NeMO-C 2024: Neutrinos y Materia Oscura en Colombia

Wednesday 24 July 2024 - Thursday 25 July 2024

Universidad de Medellín

Book of Abstracts

Contents

1

Dark matter stability and neutrinos nature from broken non-abelian discrete symmetries

Authors: Andres Layana[1]; Cesar Bonilla Díaz[2]

[1] *UCN*

[2] *Universidad Católica del Norte*

Corresponding Authors: layana.ramirez.a@gmail.com, cesar.bonilla@ucn.cl

Se estudia el rompimiento espontáneo de simetrías discretas no abelianas que dejen simetrías residuales conservadas. Con esto, podremos construir extensiones del modelo estándar que incluyan un sector oscuro que proporciona un candidato a materia oscura tipo WIMP. Al mismo tiempo que generan términos de masa para los neutrinos. Exploramos el espacio de parámetros para verificar la viabilidad del modelo y definir nuevos fenómenos observables detectables experimentalmente en el futuro cercano. Esto podría incluir procesos de violación de sabor en la desintegración del leptón tau y el quark top, los cuales están siendo analizados actualmente por el experimento CMS, asi como la detección de posibles candidatos a materia oscura: directamente a través de la colaboraciones como DARWIN, e indirectamente mediante datos recopilados por CTA entre otros.

2

Dark matter-electron interactions in a L_{\mu} - L_{\tau} symmetry model

Author: Fredy Alexander Ochoa Perez[None]

Co-authors: Gonzalo Herrera [1]; Pablo Figueroa [2]

[1] *TUM, MPP*

[2] *Max Planck Institute for Physics*

Corresponding Authors: gonzalo.herrera@tum.de, faochoap@unal.edu.co, pablof@mpp.mpg.de

We consider an L_{\mu} - L_{\tau} abelian symmmetry extension of the Standard Model to derive spin-independent and spin-dependent interactions of fermion dark matter and electrons through the new gauge boson. We explore prospects with XLZD and OSCURA experiments to close the constraints in the parameter space able to explain simultaneously the recent measurement on the anomalous magnetic moment of the muon and the observed relic density of dark matter.

3

Thermal Dark Matter with Low-Temperature Reheating

Authors: Kuldeep Deka[1]; Marta Losada[2]; Nicolás Bernal[1]

[1] *New York University Abu Dhabi*

[2] *NYUAD*

Corresponding Author: nicolas.bernal@nyu.edu

We explore the production of thermal dark matter (DM) candidates (WIMPs, SIMPs, ELDERs and Cannibals) during cosmic reheating. Assuming a general parametrization for the scaling of the inflaton energy density and the standard model (SM) temperature, we study the requirements for kinetic

and chemical DM freeze-out in a model-independent way. For each of the mechanisms, up to two solutions that fit the entire observed DM relic density exist, for a given reheating scenario and DM mass. As an example, we assume a simple particle physics model in which DM interacts with itself and with SM through contact interactions. We find that low-temperature reheating can accommodate a wider range of couplings and larger masses than those permitted in the usual instantaneous high-temperature reheating. This results in DM solutions for WIMPs reaching masses as high as 10^{14} GeV, whereas for SIMPs and ELDERs, we can reach masses of 10^{13} GeV. Interestingly, current experimental data already constrain the enlarged parameter space of these models with low-reheating temperatures. Next-generation experiments could further probe these scenarios.

4

Effective dark matter

Author: DIEGO ALEJANDRO RESTREPO QUINTERO[None]

Corresponding Author: restrepo@udea.edu.co

Restrictions in Wilson coefficients for Dark matter simplified models

5

Collider analysis of the U(1)_L globally gauged scotogenic model within compressed mass spectrum scenarios.

Author: Andrés Flórez[1]

[1] *Universidad de Los Andes*

Corresponding Author: ca.florez@uniandes.edu.co

In this talk we present an variation of the Scotogenic Model, that extends the gauge group by a global U(1) symmetry, and a singlet scalar 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 compatible parameter space for both fermionic and scalar dark matter, which can be considered in a compressed mass spectrum between the lightest fermionic and scalar states. Then, we make an analysis of the behavior of the production cross section of the DM candidate particle, for both Drell-Yan and Vector Boson Fusion mechanisms and different compressed mass spectra scenarios, as a function of the mass and compare it with the latest results given by the ATLAS and CMS experiments to establish the detection feasibility of the model at the LHC.

6

Phenomenology of a singlet-doublet-triplet scotogenic framework

Authors: Bjorn HERRMANN[None]; Maud SARAZIN[None]; Ugo DE NOYERS[1]

[1] *LAPTh / Université Savoie Mont Blanc*

Corresponding Authors: ugo.denoyers@lapth.cnrs.fr, bjorn.herrmann@lapth.cnrs.fr, m.sarazin@uniandes.edu.co

I will present a triplet-scotogenic model, so called “T1-2G”, in order to provide a solution to neutrino masses, and dark matter, while satisfying the limit on lepton flavor violation processes. The viable

region of the parameter space is determined through a Markov Chain Monte Carlo numerical code, and satisfies both dark matter observable and lepton flavor violation constraints.

7

Reopening the Z portal with semi-annihilations

Author: Óscar Zapata[1]

Co-authors: María J. Domínguez [1]; OSCAR ANDRES RODRIGUEZ CIFUENTES

[1] *Universidad de Antioquia*

Corresponding Authors: oscara.rodriguez@udea.edu.co, mjose.dominguez@udea.edu.co, oalberto.zapata@udea.edu.co

In one-component dark matter (DM) scenarios is commonly assumed that a scalar WIMP must either be part of an $SU(2)_L$ multiplet with zero hypercharge or have suppressed vector interactions with the Z gauge boson to circumvent stringent direct detection (DD) bounds. In this work, we demonstrate that multi-component scenarios with a dark scalar doublet exhibiting vector-like interactions with the Z boson are also compatible with bounds arising from DD searches. Specifically, we consider a simple extension of the Standard Model wherein the dark sector comprises a doublet and a complex singlet ϕ, both charged under a Z_6 symmetry. We find that semi-annihilation processes drastically reduce the relic abundance of the neutral component of the doublet, H^0, sufficiently attenuating the effects of its large Z-mediated elastic scattering cross-section with nucleons to satisfy the DD constraints. Although the contribution of H^0 to the total relic abundance is nearly negligible, with ϕ dominating, both dark matter components are expected to be detectable in ongoing and future DD experiments. The viability of the model is tested against several theoretical and experimental constraints, resulting in a parameter space featuring a non-degenerate mass spectrum at the electroweak scale.

8

Registration and Welcome

Author: David Vanegas Forero[1]

[1] *Universidad de Medellin*

Corresponding Author: dvanegas@udemedellin.edu.co

9

Dark Matter - Overview

Author: Nicolás Bernal[1]

[1] *New York University Abu Dhabi*

Corresponding Author: nicolas.bernal@nyu.edu

10

Neutrinos - Overview

Author: David Vanegas Forero[1]

[1] *Universidad de Medellin*

Corresponding Author: dvanegas@udemedellin.edu.co

11

Exercises

Author: Nicolás Bernal[1]

[1] *New York University Abu Dhabi*

Corresponding Author: nicolas.bernal@nyu.edu

13

$\mu - \tau$ reflection symmetry and magic neutrino mass matrix

Author: Sergio Tostado[1]

Co-author: Diana C. Rivera-Agudelo [1]

[1] *Universidad Santiago de Cali*

Corresponding Authors: tostado87@gmail.com, c.diana.rivera@gmail.com

The searches for an underlying pattern in neutrino masses have motivated different proposals for textures in the neutrino mass matrix, which is also related to particular arranges of the mixing matrix. The current precise determinations of neutrino mixings have discarded some of the most studied proposals, such as the one involving a $\mu-\tau$ exchange symmetry. In this work, we investigate the relation of a still allowed $\mu - \tau$ reflection symmetry with the constraints of a magic pattern in the neutrino mass matrix. We show that both conditions cannot be fulfilled simultaneously in an exact but rather in an approximate way. These considerations may have some effects on the values of the CP-violating phases and in some observables like the neutrinoless double beta decay amplitude, which may be explored in future experiments.

14

Dark matter in QCD-like theories with a theta vacuum: cosmological and astrophysical implications

Author: Oscar Zapata[None]

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

QCD-like theories in which the dark matter (DM) of the Universe is hypothesized to be a thermal relic in the form of a dark pion has been extensively investigated, with most studies neglecting the CP-violating θ-angle associated with the topological vacuum. We point out that a non-vanishing θ could potentially trigger resonant number-changing processes giving rise to the observed relic density in agreement with perturbative unitarity as well as observations of clusters of galaxies. This constitutes a novel production mechanism of MeV DM and an alternative to those relying on the Wess-Zumino-Witten term. Moreover, for specific meson mass spectra, similar resonant scatterings serve as a realization of velocity-dependent self-interacting DM without a light mediator. Explicit benchmark models are presented together with a discussion of possible signals.

15

LArSoft and its applications in DUNE

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

[1] *Universidad Antonio Nariño*

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

In this talk we are going to provide an introduction to Fermilab computing and how to set up an account in Fermilab to use The Liquid Argon Software (LArSoft) and Its main functionalities. This tutorial will present the principal LArSoft modules used as tools in the simulation and reconstruction of different phenomena across liquid Argon time projection chambers, which are employed in neutrino experiments like DUNE. The main objective of this talk is to enable the audience to understand how a LArSoft simulation is conducted in DUNE, with special focus in the photon simulation module, while utilizing the ROOT framework for visualization results. Finally, we will present the broad context of data analysis tools used in the DUNE experiment.

16

Breve introducción al sistema de detección de fotones del proyecto DUNE

Author: Jorge Eduardo Ossa Sánchez[1]

[1] *Universidad de Medellín, Estudiante Doctorado en Modelación y Computación Científica*

Corresponding Author: osgeorge@utp.edu.co

El Proyecto DUNE cuyo objetivo es ahondar en el estudio y comprensión de los neutrinos consta de un generador de haz de neutrinos captados luego por un detector cercano y posteriormente por un detector lejano. Para detectar dichas partículas se hace necesario un gran volumen de material sensible y su correspondiente hardware orientado a amplificar y digitalizar la señal de lo los eventos físicos que caracterizan su interacción. En este orden de ideas, y acorde con los eventos físicos de interés, se hace necesario un sistema de detección de fotones. En esta exposición se hará una breve reseña del sistema de detección de fotones del detector lejano del proyecto DUNE en su detector de fase simple.

17

Fuzzy dark matter modeling of the dynamical behavior of nearby isolated dwarf galaxies.

Author: Andrés Fernando Castillo Ramirez[1]

[1] *IAC/ULL*

Corresponding Author: afcastillor@unal.edu.co

We investigate a model based on fuzzy dark matter (FDM) formalism to describe rotation curves of nearby isolated dwarf galaxies. Our study evaluates the consistency of the FDM behavior with high resolution rotation curves from the LITTLE THINGS 3D catalog, which contains dark matter dominated galaxies. We find that the phenomenological model incorporating a central soliton structure, as predicted by FDM, accurately represents the dynamics of the dwarf galaxies and their density profiles. Nevertheless, the halo mass function prediction of FDM is not compatible with

the determination of the number of observable haloes in the distances of the nearby group of irregular dwarf galaxies.This discrepancy presents a catch-22 paradox for the minimal FDM model, particularly within the axion mass range that permits the formation of soliton cores.

18

Fenomenología de un modelo de masas de neutrinos de tipo dirac.

Author: Sebastián Manco[1]

Co-authors: Amalia Betancur Rodriguez [2]; Guillermo Palacio

[1] *EIA University*

[2] *EIA University (CO)*

Corresponding Authors: gapalacic@gmail.com, amalia.betancur.rodriguez@cern.ch, sebastian.mancom@gmail.com

El modelo estándar de la física de partículas ha demostrado ser la teoría más exitosa de la historia, gracias a su impresionante poder predictivo y su capacidad para explicar una amplia gama de fenómenos naturales. No obstante, esta teoría no es definitiva y deja varias preguntas sin resolver, siendo una de las más intrigantes: ¿cómo adquieren masa los neutrinos? En este trabajo, abordamos esta cuestión proponiendo un modelo de masas de neutrinos de tipo Dirac en el contexto de la física más allá del modelo estándar. Presentamos el lagrangiano asociado a este modelo y exploramos el espacio de parámetros relevante. Posteriormente, derivamos la expresión para la matriz de masa de los neutrinos \(m_ν). Adicionalmente, encontramos una parametrización para sus acoples, lo que permite restringir la nueva física usando resultados de física de neutrinos. Este modelo puede también ser explorado por otros decaimientos $h \to \gamma\gamma$ y $\mu \to e\gamma$, destacando sus implicaciones fenomenológicas y potenciales señales experimentales.

19

Massive Kalb-Ramond field as Feebly-interacting dark matter

The Kalb-Ramond (KR) field is an antisymmetric rank two tensor that appears in the context of string theory. In this work, we consider the massive KR field as a dark matter candidate and we study its production via the FIMP mechanism trough the Higgs portal. We find that the KR field gives account for the relic density of dark matter today for a wide range of masses.