K+ is used for normalization.

LHC results / 31

COFFEA: Columnar Object Framework For Effective Analysis

Author: Daniel Ocampo Henao[1]

[1] *Universidad de Antioquia (CO)*

Corresponding Author: daniel.ocampo.henao@cern.ch

Columnar analysis is a paradigm that describes the way the user writes the analysis application that is best described in contrast to the the traditional paradigm in high-energy particle physics (HEP) of using an event loop. Coffea is a prototype package for pulling together all the typical needs of a high-energy collider physics (HEP) analysis. In this talk I will provide an introduction to Coffea and it's functionalities. We will have a hands on tutorial on how to implement a basic analysis.

Theory and Phenomenology / 32

Decay constants and mass spectrum of pseudoscalars mesons

Author: Ruben Hernando Criollo Estrella[1]

[1] *Universidad de Nariño*

Corresponding Author: rubencriollo1007@gmail.com

The Schwinger-Dyson equations (DSE) were obtained from a mass functional generation $M(p)$ for a fermion propagator. The DSE are obtained, which are analogous to the Euler-Lagrange equations in Quantum field theory (QFT), since they are the equations of motion of the Green's functions . The DSE's are an infinite set of integral equations coupled to each other and it is only possible to solve them by means of a truncation scheme. The Bethe-Salpeter equations (BSE) have as a solution the wave function of the states bound to a system of two particles. The BSEs are obtained from a covariant relativistic formalism. We solve abelian models for quantum chromodynamics (QCD) at low energies, which rules allow us to obtain the spectrum of mass from pseudoscalar mesons $J_p = 0^-$ and the decay constants.

LHC results / **33**

Machine learning approach for vector boson fusion identification

Authors: Anderson Alexis Ruales Barbosa[1]; Jose Ruiz[1]; Raul Ramos[2]

[1] *Universidad de Antioquia (CO)*

[2] *Universidad de Antioquia*

Corresponding Authors: raul.ramos@udea.edu.co, arualesb.1@cern.ch, jose.ruiz@cern.ch

The strength of the Higgs boson's coupling with other fermions and bosons is extensively studied during the first two LHC runs. In this work, the production of the Higgs boson, namely, Vector Boson Fusion (VBF) is studied. VBF is the process of two quarks, each of which emits a vector boson, W or Z boson, which then merge to create a Higgs boson. Machine learning (ML) models are built to discriminate Higgs boson events from non-Higgs boson events. The results of these models are compared with those obtained by making linear cuts.

Dark Matter / Cosmology / Astroparticles / **34**

Optimización de la eficiencia de detección de neutrones de un detector Cherenkov de agua

Author: Victor Clarizio-Canelon[1]

Co-authors: Christian Sarmiento-Cano [2]; Luis Otiniano [3]; Diego Castillo-Morales [2]; Luis Nuñez

[1] *Universidad Central de Venezuela - Universidad Industrial de Santander*

[2] *Universidad Industrial de Santander*

[3] *Comisión Nacional de Investigación y Desarrollo Aeroespacial*

Corresponding Author: vclariziosaeucv@gmail.com

Los neutrones son partículas subatómicas que conforman parte de la componente hadrónica de los rayos cósmicos que ingresan a la Tierra. Su detección y caracterización es de particular interés para el estudio de decrecimientos de Forbush producidos por la emisión de masa coronal que altera el flujo de rayos cósmicos. El decrecimiento de Forbush se evidencia mayoritariamente en energías

inferiores a los cientos de GeV. Los detectores de neutrones son especialmente sensibles a estos cambios y, por lo tanto, muy eficientes para estudiar este fenómeno. En este trabajo se realiza la calibración, caracterización y puesta en marcha de un detector de agua Cherenkov en el campus de la Universidad Industrial de Santander. Se busca optimizar la eficiencia de este detector Cherenkov agregando compuestos de cloro al volumen activo del tanque para la detección de neutrones cósmicos de baja energía.

Dark Matter / Cosmology / Astroparticles / **35**

Muografía en la Industria Petroquímica

Author: Rafael Martinez Rivero[None]

Co-authors: Alexander Martínez [1]; Christian Sarmiento-Cano [1]; Diego Morales Castillo [1]; Luis Alberto Nuñez Villavicencio ; Víctor Gabriel Baldovino Medrano

[1] *Universidad Industrial de Santander*

Corresponding Authors: rafari712@gmail.com, lnunez@saber.uis.edu.co, christian.sarmiento@correo.uis.edu.co

En la actualidad existe la necesidad de estudiar las estructuras internas de los sistemas de producción en la industria. Estas estructuras pueden ser de grandes dimensiones lo dificulta la observación de los componentes internos por medio de técnicas convencionales como el empleo de rayos gamma. Particularmente en las Torres de Craqueo Catalítico de la industria Petroquímica, deben monitorearse las densidades entre sus capas con el objetivo de determinar la cantidad de residuos para su eventual mantenimiento. Para esta tarea se propone la implementación de la muografía como técnica de detección de variaciones de densidad en las torres. En este trabajo se determinó la resolución, espacial y temporal, de esta técnica con el fin de explorar la viabilidad de su implementación. Se realizaron simulaciones del flujo de muones para diferentes configuraciones de densidad. Además se realizaron mediciones del flujo detectado por una torre de paneles centelladores, entre los cuales se dispuso un recipiente donde se colocaron objetos de diferentes densidades, donde se logró obtener una disminución de hasta un 20% del flujo de muones para diferentes rangos de densidad de la muestra.

Dark Matter / Cosmology / Astroparticles / **36**

Scalar potential analysis of the Z5 multi-component dark matter model

Authors: DIEGO ALEJANDRO RIOS PEREZ[None]; Oscar Zapata[None]

Corresponding Authors: oalberto.zapata@udea.edu.co, diego.riosp@udea.edu.co

In recent years the multi-component scalar dark matter models with discrete symmetries $\mathbb{Z}_N$ have been widely studied in the literature. Among them, the $\mathbb{Z}_5$ model proposes two complex fields that transform as singlets under the Standard Model gauge group. The scalar potential brings along with eleven free parameters that must be restricted. In that sense, the primary purpose of this research is to develop a detailed analysis of the scalar potential with the objective of establishing the perturbative unitarity, vacuum stability, and positivity conditions, and finally to determine the viable parameter space of the model.

Dark Matter / Cosmology / Astroparticles / **37**

Simulaciones de Neutrones Cósmicos de Baja Energía para Agricultura de Precisión

Author: Yessica Dominguez[None]

Co-authors: Christian Sarmiento-Cano [1]; Hernan Asorey [2]; Luis Alberto Nuñez Villavicencio

[1] *Universidad Industrial de Santander*

[2] *Comision Nacional de Energia Atomica*

Corresponding Authors: yessicadomin@gmail.com, asoreyh@cab.cnea.gov.ar, lnunez@saber.uis.edu.co

Una aplicación de los neutrones cósmicos se basa en optimizar el consumo de agua mediante la automatización de los sistemas de riego en la industria agrícola. Los neutrones interactúan fácilmente con el hidrógeno, el cual se encuentra en las moléculas de agua presentes en la humedad del suelo. Actualmente se cuenta con sensores diseñados para detectar los neutrones de bajas energías que emergen del suelo luego de la interacción con el suelo húmedo. Mediante simulaciones se pueden hacer predicciones de diferentes configuraciones de estos escenarios que, por ejemplo, son de ayuda en la calibración de los sensores. URANOS (Ultra Rapid Neutron-Only Simulation) es un software, que se presenta como una opción intuitiva para el usuario, donde se puede simular la interacción de neutrones de bajas energías con el suelo. Sin embargo, al usar modelos parametrizados para el flujo de rayos cósmicos y la respuesta de la interacción entre los neutrones y el suelo húmedo se corre el riesgo de propagar errores y obtener resultados de baja confiabilidad. Por otra parte FLUKA es un entorno de simulación Montecarlo de propagación de partículas y su interacción con el medio, el cual usa de base principios físicos. En este trabajo se comparó los resultados de las simulaciones hechas en URANOS con los resultados de FLUKA con el fin de incluir una mejora en las parametrizaciones del flujo de neutrones de bajas energías a las que se encuentran sujetos los modelos utilizados en URANOS.

Neutrino experiments / **38**

Updated U235 Spectrum Measurement from the PROSPECT-I Data Set

Author: Diego Venegas Vargas[None]

Corresponding Author: dvenega1@vols.utk.edu

D. Venegas-Vargas
on behalf of the PROSPECT collaboration

PROSPECT is a reactor antineutrino experiment consisting of a 4-ton liquid scintillator antineutrino detector divided into an 11x14 array of optically separated segments. The detector was designed to probe the existence of sterile neutrino oscillations and precisely measure the antineutrino spectrum resulting from 235U fission. Data was taken in 2018 and 2019 with a first-generation detector called PROSPECT-I that was located on the Earth's surface roughly 7 m from the 85 MW, compact, highly-enriched High Flux Isotope Reactor (HFIR) at Oak Ridge National Laboratory. This dataset has already had a substantial impact by placing stringent limits on sterile neutrino oscillations at the eV scale, setting new direct limits on boosted dark matter models, providing a precision 235U spectral measurement, and demonstrating unique neutrino detection capabilities. During the data collection period, information coming from a small number of PMTs had to be excluded causing an overall statistical impact on previous results. To recover this otherwise lost information, two new data analysis tools known as Data Splitting and Single Ended Event Reconstruction have been implemented resulting in a multi-period analysis with improved antineutrino event selection criteria. This presentation will review the impact of this new analysis effort in the measurement of the 235U spectrum, as well as the strategy for new oscillation and flux analyses.

This work is supported by the US DOE Office of High Energy Physics, the Heising-Simons Foundation, CFREF and NSERC of Canada, and internal investments at all institutions.

Dark Matter / Cosmology / Astroparticles / **39**

Dark Matter production in Non-Standard Cosmologies

Author: Valentina Franco Velásquez[1]

Co-authors: Nicolás Bernal [2]; Oscar Zapata [1]

[1] *Universidad de Antioquia*

[2] *Universidad Antonio Nariño*

Corresponding Authors: nicolas.bernal@uan.edu.co, valentina.franco@udea.edu.co, ozapata@fisica.udea.edu.co

Synopsis In the standard cosmological scenario, it is proposed a Universe dominated by radiation just after the inflationary phase and prior to Big Bang Nucleosynthesis (BBN) but actually, there is not much observational information supporting this hypothesis. This research project is intended to take advantage of this gap in our knowledge of cosmic history to modify the post-inflationary period and alter Dark Matter (DM) production through the introduction of a time-dependent inflaton decay rate.

The existence of DM in the Universe has been one of the open and more relevant questions in physics and astronomy in the last decades. There are a large number of gravitational evidence about its existence, but there is no conclusive evidence about its nature as a particle. Through the previous decades, a worldwide program focused on discovering this particle has been carried out following three major strategies: direct detection, indirect detection, and production at colliders.

Despite the great effort, the DM particle nature remains one of the central mysteries in physics. The important thing is that there is no particle belonging to the Standard Model (SM) of particle physics with the required properties to explain the observed astrophysical phenomena related to DM.

Until relatively recently the DM models proposed hinged on a standard cosmology basis, however, due to the enormous difficulty present in detecting this particle, it was evident the necessity to introduce models in different scenarios.

According to standard cosmology, the Universe has undergone a series of stages characterized by definite processes and the domination of one component over the rest during its evolution. Summarizing, in its first seconds, the Universe went through three main periods, inflation, reheating, and BBN. In the standard scenario, during inflation, a Universe dominated by a scalar field is hypothesized followed by a period of radiation domination from the end of reheating until BBN. However, there are no reasons to assume that the Universe was radiation-dominated prior to BBN simply because at the moment we do not have much observational information about this period and, in this sense, it is, therefore, possible that the cosmological history featured, for example, an additional early matter-dominated epoch due to e.g. slow post-inflationary reheating or massive metastable particles that dominated the total energy density. Even more exotic scenarios that change the expansion history of the Universe compared to the standard radiation-dominated case can also be realized, all of them are called non-standard cosmologies and they can have significant consequences for the physics of the early Universe.

One of the most interesting consequences concerning non-standard cosmologies is that early periods in these scenarios can alter the cosmological abundances of particle species. In particular, they can have a significant impact on our expectations for the DM relic abundance, since non-standard eras can change the expansion rate of the Universe, leading to entropy injections that may dilute the DM relic abundance, or provide a non-thermal production mechanism for DM.

In the frame of the present work, it is pretended to develop the phenomenology of a simplified WIMP DM model in a non-standard cosmology with a matter-dominated Universe in the period ranging from the end of inflation and the end of reheating and with a generic time-dependent rate for dissipation of matter into radiation [1]. The main goal of this research project is to find the parameter space for a WIMP particle in the proposed frame able to account for 85% of DM in the Universe and evade the constraints imposed by experiments.

References

[1] Raymond T. Co, Eric Gonzalez, and Keisuke Harigaya. Increasing temperature toward the completion of reheating. Journal of Cosmology and Astroparticle Physics, 2020(11):038–038, nov 2020.

LHC results / **40**

Boosted Higgs boson in association with a vector boson

Author: Juan Manuel Moreno Perez[1]

[1] *Universidad Nacional de Colombia (CO)*

Corresponding Author: jummorenope@unal.edu.co

This work studies the improvement that could be obtained by applying machine learning techniques to an ongoing event selection.

Neutrino experiments / **41**

Constraints on CP-violating Non-Standard neutrino interactions from NOvA

Author: Mario A Acero[1]

[1] *Universidad del Atlantico*

Corresponding Author: marioacero@mail.uniatlantico.edu.co

The NOvA experiment studies the disappearance of muon (anti)neutrinos and the appearance of electron (anti)neutrinos to measure the parameters governing the oscillation of neutrinos at the so-called atmospheric sector. Thanks to the long distance travelled by the neutrinos through the earth, NOvA can also explore the effects of possible Non-Standard Interactions with matter. Here I present the constraints on the NSI parameters based on the analysis of recent NOvA data.

Theory and Phenomenology / **42**

$\mathrm{SU}(4)$ weak singlet leptoquark in $R_{K^{(*)}}$ flavor anomalies

Author: Oscar David Rosero Cárdenas[1]

Co-author: Eduardo Rojas

[1] *Universidad de Nariño*

Corresponding Authors: eduro4000@gmail.com, odroseroc@gmail.com

We present a detailed study of a proposed model to explain the experimental hints of new physics in B meson decays within the frameork of the Pati-Salam unification. The model is based on the local gauge group $\mathrm{SU}(4)_L \otimes \mathrm{SU}(4)_R \otimes \mathrm{SU}(2)_L \otimes \mathrm{U}(1)'$ and part of its gauge bosons are (3,1)2/3 vector leptoquarks. The key feature of the model is that $\mathrm{SU}(4)_R$ is broken at a high energy scale, which suppresses right-handed lepton flavor changing currents at the low energy scale. The constraints imposed on the model by independent measurements show that the mass of the leptoquark can be as low as 10 TeV, not requiring the introduction of quarks or leptons mixings with new vector-like fermions. We obtain constraints from various pseudo-observables for the leptoquark couplings and contrast them against a model-independent analysis.

Dark Matter / Cosmology / Astroparticles / **43**

Enhancing the early universe with rotating axion field.

Corresponding Author: nicoelfisico@gmail.com

Rotations of an axion field in field space provide a natural origin for an era of kination domination in the early universe. We investigate how this cosmological scenario affects the spectrum of possible primordial gravitational waves, its implication for structure formation and relieving the Hubble tension.

Neutrinos theory / **44**

Anomaly-free abelian gauge symmetries with neutrino mass models

Author: KIMY JOHANA AGUDELO JARAMILLO[1]

[1] *Universidad de Antioquia*

Corresponding Author: kimy.agudelo@udea.edu.co

In this work, we show a study of the generation of neutrino masses is carried out from the seesaw type II Mechanism for Dirac neutrinos. These mechanisms not only explain the mass of the neutrino but also its small value compared to charged quarks and leptons. Therefore, a model is proposed to obtain the small neutrino masses by extending the visible content of the Standard Model (SM) with S and two right-handed singlet neutrinos (ν_{R_1}, ν_{R_2}). These right-handed neutrinos are charged under a new symmetry $U(1)_X$. 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.
hidden sector.
Extending the SM with a new abelian symmetry automatically violates the invariant of Lorentz, therefore the following conditions must

\begin{equation}
\sum_{\alpha=1}^{N'} n_{\alpha} + 3m =0 \„
\end{equation}
%
\begin{equation}
\sum_{\alpha=1}^{N'} n'^{3}_{\alpha} +3m^{3} = 0\„
\end{equation}

where, n_α is defined as the charge of the chiral fermions under the new symmetry and $3m$ the sum of the charges of the SM and $m \equiv e + 2L$. If the SM is extended with an additional dark $U(1)_D$ gauge symmetry (under which it is uncharged), and N right-handed chiral fields singlets under the SM group, the $U(1)_D$ is not anomalous if the Diophantine equations are fulfilled

\begin{align}
\sum_{\alpha=1}^{N} n_{\alpha} =&0\„ &
\sum_{\alpha=1}^{N} n'^{3}_{\alpha} =& 0\,.
\end{align}

Dark Matter / Cosmology / Astroparticles / **45**

Analysis of the mechanisms of dark matter production in the early universe.

Author: Mateo Escorcia[1]

Co-authors: Mario A Acero [2]; Nicolás Bernal [3]

[1] *Universidad del Atlántico*

[2] *Universidad del Atlantico*

[3] *Universidad Antonio Nariño*

Corresponding Authors: marioacero@mail.uniatlantico.edu.co, macteos@gmail.com, nicolas.bernal@uan.edu.co

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. Once we have the results, we adapt the calculations to characterize the Feebly Interacting Massive Particles or FIMP and Strongly Interacting Massive Particles or SIMP.

LHC experiments / **46**

Test of Techniques for the Assembly of Silicon Pixel Detector Modules Needed for the High-Luminosity Upgrade of the CMS Experiment at CERN

Author: Neidy Lorena Bucuru Rodriguez[1]

Co-authors: Carlos Sandoval Usme [2]; Matthew Jones [1]; Souvik Das [1]

[1] *Purdue University (US)*

[2] *Universidad Nacional de Colombia*

Corresponding Authors: carlos.sandoval@cern.ch, souvik.das@cern.ch, matthew.timothy.jones@cern.ch, nlbucurur@unal.edu.co

The stages of the assembly process and preliminary testing of four-chip silicon modules (CROCs) designed to detect charged particles in the TFPX region of the Inner tracker at CMS experiment within the framework of CERN High Luminosity updates are detailed. These stages correspond to assembly using an Aerotech gantry, positioning data collection based on the angular opening and the average slide of the chips to select the modules prepared for the wire bonding process, and ends with the performance of two types of tests on these modules, the Shunt and Low Drop output Voltage (SLDO) and pixel alive test.
In addition, it is recognized the importance of implementing this rigorous module assembly process in the future reconstruction of physical phenomena, product of proton-proton collisions, which could explain and deepen the understanding of the behavior of elementary particles within the standard model and even study the physics beyond it.
In the assembly process, it was found that both the average angular opening and the average slide of the HDI with each of the chips did not exceed 25 μm, which makes the assembled modules suitable for performing the wire bonding process.
In the testing process, it was possible to observe the behavior of the chips against the growth of the current induced by the power supply and also the number of functional pixels in the chips. A good correspondence was found between the results and the expected behavior for the chips.

LHC results / **48**

Calibration of the Jet Vertex Tagger algorithm in the ATLAS detector

Authors: Carlos Sandoval Usme[1]; Laura Juliana Caviedes Betancourt[2]

[1] *Universidad Nacional de Colombia*

[2] *Universidad Nacional de Colombia (CO)*

Corresponding Authors: laura.juliana.caviedes.betancourt@cern.ch, carlos.sandoval@cern.ch

This work uses jet-vertex tagger (JVT) and forward jet-vertex-tagger (fJVT) which discriminate pile-up events from high scattering processes coming from the first vertex and thus calibrate these algorithms by determining the scaling factors of their efficiency with their corresponding uncertainties using data from the ATLAS experiment.

LHC experiments / 49

Optimization of a jet finding algorithm for the HL-LHC ATLAS L0 trigger

Author: Carlos Fernando Buitrago Cardenas[1]

Co-authors: Carlos Sandoval Usme [2]; Gabriel Palacino [3]

[1] *Universidad Nacional de Colombia (CO)*

[2] *Universidad Nacional de Colombia*

[3] *Indiana University (US)*

Corresponding Authors: carlos.fernando.buitrago.cardenas@cern.ch, gabriel.palacino@cern.ch, carlos.sandoval@cern.ch

Upcoming hardware updates to the ATLAS detector will allow for jet finding algorithms similar to those used offline to be implemented at the lowest level of the trigger. This will allow to increase the coherence between the data selected in the analyses and those selected by the trigger. Motivated by the fact that the anti-kT is one of the most commonly used jet finding algorithms in the ATLAS analyses, we studied the performance of a modified anti-kT algorithm based on regions of interest (ROIs) which was developed with the intention to be run online in the L0 trigger of the HL-LHC ATLAS detector, and carried out a series of optimizations in order to improve the resulting trigger efficiency.

LHC results / 50

Use of the Lund plane technique for the identification of W bosons in ATLAS experiment

Author: Rafael Andrei Vinasco Soler[1]

Co-authors: Carlos Sandoval Usme [2]; Reina Coromoto Camacho Toro [3]

[1] *Universidad Nacional de Colombia (CO)*

[2] *Universidad Nacional de Colombia*

[3] *LPNHE-Paris CNRS/IN2P3*

Corresponding Authors: rafael.andrei.vinasco.soler@cern.ch, carlos.sandoval@cern.ch, reina.camacho@cern.ch

Particle tagger methods are a powerful tool to filter unwanted data and improve the final results of the experiment. In this case, the performance of different tagger methods of W bosons in collision events of the ATLAS experiment will be studied, taking special attention to the methods based on the so-called Lund Jet Plane, which according to preliminary results presents a better performance than the methods currently used.

Neutrinos theory / 51

El fenómeno de cambio de sabor de neutrinos desde la teoría cuántica de campos

Author: Jairo Luis Jiménez Mejía[1]

[1] *Universidad del Atlántico*

Corresponding Author: jairoljimenez@mail.uniatlantico.edu.co

Aunque el fenómeno de oscilación de neutrinos es bien conocido y estudiado, el acercamiento estándar desde la mecánica cuántica incluye algunos problemas, por ejemplo, en el cálculo de la probabilidad de oscilación. Estudiando la oscilación desde la Teoría Cuántica de Campos se busca ofrecer un mejor panorama en cuanto a estos problemas y plantear la posibilidad de organizar y dar solución a las paradojas presentadas por dicho fenómeno.

Neutrinos theory / 52

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

Author: RICARDO JOSE ZAMORA BARRIOS[1]

[1] *Universidad del atlantico*

Corresponding Author: rjzamora@mail.uniatlantico.edu.co

El objetivo principal es exponer los límites de la mecánica cuántica con ayuda de la desigualdad de Leggett-Garg, utilizando el fenómeno de oscilación de neutrinos como mediador entre los dos, el cual se fundamenta en el cambio de estado de sabor, fenómeno que corresponde a una superposición coherente de los estados de masa. Se propone estudiar la violación de la desigualdad de Leggett-Garg con neutrinos, debido al hecho de que la longitud de coherencia cuántica en la que se produce la interferencia de los estados de masa y se observa el fenómeno de oscilación, se extiende a distancias considerablemente grandes, lo cual será beneficioso para ampliar el entendimiento que se tiene sobre los límites de la naturaleza entre lo clásico y lo cuántico.

Theory and Phenomenology / 53

Multicomponent scalar dark matter: recent developments

Author: Oscar Zapata[None]

Corresponding Author: oalberto.zapata@udea.edu.co

In this talk I will discuss some recent developments concerning scenarios of multi-component scalar dark matter based on a single ZN symmetry.

QCD and Heavy Flavours / 55

Flavored axions and the flavor problem

Author: juan salazar[1]

[1] *Universidad de Nariño*

Corresponding Author: jusala@gmail.com

A Peccei-Quinn˜(PQ) symmetry is proposed, in order to generate in the standard Model˜(SM) quark sector a realistic mass matrix ansatz with five texture-zeros. Limiting our analysis to Hermitian mass matrices we show that this requires a minimum of 4 Higgs doublets. This model allows assigning values close to 1 for several Yukawa couplings, giving insight into the origin of the mass scales in the SM. Since the PQ charges are non-universal the model features Flavor-Changing Neutral Currents˜(FCNC) at the tree level. From the analytical expressions for the FCNC we report the allowed region in the parameter space obtained from the measurements of branching ratios of semileptonic meson decays.

Dark Matter / Cosmology / Astroparticles / **57**

Fermion and scalar two-component dark matter from a Z4 symmetry

Author: Carlos E. Yaguna[1]

[1] *UPTC*

Corresponding Author: cyaguna@gmail.com

We revisit a two-component dark matter model in which the dark matter particles are a singlet fermion (ψ) and a singlet scalar (S), both stabilized by a single Z4 symmetry. The model is remarkably simple, with its phenomenology determined by just five parameters: the two dark matter masses and three dimensionless couplings. In fact, S interacts with the Standard Model particles via the usual Higgs portal, whereas ψ only interacts directly with S, via the Yukawa terms $\psi c^{-}(ys+yp\gamma 5)\psi S$. We consider the two possible mass hierarchies among the dark matter particles, MS<Mψ and Mψ<MS, and numerically investigate the consistency of the model with current bounds. The main novelties of our analysis are the inclusion of the yp coupling, the update of the direct-detection limits, and a more detailed characterization of the viable parameter space. For dark matter masses below 1.3 TeV or so, we find that not only is the model compatible with all known constraints, but it also gives rise to observable signals in future dark matter experiments. Our results show that both dark matter particles may be observed in direct-detection experiments and that the most relevant indirect-detection channel is due to the annihilation of ψ. We also argue that this setup can be extended to other ZN symmetries and additional dark matter particles.

Dark Matter / Cosmology / Astroparticles / **58**

Expansión acelerada tardía del universo en un modelo de gravitación modificada tipo f(R, G) con acoplamiento a campos escalares.

Author: CARLOS ALBERTO MEZA MORALES[1]

Co-author: Alexander Oliveros Garcia [1]

[1] *Universidad del Atlantico*

Corresponding Authors: camezam@mail.uniatlantico.edu.co, alexanderoliveros@mail.uniatlantico.edu.co

En este trabajo, se estudia la expansión acelerada tardía del universo en un modelo de gravitación modificada tipo f (R, G) con acoplamiento de un campo escalar al invariante de Gauss-Bonnet. En este sentido se consideran tres propuestas para f(R) del tipo exponencial en el escalar de curvatura R.

En primera instancia se obtienen las ecuaciones generales de movimiento asociadas al modelo propuesto, las cuales se expresan mejor de manera conveniente en términos de la cantidad statefinder yH(z) que se usa con frecuencia en la literatura, posteriormente se resuelven numéricamente considerando condiciones iniciales motivadas físicamente, valores apropiados de los parámetros del modelo para las tres propuestas que se tienen de la función f(R) y distintas formas para el potencial del campo escalar y la función de acoplamiento al invariante de Gauss-Bonnet. Por último, se verifica si para las distintas propuestas de f(R) la fenomenología resultante es compatible con los últimos datos de la colaboración Planck 2018, además los resultados obtenidos se comparan con los correspondientes al modelo Lambda-Cold-Dark- Matter.

QCD and Heavy Flavours / **59**

D+s ——> K+K-K+ radiation topologies analysis

Author: David Alejandro Baron Ospina[None]

Corresponding Author: dabarono@unal.edu.co

There is no unique way of considering which one is the topology supposed to be the dominant one in decays such as $D_s^+ \to K^+K^-K^+$ or $D^+ \to K^+K^-K^+$. There could be relevant contributions coming from either the radiation topology or the annihilation one. Meanwhile, there are extensive analyses of the annihilation topologies considering the weak vertex as a constant, exists at the moment no clear way of radiation topologies management. The present work consists of presenting a parametrization for the radiation topologies, firstly in terms of form factors and secondly taking the limit where the weak vertex is a constant. Additionally, it is presented a differential decay rate analysis in terms of the invariant masses of the channel, and it is shonw how the radiation topologies should be coupled to the unitarized amplitudes with two bodies final states interactions.

Theory and Phenomenology / **60**

The Higgs Boson

Corresponding Author: deflo@unsam.edu.ar

Neutrinos theory / **61**

Beyond the standard model neutrinos

Corresponding Author: orlando@ifi.unicamp.br

Theory and Phenomenology / **62**

The X17 anomaly: status and prospects

Corresponding Author: enrico.nardi@lnf.infn.it

Neutrino experiments / **63**

Neutrinos and Dark Matter

Corresponding Author: alexis@nucleares.unam.mx

Neutrino experiments / **64**

Global status of neutrino oscillation parameters

Corresponding Author: dvanegas@udemedellin.edu.co

LHC experiments / **65**

ATLAS experiment status and perspectives

Corresponding Author: gabriela.navarro@uan.edu.co

LHC experiments / **66**

CMS experiment status and perspectives

Corresponding Author: camilo.carrillo@cern.ch

Dark Matter / Cosmology / Astroparticles / **67**

Dark Matter Direct Detection Searches

Corresponding Author: tim.wolf@mpi-hd.mpg.de

Neutrinos theory / **68**

Different aspects of neutrino phenomenology

Corresponding Author: daristi@gmail.com

LHC results / **69**

Jet physics at the LHC

Corresponding Author: reina.camacho@cern.ch

QCD and Heavy Flavours / **70**

Quarkonium production

Corresponding Author: sergey.barsuk@cern.ch

LHC results / **71**

BSM Physics at the LHC, status and perspectives

Corresponding Author: andres.florez@cern.ch

Neutrino experiments / **72**

Neutrino physics and Dark Matter searches with the Coherent CAPTAIN-Mills (CCM) experiment

Authors: Alexis Aguilar-Arevalo[1]; for the CCM Collaboration[None]

[1] *Instituto de Ciencias Nucleares, UNAM*

Corresponding Author: alexis@nucleares.unam.mx

The 10 ton liquid argon (LAr) scintillation detector Coherent CAPTAIN-Mills, at the LANSCE facility of the Los Alamos National Laboratory, sits at a distance of 23 m from the core of the Lujan Center spallation source, which is a copious source of neutrinos from stopped pions, as well as, possibly, new particles belonging to a hypothetical Dark Sector of particle physics. Besides studying neutrino interactions in LAr at energies below 52.8 MeV, relevant for future neutrino experiments, CCM has a rich physics program comprising searches for Dark Photons, Axion-like Particles (ALPs), and neutral heavy leptons with masses in the range of keV to MeV, exploring new regions of parameter space for these searches. A prototype detector instrumented with 120 PMTs, CCM120 operated between 2018 and 2019, demonstrating the potential of such a detector for the search of Sub-GeV dark matter. The upgraded CCM200 detector, with 200 PMTs, improved shielding and LAr filtration and purification system is now taking beam. In this talk the status of the experiment, as well as results from CCM120 and expected sensitivity to new physics of CCM200 will be presented.

CONHEP network meeting / **73**

IPPOG

Corresponding Author: steven.goldfarb@cern.ch

CONHEP network meeting / **74**

LA-CoNGA Physics

Corresponding Author: reina.camacho@cern.ch

CONHEP network meeting / **75**

Erasmus+ - Paris Saclay

Comunicación y diversidad / **76**

Panel y mesas de trabajo: Diversidad, Equidad e inclusión (DEI)

Corresponding Authors: reina.camacho@cern.ch, jose.ruiz@cern.ch, gabriela.navarro@uan.edu.co

- Identificación de problemáticas
- Definición de indicadores, calidad de los datos existentes
- Acciones afirmativas en DEI
- Voces desde el sur global: ¿cómo se vive el trabajar en HECAP desde Colombia?
- Género en ciencia
- Hablemos de interseccionalidad
- Vida estudiantil y postdoctoral: retos y perspectivas

Comunicación y diversidad / **77**

Diversidad y género en HEP

Corresponding Author: dilia.maria.portillo.quintero@cern.ch

CONHEP network meeting / **78**

COMHEP VIII

Corresponding Author: carlos.sandoval@cern.ch

79

Closing

Corresponding Author: carlos.sandoval@cern.ch