NuCo 2021: Neutrinos en Colombia

Wednesday, 28 July 2021 - Friday, 30 July 2021

Book of Abstracts

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Neutrino non-standard interactions: a possible solution to the NOvA and T2K tension

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The latest data of the two long-baseline accelerator experiments NOvA and T2K, analysed in the standard 3-flavor scenario, display a discrepancy. A mismatch in the determination of the standard CP-phase δ_{CP} extracted by the two experiments is evident in the normal neutrino mass ordering. While NOvA prefers values close to $\delta_{CP} \sim 0.8\pi$, T2K identifies values of $\delta_{CP} \sim 1.4\pi$. Such two estimates are in disagreement at more than 90% C.L. for 2 d.o.f.. We show that such a tension can be resolved if one hypothesizes the existence of complex neutral-current non-standard interactions (NSI) of the flavor changing type involving the $-\mu$ or the $-\tau$ sectors with couplings $|\varepsilon_{e\mu}|$ ~ $|\varepsilon_{e\tau}|$ ~ 0.2. We find that in case of normal mass ordering there is a 2.1σ preference of the non-zero NSI coupling $|\varepsilon_{e\mu}|$ and 1.9σ preference of $|\varepsilon_{e\tau}|$. Remarkably, in the presence of such NSI, both experiments point towards the same common value of the standard CP-phase $\delta_{CP} \sim 3\pi/2$. Our analysis also highlights an intriguing preference for maximal CP-violation in the non-standard sector with the dynamical NSI CP-phases having best fit close to $\phi_{e\mu}$ ˜ $\phi_{e\tau}$ ˜ $3\pi/2$. Although not very strong this might be a possible sign of physics beyond the Standard Model. It is also worth to mention that in case of inverted ordering the preference of non-zero NSI couplings |\varepsilon_{e\mu}| and |\varepsilon_{e\tau}| lies only at 1σ confidence level respectively.

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Neutrino oscillations in extended theories of gravity

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In this talk, I discuss the investigation revolving around neutrino oscillations within the framework of extended theories of gravity. Based on the covariant reformulation of Pontecorvo's formalism, the oscillation probability of neutrinos propagating in static spacetimes described by gravitational actions quadratic in the curvature invariants is evaluated. For the sake of simplicity, calculations are carried out in the two-flavor approximation. Remarkably, it is shown that the neutrino phase is sensitive to the violation of the strong equivalence principle. By way of illustration, I specialize the analysis to various extended models of gravity in order both to quantify such a violation and to understand how the characteristic free parameters of these models affect neutrino oscillation phase. The possibility to fix new bounds on these parameters and to constrain extended theories of gravity is finally discussed.

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Radiative neutrino mass models

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I will discuss several models where the masses of the light active neutrinos are radiatively generated. Mechanisms for generating the SM charged fermion mass hierarchy will also be presented. Some phenomenological aspects, such as Dark matter, charged lepton flavor violation, collider signatures, electron and muon anomalous magnetic moments will be discussed as well.

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Constraining Sommerfeld-Enhancement via Inflationary Perturbations: Dark Matter and Neutrino Interactions

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In ΛCDM cosmology, Dark Matter (DM) and neutrinos are assumed to be non-interacting. However, it is possible to have scenarios, where DM-neutrino interaction may be present, leading to scattering of DM with neutrinos and annihilation of DM into neutrinos. We investigate the viability of such scenarios in the light of cosmological data by making use of the PLANCK-2018 and BOSS-BAO 2014 dataset and constrain these processes in the light of the same. We also discuss a particle DM model where DM-neutrino interaction is present, and map the constraints to the parameter space of the model.

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Probing the two-neutrino exchange force using atomic parity violation

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The exchange of two neutrinos at one loop leads to a long-range parity-violating force between fermions. In this talk, I will explore the two-neutrino force in the backdrop of atomic physics. This is the largest parity-violating long-range force in the Standard Model. The effect of this force can be searched for in experiments that probe atomic parity violation by measuring the optical rotation of light as it passes through a sample of vaporized atoms. I will present the results of calculations for the hydrogen atom to demonstrate this effect. Although the effect is too small to be observed in hydrogen in the foreseeable future, our approach may be applied to other setups where long-range parity violation is large enough to be probed experimentally.

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Neutrino oscillations the on-shell way

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On-shell scattering amplitudes are an interesting approach in which amplitudes can be computed without introducing any field nor Lagrangian. In other words, they are a powerful tool to "do QFT without fields". In this talk, we will show how to use such techniques to describe neutrino oscillations. The power of this approach will allow us to derive (I) the PMNS matrix without diagonalizing any mass matrix, and (II) an amplitude for neutrino oscillations that automatically contains all possible corrections coming from new physics.

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Some consequences of non-standard neutrino interactions

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In most of the proposals for new physics beyond the standard model neutrinos have new interactions. Here we pointed out that some of these interactions have consequences which, although at present they seem purely academic, they probably have to be taken into account in the future neutrino experiments. They range from obscuring the neutrino mass ordering to misidentification of the flavour neutrinos, or the experimental ability to distinguish neutrinos from antineutrinos.

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Neutrino physics at a reactor with the CONNIE experiment

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The CONNIE experiment uses fully depleted high-resistivity CCDs with the goal of detecting the coherent elastic neutrino nucleus (CEvNS) scattering of reactor antineutrinos off silicon nuclei, and to probe physics beyond the Standard Model (SM). It is located at 30 m from the core of the 3.8 GW Angra 2 nuclear reactor in Brazil. Since its 2016 upgrade, the experiment has operated with a low noise level of <2e- RMS and an active mass of 50 g. The analysis of the 2016-2018 data has been used to set a 95% C.L. limit on the CEvNS rate, which has been translated into stringent constraints on simplified SM extensions involving light mediators. In this talk, we report on the performance of the detector over the last 4 years, the finalized blind analysis of the 2019 data which features a reduced energy threshold (50 eV), and future perspectives for using skipper CCDs to observe CEvNS at reactors.

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Constraints on generalized neutrino interactions

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I will introduce a new neutral current neutrino data analysis applied to generalized neutrino interactions (GNI). By combining data on electron-positron collisions, neutrino-electron scattering, and neutrino deep inelastic scattering, I will compute new constrains on scalar, pseudoscalar, and tensor new physics effective couplings. Due to the global analysis, the results are robust, and some GNI parameters are better restricted.

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The Scattering and Neutrino Detector at the LHC

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SND@LHC is a compact and stand-alone experiment to perform measurements with neutrinos produced at the LHC in a hitherto unexplored pseudo-rapidity region of $7.2 < \eta < 8.6$, complementary to all the other experiments at the LHC. The experiment is to be located 480 m downstream of IP1 in the unused TI18 tunnel. The detector is composed of a hybrid system based on an 800 kg target mass of tungsten plates, interleaved with emulsion and electronic trackers, followed downstream by a calorimeter and a muon system. The configuration allows efficiently distinguishing between all three neutrino flavours, opening a unique opportunity to probe physics of heavy flavour production at the LHC in the region that is not accessible to ATLAS, CMS and LHCb. This region is of particular interest also for future circular colliders and for predictions of very high-energy atmospheric neutrinos. The detector concept is also well suited to searching for Feebly Interacting Particles via signatures of scattering in the detector target. The first phase aims at operating the detector throughout LHC Run 3 to collect a total of 150 fb^{-1}. The experiment was recently approved by the Research Board at CERN. A new era of collider neutrino physics is just starting.

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Neutrino-induced Single Pion Production with Light Nuclei

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Single pion production datasets from the Argonne (ANL) and Brookhaven (BNL) Bubble Chamber neutrino experiments are heavily used to test and tune pion production models. Measurements as a function of the true neutrino energy (E_ν) and four-momentum transfer (Q^2) are typically used for this purpose, so our objective is to investigate and utilize other observables that are also available from these experiments. We simulate neutrino-deuterium scattering events using the ANL/BNL fluxes and digitize histograms of the previously unexplored nucleon-pion, nucleon-muon and muon-pion invariant mass (W) distributions. The NUISANCE framework is used to compare the theoretical predictions of four event generators to the data that ANL and BNL published in the 1980s. For the NEUT simulation package, we use event-reweighting to make variations in the non-resonant background scaling factor $I_{1/2}$ and two other parameters appearing in the Graczyk-Sobczyk resonance model's axial form factor, namely the axial mass M_A^{RES} and the resonant normalization factor ${C_A}^5(0)$. We investigate fitting these parameters to various combinations of the E_ν and W datasets. A study of the resulting set of post-fit parameter values could help in addressing the systematic uncertainties encountered in neutrino oscillation experiments.

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Resolving a challenging supersymmetric low-scale seesaw scenario at the ILC

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We investigate a scenario inspired by natural supersymmetry, where neutrino data is explained within a low-scale seesaw scenario. For this the Minimal Supersymmetric Standard Model is extended by adding light right-handed neutrinos and their superpartners, the R-sneutrinos. Moreover, we consider the lightest neutralinos to be higgsino-like. We first update a previous analysis and assess to which extent does existing LHC data constrain the allowed slepton masses. Here we find scenarios where sleptons with masses as low as 175 GeV are consistent with existing data. However, we also show that the up-coming run will either discover or rule out sleptons with masses of 300 GeV, even for these challenging scenarios.

We then take a scenario which is on the borderline of observability of the upcoming LHC run assuming a luminosity of 300 fb^{-1}. We demonstrate that a prospective international e^+e^- linear collider with a center of mass energy of 1 TeV will be able to discover sleptons in scenarios which are difficult for the LHC. Moreover, we also show that a measurement of the spectrum will be possible within 1-3 percent accuracy.

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Signatures of primordial black hole dark matter at DUNE and THEIA

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Primordial black holes (PBHs) are a potential dark matter candidate whose masses can span over many orders of magnitude. If they have masses in the 10ˆ15 − 10ˆ17 g range, they can emit sizeable fluxes of MeV neutrinos through evaporation via Hawking radiation. We explore the possibility of detecting light (non-)rotating PBHs with future neutrino experiments DUNE and THEIA. We will show that they will be able to set competitive constraints on PBH dark matter, thus providing complementary probes in a part of the PBH parameter space currently constrained mainly by photon data.

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Background from neutrino interactions in dark matter searches at DUNE-ND.

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Interactions from neutrino-beam with liquid argon are critical backgrounds in the detection of long-lived bosons at DUNE-ND. In this work, we examine the influence of neutrino-electron scattering and ve-CCQE events in search of dark photons as portals of multicomponent light dark matter using the main attributes of DUNE-PRISM.

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Sensitivity of the elastic neutrino-electron and coherent elastic neutrino-nucleus scattering experiments to the neutrino electric millicharge

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Different constraints to the neutrino electric millicharge (NEM) have been achieved by studying interactions such as the elastic neutrino-electric scattering (ENES). In recent years, bounds on this parameter are also being obtained from data of the COHERENT experiment. We studied the potential of the coherent elastic neutrino-nucleus scattering (CEvNS) in future reactor neutrino experiments

to constrain the NEM. Additionally, we show results for limits on the NEM from ENES experiments. In both cases we used a combination of several experimental data, where bounds up to the order of 10ˆ{-14}e are attained from CEvNS experimental proposals. We will talk about these outcomes at NuCo 2021.

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PBHs and Neutrinos

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PBHs and neutrinos

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Neutrino and Nuclear Properties from Coherent Elastic Neutrino-Nucleus Scattering

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I will review the process of coherent elastic neutrino-nucleus scattering,
with emphasis on its recent observation in the COHERENT experiment with CsI and Ar targets.
I will discuss:
the determination of the radius of the nuclear neutron distributions in Cs, I and Ar;
the determination of the low-energy value of the weak mixing angle;
the constraints on non-standard neutrino properties:
neutrino magnetic moments, charges, charge radii, and non-standard interactions.

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Light sterile neutrinos and reactor experiments

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Most observations in neutrino oscillation physics are well described within the three-neutrino paradigm. There are, however, some anomalies which might hint towards the existence of a fourth (and sterile) neutrino with eV-scale mass. I discuss the current status of searches of this type of neutrino at reactor experiments. I discuss the status of the rate anomaly and also the status of searches at ratio experiments. Finally, I compare the results from searches at reactor experiments with searches at other types of experiments.

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Two texture zeros and neutrino mass matrix

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The non-zero value of the reactor mixing angle θ_{13} has ruled out the possibility of μ-τ symmetry in neutrino mass matrix, there can still be a magic symmetry in neutrino mass matrix. In this context, we explore several classes of two texture zeros such as Class A, Class B, Class C and Class D in magic neutrino mass matrix and obtain the relation between one unknown phase ϕ and two known parameters: Δm^2_{23} and ratio of two mass square difference (r=$\Delta m^2_{12}/\Delta m^2_{23}$). We also analyses the variation of unknown phase ϕ with respect to mixing angles (θ_{13} and θ_{23}), Dirac CP violating phase δ, Majorana phases (α and β) and Jarlskog invariant CP violation parameter J and their experimental validity.

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A global overview of the three-neutrino oscillation picture

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In this talk, I will present the current status of global analyses to neutrino oscillation data in the three-flavor framework. I will discuss the recent hints in favor of normal mass ordering and maximal CP violation as well as the different tensions we find when combining different data samples. The robustness of the current oscillation picture in the presence of new physics beyond the Standard Model will be addressed too.

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CP violation in mixing and oscillations for leptogenesis with quasi-degenerate neutrinos

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We will present an approach to study the sources of CP violation for baryogenesis models with quasi-degenerate neutrinos. The source term we obtain has contributions that can be identified with CP violation from mixing, oscillations and interference between both. The relative signs and sizes of these contributions will be discussed, as well as unitarity requirements and the connection to the procedure of real intermediate state subtraction.

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Heavy decaying dark matter at future neutrino radio telescopes

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In the next decade, ultra-high-energy neutrinos in the EeV-ZeV energy range will be potentially detected by next-generation neutrino telescopes. Although their primary goals are to observe cosmogenic neutrinos and to gain insight into extreme astrophysical environments, they have the great potential of indirectly probing the nature of dark matter. In this talk, we study the projected sensitivity of up-coming radio neutrino telescopes, such as RNO-G, GRAND and IceCube-gen2 radio array, to decaying dark matter scenarios. We investigate different dark matter decaying channels and masses, from 10^7 to 10^{15} GeV. By assuming the observation of cosmogenic or newborn pulsar neutrinos, we forecast conservative constraints on the lifetime of heavy dark matter particles. We find that these limits are competitive with and highly complementary to previous multi-messenger analyses.

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A search for pseudo-Dirac neutrinos in the Cosmos

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The most fundamental question on neutrino physics is whether their fermionic nature is Dirac or Majorana. Nevertheless, this should not be taken as a dichotomy. In fact, there is a scenario in which neutrinos are Majorana but behave for all practical purposes as Dirac; they would be *pseudo-Dirac* neutrinos. In this case, the only hope for determining their true nature is searching for active-sterile oscillations, which would only develop on astrophysical scales. In this talk, we consider the limits (and hints) on the pseudo-Dirac scenario derived by studying the neutrinos that originated from the supernova explosion in 1987. We further explore the future sensitivity on active-sterile oscillations in the case that a Supernova occurs at 10 kpc and by studying the diffuse supernova neutrino background.

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La dispersión (anti)neutrino-electrón como estudio de interacciones no estándares del neutrino

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Dentro de los bloques constitutivos de la materia se encuentran los neutrinos, su estudio ha jugado un papel principal no sólo a la hora de confirmar las predicciones teóricas del modelo estándar (ME), sino también en la búsqueda de nueva física (NF). Una de las evidencias más claras de NF que tenemos hasta la fecha, se conoce como oscilaciones de neutrinos.
Actualmente la física de neutrinos se encuentra en una era de precisión; los parámetros que describen el fenómeno de oscilaciones de neutrinos están siendo medidos con una exactitud que va en aumento. Futuros experimentos tendrán como objetivo determinar efectos subdominantes que revelen interacciones adicionales de los neutrinos con la materia, también conocidas como Interacciones No Estándar (INE).
En esta charla presentaremos el trabajo de investigación que me encuentro actualmente desarrollando para obtener el título de grado en Físico por la Universidad de Pamplona. Se abordará el estudio fenomenológico de las INE asociadas a NF en el sector de neutrinos. Para llevar a cabo esta investigación, en primer lugar, se estudiará la dispersión (anti)neutrino-electrón bajo el ME de la física de partículas elementales y posteriormente se analizará el impacto que tienen dichas interacciones adicionales, de los neutrinos con la materia, en la dispersión (anti)neutrino-electrón. Esta última parte de la investigación, abarcará un estudio estadístico sobre el análisis de datos experimentales y su implementación en los códigos numéricos que nos permitirán obtener cotas a los parámetros de INE.

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Inelastic Axial and Vector Structure Functions for Electron- and Neutrino- Nucleon Scattering 2021 Update

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We report on an update (2021) of a phenomelogical model for inelastic neutrino- and electron-nucleon scattering cross sections using effective leading order parton distribution functions with a new scaling variable ξ_w. Non-perturbative effects are well described using the ξ_w scaling variable in combination with multiplicative K factors at low Q^2. The model describes all inelastic charged lepton-nucleon scattering data (HERA/NMC/BCDMS/SLAC/JLab) ranging from very high Q^2 to very low Q^2 and down to the $Q^2 = 0$ photo-production region. The model has been developed to be used in analysis of neutrino oscillation experiments in the few
GeV region. The 2021 update accounts for the difference between axial and vector structure function which brings it into better agreement with existing inelastic neutrino-nucleon scattering measurements.

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Charting New Directions in the BSM Landscape with Neutrino Experiments

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In this talk I will review the broad array of new physics that can be found at neutrino experiments.

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Asymmetries from effective interactions of heavy Majorana neutrinos in future lepton colliders

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We study the potential of forward–backward and other angular asymmetries to reveal the production of heavy Majorana neutrinos with effective interactions in a simple benchmark scenario with dim-6 scalar, vector and tensor operators and neglecting the tiny heavy-active Type I seesaw mixings. Asymmetries between particles produced jointly with the N and its decay products, or indeed between them, can be complementary to displacement observables to seek for the production of heavy N in lepton colliders. We present the $e^+e^- \to \nu N \to \nu\mu jj$ and $e^+e^- \to \nu N \to \nu\mu\mu\nu$ case studies to show the cuts on kinematic variables to separate our signal from SM backgrounds and possible analyses.

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Five texture zeros in the lepton sector.

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In this talk, we analyze textures zeros in the lepton sector to predict the neutrino masses using like Ramond-Robert-Ross (RRR) forms in the quark sector. To do that, we extend beyond the Standard Model with three right-handed neutrinos by assuming Dirac masses for the neutrinos. We find the non-standard unitary lepton mixing matrix in an analytical way and used it with the current data to predict the lightest neutrino mass and the cp-phase, for each RRR case.

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Heavy Sterile Neutrino Decay at Short-Baseline Experiments

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We studied a neutrino decay scenario as a potential solution to conciliate the tension between appearance and disappearance data at the short-baseline experiments. Particularly, we considered a heavy neutrino mass-eigenstate that decays into a usual light neutrino plus a massless scalar. Under this neutrino decay hypothesis, we fitted LSND and MiniBooNE electron neutrino appearance data assuming Dirac or Majorana neutrinos. We obtained reasonable results for both cases. Including muon

neutrino disappearance searches, and also current bounds on the new decay coupling constant, we noticed that the heavy neutrino decay scenario is compatible as long as $1\ \mathrm{MeV} \geq m_4 \geq 10$ keV. Finally, we showed that the future SBN program at Fermilab has the potential to definitively test the considered decay hypothesis.

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La dispersión elástica coherente neutrino-núcleo como prueba del modelo estándar

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Durante esta charla expondré mi propuesta de investigación de trabajo de grado para optar al título de pregrado de Físico. Se abordará el estudio de la dispersión elástica coherente neutrino-núcleo (CEvNS). Esta línea de investigación actualmente es un área muy activa de la física de neutrinos debido a su descubrimiento recientemente por parte de la colaboración COHERENT. Para el desarrollo de la investigación, se considerarán propuestas experimentales que planean detectar CEvNS, utilizando antineutrinos de reactor como fuente, las cuales se encuentran actualmente en desarrollo. El propósito de llevar a cabo esta investigación consiste en restringir parámetros fundamentales del Modelo Estándar, tales como el ángulo de mezcla débil a bajas energías, dicho análisis se llevará a cabo mediante un análisis estadístico χ2

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Neutrinos in cosmology: Challenges and future perspectives

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Neutrinos are not only a cornerstone of particle physics but also for cosmology. From the point of view of particle physics, neutrinos are fundamental particles (specifically neutral leptons), which in principle come in three flavors (ν_e, ν_μ, ν_τ) and have the property that they can be transformed into each other (Oscillations). Due to this property, it is well known that neutrinos have mass (very, very small), which goes beyond the standard model of particle physics. However, its absolute mass scale is still a mystery, along with other properties such as hierarchy between them (normal, inverse, or degenerate ordering) and if they are Dirac or Majorana particles (Neutrinos / Anti-Neutrinos are the same particle?). On the other hand, from the point of view of cosmology, neutrinos are the second most abundant species in the Universe after photons, which implies that they can considerably affect the dynamics of cosmic expansion. In this talk, I will show how can be addressed these essential questions from the point of view of cosmology (which is complementary information for particle physics) and how can use them to alleviate tensions between measurements of parameters such as H_0 and σ_8. In addition to this, I will show what are the perspectives for future experiments such as CMB-S4, CORE, and Vera Rubin LSST observatory, through forecast and large-scale structure simulations.

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Neutrino Lines from Dark Matter

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While photon lines -or monochromatic photons- are known to arise in many dark matter models, neutrino lines are not so common.
In this talk, I will discuss simple dark matter models, whose main indirect detection signature is the production of monochromatic neutrinos. Such features play an important role in indirect dark matter searches because they can be better discriminated against the astrophysical background. I will discuss the implications for neutrino telescopes and the interplay with other indirect detection channels.

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Beyond the Standard Model Physics Opportunities with the Deep Underground Neutrino Experiment

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The Deep Underground Neutrino Experiment (DUNE) international project, currently under construction, will enable an exciting program for precision neutrino physics and beyond. Two multi-detector facilities will be exposed to the world's most intense neutrino beam: the Near Detector complex will measure the beam flux and composition 575 m downstream of the production target, at Fermilab; and the Far Detector complex, including four 17 kton LArTPC modules, will remeasure the beam 1300 km away, when installed about 1.5 km deep in the Sanford Underground Research Facility in South Dakota.
The combination of the high-intensity Long-Baseline Neutrino Facility (LBNF) beam with DUNE's highly-capable Near Detector and massive high-resolution LArTPC Far Detector opens up prospects for a rich program of Beyond the Standard Model (BSM) physics searches. These searches include discovery of new particles (sterile neutrinos, dark matter, heavy neutral leptons, etc.), precision tests of the neutrino mixing matrix including non-standard neutrino interactions, and the detailed study of rare processes (e.g. neutrino trident production). In this talk, I will go over promising opportunities for BSM Physics probes with DUNE, and discuss their potential impact and outcomes.

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Solar Neutrinos, Sterile Neutrinos and Dark Matter Experiments

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Solar neutrino scattering with electron via a light mediator, either scalar or vector can be searched in Xenon-based Dark Matter experiments. A keV sterile neutrino instead of an active neutrino can appear in the final state for the recoil electron. Such a scenario is difficult to probe in other types of experiments and can be used to obtain stringent bounds on new interactions. Moreover, a sterile neutrino with mass at the 100 keV allows the explanation of the Xenon1T excess. We also briefly discuss the case of sterile neutrino final state with light Z' mediator.

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Effect of light sterile states on measurements at long-baseline experiments

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In [1], we show that the presence of even one sterile neutrino of mass ~1 eV can significantly impact the measurements of CP violation in long baseline experiments. Using a probability level analysis, we discuss the large magnitude of these effects, and show how they translate into significant event rate deviations at DUNE. Our results demonstrate that measurements which, when interpreted in the context of the standard three family paradigm, indicate CP conservation at long baselines, may, in fact hide large CP violation if there is a sterile state. In [2], we show that neutral current (NC) measurements at neutrino detectors can play a valuable role in the search for new physics. Such measurements have certain intrinsic features and advantages that can fruitfully be combined with the usual well-studied charged lepton detection channels in order to probe the presence of new interactions or new light states. In addition to the fact that NC events are immune to uncertainties in standard model neutrino mixing and mass parameters, they can have small matter effects and superior rates since all three flavours participate. We also show, as a general feature, that NC measurements provide access to different combinations of CP phases and mixing parameters compared to CC measurements at both long and short baseline experiments.

References:
[1] R. Gandhi, B. Kayser, M. Masud, S. Prakash, "The impact of sterile neutrinos on CP measurements at long baselines", JHEP 11 (2015) 039.
[2] R. Gandhi, B. Kayser, S. Prakash, S. Roy, "What measurements of neutrino neutral current events can reveal", JHEP 11 (2017) 202.

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Testing invisible neutrino decay scenarios by using Earth matter effects on Core-Collapse Supernova neutrinos.

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As the core-collapse supernova (CCSN) neutrinos cross the Earth, the matter effects introduce modulations on the CCSN neutrino spectra. Studying these modulations could help us to solve the neutrino mass ordering problem. However, the matter effect besides is expected to be rather small, could

be difficult to observe because of the uncertainties in the calculation of the CCSN neutrino spectra such as the average neutrino energies and even the supernova distance. In this work we explore the possibility that, by including a non standard neutrino property as invisible neutrino decay, would enhance the Earth matter effects. We find that in the invisible neutrino decay scenario, Earth matter effects exist for both ν_e and $\bar{\nu}_e$ for both mass ordering at the same time. Also we find that if the CCSN neutrino crosses the mantle there is a high probability of observing the Earth matter effects.

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Neutrinos Roadmap in Latinamerica and Colombia (LASF4RI for HECAP)

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For the first time the scientific community working at the forefront of research in High-Energy, Cosmology and Astroparticle Physics (HECAP) in Latin American have come together to discuss and provide scientific input towards the development of a regional strategy for these fields of knowledge. The strategy, LASF4RI for HECAP, is coordinated with the Highest Authorities of Science and Technology of the region and scaled to the Heads of States. LASF4RI is unfolded in two main avenues: the development of new experiments/facilities in the region and the construction of synergies for a more compelling and coordinated participation in global projects.
Neutrinos constitutes a fundamental part of LASF4RI, with a significant participation of Latin American scientists and engineers both in experiments trying to pin down the fundamental nature and properties of neutrinos, as well as in experiments using neutrinos as a probe. Groundbreaking applications are also seen in the horizon, specifically in emerging technologies for Nuclear Safeguards with a regional hallmark. Theorists in the region address a wealth of physics domains including precision oscillation measurements, neutrinos cross-sections, non-standard interactions, CP-violation, new neutrino states, astrophysical neutrinos, etc.
This contribution presents the status of LASF4RI from the Neutrino perspective, with a focus on strengthening the synergies between experimentalists and theorists towards common and coordinated targets along working groups in the COlombian Network of High Energy Physics (CONHEP). Furthermore, the strategic leverage on accessible infrastructures and science framed into global data analysis networks.

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Front-end readout electronics for the PDS-SP of the DUNE Experiment.

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The Deep Underground Neutrino Experiment (DUNE) is an international collaboration under construction in the USA. Colombian institutions are involved in the development of the DUNE experiment and are a good example of how Latin American countries can contribute efectivelly to a mega-science experiment. This talk summarizes the Colombian activities in the design of the front-end readout electronics (DAPHNE) for the photon detection system of DUNE and presents the perspectives for the future regional working around the project.

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The effective number of neutrinos: towards a precise calculation in the SM

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The effective number of neutrinos (Neff) is an important cosmological parameter that measures the amount of radiation in the early Universe. Its precise value is necessary to put constraints to models beyond the SM that require extra radiation in the Universe. In the recent years, the progress made in the knowledge about the relevant physical processes that affect the calculation of Neff have allowed the development of a new code for its precise calculation. I will discuss the results of such calculation, focusing on the remaining uncertainties and the improvements made with respect to previous computations.

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Sensitivities on NSI parameters from NOvA

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Through the study of neutrino oscillations at the long-baseline NOvA Experiment, it is possible to explore some aspects of physics Beyond the Standard Model (BSM) on the neutrino sector. In this talk, we discuss the current status of the sensitivities on Non-Standard Interactions (NSI) parameters based on the muon (anti)neutrino disappearance simulated data. We focus on how the NSI flavor-changing parameters $|\varepsilon_{\mu\tau}|$ and $\delta_{\mu\tau}$ affect the determination of the standard oscillation parameters $\sin^2(\theta_{23})$ and Δm^2_{32}, and show the relation between each parameter.

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LED

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Neutrino experiments as constraints on Effective Field Theory

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We will discuss how to systematically study physics beyond the standard model (BSM) in the neutrino experiments within the standard model Effective Field Theory (SMEFT) framework. In this way, the analysis of the data can capture large classes of models, where the new degrees of freedom have masses well above the relevant energy for the experiment. Moreover, it allows to compare several experiments in a unified framework and in a systematic way. The approach could be applied to several short- and long baseline neutrino experiments. We will show the results of this approach at the FASERν experiment, installed 480 m downstream of the ATLAS interaction point, as well as the Daya Bay and RENO experiments. For some coupling structures, we find that FASERν will be able to constrain interactions that are almost three orders of magnitude weaker than the Standard Model weak interactions, implying that FASERν will be indirectly probing new physics at the 10 TeV scale.

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Complementarity between dark matter direct searches and CEν\nuνNS experiments in U(1)' models

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We explore the possibility of having a fermionic dark matter candidate within $U(1)'$ models for CEνNS experiments in light of the latest COHERENT data and the current and future dark matter direct detection experiments. A vector-like fermionic dark matter has been introduced which is charged under $U(1)'$ symmetry, naturally stable after spontaneous symmetry breaking. We perform a complementary investigation using CEνNS experiments and dark matter direct detection searches to explore dark matter as well as Z' boson parameter space. Depending on numerous other constraints arising from the beam dump, LHCb, BABAR, and the forthcoming reactor experiment proposed by the SBC collaboration, we explore the allowed region of Z' portal dark matter.

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Unveiling the Majorana nature of neutrinos via precision measurement of the CP violation

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The interaction of an (external) decoherence environment with a neutrino system can turn on the Majorana phases in the neutrino oscillation channels $\nu \to \nu$ and and $\bar{\nu} \to \bar{\nu}$. As a consequence, and relying upon the value of the Majorana phase and the magnitude of the leading decoherence parameter, a distorted measurement of the Dirac *CP* violation phase $\delta_{\rm CP}$ at DUNE is expected. This distortion would be evident by the disagreement between the CP violation measurements that will

take place in DUNE and T2HK. An exploration of the measurement of the Majorana phase at DUNE is also displayed.

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JUNO and the Neutrino Mass Ordering

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The neutrino mass ordering is one of the most pressing unknowns in neutrino physics. This measurement is a flagship of the JUNO reactor neutrino oscillation experiment. In this talk we will discuss the role JUNO can play in the unraveling of the neutrino mass ordering at 3σ or better before the end of the decade.

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A prototype model for quasi-Dirac neutrinos

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In this talk, we will discuss a prototype model for quasi-Dirac neutrinos. Light neutrino mass is still explained by a seesaw mechanism involving new heavy fermion degrees of freedom (heavy neutrinos). In the limit of lepton number conservation (at the Lagrangian level), we have the Dirac seesaw mechanism. Once small lepton number violation is introduced, both light and heavy neutrinos will respectively be split into quasi-Dirac pairs. While the mass splitting is a priori a free parameter (depending on the lepton number violating parameters in the theory), once one impose the condition of successful low scale (sub TeV) leptogenesis, intriguingly, the mass splitting for light neutrinos falls in the regime testable in neutrino oscillation experiments.

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An ultraviolet completion for the Scotogenic model

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The Scotogenic model is an economical scenario that generates neutrino masses at the 1-loop level and includes a dark matter candidate. This is achieved by means of an ad-hoc $\mathbb{Z}_2$ symmetry, which forbids the tree-level generation of neutrino masses and stabilizes the lightest $\mathbb{Z}_2$-odd state. Neutrino masses are also suppressed by a quartic coupling, usually denoted by λ_5. While the smallness of this parameter is natural, it is not explained in the context of the Scotogenic model. We construct an ultraviolet completion of the Scotogenic model that provides a natural explanation for the smallness

of the λ_5 parameter and induces the $\mathbb{Z}_2$ parity as the low-energy remnant of a global $\mathrm{U}(1)$ symmetry at high energies. The low-energy spectrum contains, besides the usual Scotogenic states, a massive scalar and a massless Goldstone boson, hence leading to novel phenomenological predictions in flavor observables, dark matter physics and colliders.

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ULDM signatures in neutrino oscillation experiments

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ULDM signatures in neutrino oscillation experiments

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Studying final state interaction with neutrino experiments

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The interactions between neutrinos and target nuclei resting in neutrino detectors are demanding to study both experimentally and theoretically. Thus, systematic uncertainties in neutrino interaction cross sections are usually the largest uncertainties reported by long-baseline neutrino oscillation experiments. Recent experimental results on Final State Interactions (FSI) show that theoretical models programmed into neutrino cross section simulators are not accurately representing the observed outputs. Currently, experimental studies are ahead of their theoretical counterparts. However, resourceful theoretical models are under development to explain the novel data. Neutrino experiments, at the front of the new findings, use various statistical techniques to tune available theoretical cross section models seeking better fits to the experimental results. The tunes do close the gap between theory and experiment, although not for all energies. This work summarized the latest attempts to tune the neutrino cross section simulators and the resulting agreements with the state-of-the-art experimental results.

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Physics opportunities of coherent elastic neutrino-nucleus scattering experiments

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An ongoing program for additional measurements of coherent elastic neutrino-nucleus scattering (CEvNS) is currently under development. Experimental facilities include nuclear power plants, multiton dark matter detectors as well as Ge and NaI detectors at the spallation neutron source. These

experiments will provide information on nuclear properties, standard model parameters and the possible presence of new physics. In this talk I will discuss some of these opportunities including the possibility of using these facilities for axion-like particle searches.

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Phenomenology of the Zee model for Dirac neutrinos and general neutrino interactions

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The Zee model for Dirac neutrinos is one of the simplest models featuring one-loop Dirac neutrino masses. The interactions between the new scalars (two singly-charged fields) and neutrinos induce general neutrino interactions (GNI) which, as a generalisation of the non standard neutrino interactions, constitute an additional tool to probe models beyond the SM like this. In this work, we consider a $U(1)_{B-L}$ gauge symmetry as the responsible for the Diracness of the neutrinos and the radiative character of the neutrino masses. We determine the viable parameter space consistent with neutrino oscillation data, leptonic rare decays and collider constraints, and establish the most relevant experimental prospects regarding lepton flavor violation searches and GNI in future solar neutrino experiments.

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Anomaly-free Abelian gauge symmetries with Dirac seesaws

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We perform a systematic analysis of Standard Model extensions with an additional anomaly-free gauge $U(1)$ symmetry, to generate tree-level Dirac neutrino masses. An anomaly-free symmetry demands nontrivial conditions to the charges of the unavoidable new states. An intensive scan was performed, looking for solutions generating neutrino masses by the type-I and type-II tree-level Dirac seesaw mechanism, via operators with dimension 5 and 6, that correspond to active or dark symmetries. Special attention was paid to the case featuring no extra massless chiral fermions.

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Concluding remarks