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Status of Neutrino Elastic-scattering Observation with NaI(Tl) experiment

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The Neutrino Elastic Scattering Observation with NaI(Tl) (NEON) experiment aims to observe coherent elastic neutrino-nucleus scattering (CEvNS) using reactor electron antineutrinos with a 16.5 kg NaI(Tl) detectors. A novel crystal encapsulation technique has enhanced light collection efficiency, resulting in a yield of 22 to 25 photoelectrons per keV of light. The detection facility of the NEON experiment is situated within the tendon gallery of the Hanbit Nuclear Power Plant Unit 6 in Yeonggwang, South Korea that is 23.7 meters away from the reactor core. Physics data taking started in April 2022 and stable operation since resulted in collections of 461 days reactor-on data and 144 days off data. A background level of 7 counts/day/kg/keV at 0.6 keV was observed. In this presentation, I will provide an overview of the NEON experiment, as well as the analysis status for the low-energy regime to CEvNS observation.

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The Dark Hypercharge Symmetry

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$U(1)$ extension of the Standard Model (SM) is well motivated, where the charges of SM fermions are fixed by gauge anomaly cancellations and Yukawa interactions. The scientific literature extensively covers the study of vector solutions in which SM fermions are vector-like under new $U(1)_X$ symmetry, allowing the Yukawa structure to remain invariant. On the other hand, chiral solutions in which SM fermions are chiral under new symmetry are not well explored. In this work, we venture into these relatively unexplored chiral solutions. We introduced a comprehensive set of chiral solutions for gauge anomaly cancellation, incorporating three right-handed fermions (RHFs) while preserving the SM Yukawa structure. Remarkably, these RHNs emerge as promising candidates for Dark Matter (DM). We will demonstrate in a model-independent manner using only the Z' interaction channel, that the lightest RHF, denoted as F_1, is a viable DM candidate, and it can meet all current DM constraints with a mass of M_{F_1}
$gtrsim 150$ GeV.

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2. Majorana CP-violating phases and NSI effects in Neutrino Decay

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In this work, we have analysed how neutrino decay is affected in the presence of non-standard interactions (NSI). We also considered the effect of the Majorana phase on neutrino decay in a two-flavor oscillation framework. We have examined scenarios when these sub-leading effects (NSI and decay) can be distinguished. These effects are studied on neutrino oscillation probabilities Pαβ ≡ P(να⟶νβ), and the difference ΔPαβ ≡ P(να⟶νβ) − P(ν¯α⟶ν¯β) for several accelerator and reactor neutrino experiments. Our findings indicate that the impact of the Majorana phase on decay in matter can be mimicked by the combined presence of decay and NSI. However, accurate measurements of Pαβ and ΔPαβ observables have the potential to distinguish these individual sub-leading effects from their simultaneous presence.

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Neutrino mass sum rules from modular A_4 invariance

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Modular symmetries are a novel approach to understanding the flavour structure of leptonic mixing. Using the modular A_4 flavour symmetry integrated into a type-II seesaw, we propose a simple and minimalistic model that restricts the neutrino oscillation parameter space. Most importantly, this setup leads to a sum rule in the physical neutrino masses. When combined with the mass squared differences observed in neutrino oscillations, this sum rule determines the absolute neutrino mass scale. This has significant implications for cosmology, neutrinoless double beta decay experiments, and direct neutrino mass measurements. In particular, the model predicts $\sum_i m_i \approx 0.1$ eV for both normal and inverted ordering, and thus can be fully probed by the current generation of cosmological probes in the upcoming years. Furthermore, our model has precise predictions for mixing angles which can be tested in future experiments.

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Calculating the Total Cherenkov Radiation Emitted by Low-Energy Proton in Liquid Argon (LAr) and Comparing with Argon Scintillation Light at 128 nm

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Neutrino experiments using liquid argon (LAr) detectors estimate the amount of light produced by different types of particles, but only consider scintillation light, at 128 nm, ignoring Cherenkov light contributions. This research aims to theoretically compare these two contributions to the total amount of light produced between ~ 128 −500 nm for a proton travelling in LAr and explores how to leverage these under-utilized observables for future detector applications.

A new theoretical fit of the refractive index of LAr was performed using recent experimental data, which incorporates the physics of anomalous dispersion in the UV resonance for the first time. Using this fit, we integrate the Frank-Tamm (FT) formula to calculate the instantaneous Cherenkov angular distribution and yield of a proton with a given kinetic energy, as well as the integrated distribution and yield over its trajectory. We compare our results with those obtained using two other non-absorptive refractive index fits available in the literature. Because those fits diverge at the resonance, they significantly overestimate the yield.

Additionally, Cherenkov radiation is highly collimated and emitted instantaneously, whereas scintillation light is isotropic and emitted after a delay. This fundamental difference in their angular distribution (AD) sets the ground for differentiating the Cherenkov signal over the scintillation background, resulting in a substantial observational effect $> 5\sigma$ for $\sim$ 500 MeV protons in LAr. This suggests that measurements of the collimated Cherenkov radiation could be used to measure the energy and direction of the incident protons more precisely in detector applications.

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Astrophysical neutrino search at sub-GeV energies in IceCube

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The IceCube Neutrino Observatory is sensitive from 0.5 GeV to the PeV energy range for astrophysical neutrino searches. In addition, the supernova Data Acquisition System (DAQ) allows the collaboration to be sensitive to close-by core-collapse supernovae at MeV energies. There exists, however, a gap between these covered energy ranges. This poster presents ongoing efforts to cover this gap. We will discuss various strategies to reach this goal through the use of HitSpool, a specific DAQ within IceCube, and the construction of a new event selection based on machine learning and citizen science.

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Quantum field formalism of neutrino oscillations

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The primary objective of this work is to investigate the neutrino oscillation phenomenon by utilizing wave packets within the theoretical frameworks of quantum field theory. The standard scenario involving three light neutrinos mixing is known as coherence conditions. These conditions specify that the oscillation equation obtained from plane waves precisely corresponds to the wavelet equation identified in quantum mechanics and quantum field theory. In exploring physics beyond the standard model, conventional calculations have used plane wave approximation to determine oscillation probabilities. We aim to enhance the framework by employing quantum mechanics and quantum field theory wave packets within these beyond-standard models. We aim to investigate whether specific experimental outcomes can be clarified by combining physics beyond the standard model and a thorough application of quantum field theory.

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CP violation due to a Majorana phase in two flavor neutrino oscillations with decays

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We study the conditions under which the Majorana phase of the two flavor neutrino mixing matrix appears in the oscillation probabilities and causes CP violation. We find that the Majorana phase remains in the neutrino evolution equation if the neutrino decay eigenstates are not aligned with the mass eigenstates. We show that, in general, two kinds of CP violation are possible: one due to the Majorana phase and the other due to the phase of the off-diagonal element of the neutrino decay matrix. We find that the CP violating terms in the oscillation probabilities are also sensitive to neutrino mass ordering.

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Leptogenesis in a Left-Right Symmetric Model with double seesaw

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We explore the connection between low-scale CP-violating Dirac phase~(δ) and high-scale leptogenesis in a Left-Right Symmetric Model (LRSM) with scalar bidoublet and doublets. The fermion sector of the model is extended with one sterile neutrino~(S_L) per generation to implement a double seesaw mechanism in the neutral fermion mass matrix. The double seesaw is performed via the implementation of type-I seesaw twice. The first seesaw facilitates the generation of Majorana mass term for heavy right-handed (RH) neutrinos~(N_R), and the light neutrino mass becomes linearly dependent on S_L mass in the second. In our framework, we have taken charge conjugation (C) as the discrete left-right (LR) symmetry. This choice assists in deriving the Dirac neutrino mass matrix (M_D) in terms of the light and heavy RH neutrino masses and light neutrino mixing matrix U_{PMNS} (containing δ). We illustrate the viability of unflavored thermal leptogenesis via the decay of RH neutrinos by using the obtained M_D with the masses of RH neutrinos as input parameters. A complete analysis of the Boltzmann equations describing the asymmetry evolution is performed in the unflavored regime, and it is shown that with or without Majorana phases, the CP-violating Dirac phase is sufficient to produce the required asymmetry in the leptonic sector within this framework for a given choice of input parameters. Finally, we comment on the possibility of constraining our model with the current and near-future oscillation experiments, which are aimed at refining the value of δ.

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Probing new physics at Long Baseline Experiments via Scalar NSI

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The phenomena of neutrino oscillations which confirms the non-zero masses of neutrinos, is the first firm experimental evidence of physics beyond the Standard Model(SM). According to SM neutrinos interact with matter through weak interactions mediating a W or Z bosons. The models describing Beyond Standard Model (BSM) physics often come with some additional unknown coupling of neutrinos termed as, non standard interactions(NSIs). The idea of neutrino NSI was initially proposed by Wolfenstein where the NSI is mediated by a vector boson. However, there is also a possibility of neutrinos to couple with a scalar field, which can offer unique phenomenology in neutrino oscillations. This type of scalar NSI appears as a medium-dependent correction to the neutrino mass term, which makes its effect interesting to probe further.

In this work, we have probed the impact of a scalar NSI in the long baseline sector, focussing at the three upcoming long-baseline (LBL) experiments: DUNE, T2HK and T2HKK. We show that the presence of scalar NSI may significantly impact the oscillation probabilities as well as the event rates at the detectors and the $\chi 2$ -sensitivities of CP measurements of the experiment. We also show that, a synergy among the LBL experiments (DUNE+T2HK, DUNE+T2HKK) may offer a better capability of constraining the scalar NSI parameters as well as an improved sensitivity towards CP-violation.

Keywords: Neutrino Oscillations, Non Standard Interactions, Beyond Standard Model.

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Optimization of neutron tagging for DSNB search in SK-Gd

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For the detection of diffuse supernova neutrino background (DSNB), the SK-Gd experiment had been started with 0.01% gadolinium (Gd) concentration (SK-VI) since August 2020, and then the concentration was increased to 0.03% (SK-VII) in July 2022. We achieved the anti-electron neutrino sensitivity by detecting the total 8MeV gamma from Gd neutron capture.
We also developed a neural network (NN) that selects the neutron capture events and rejects the BG events effectively. In this study, we evaluated the neutron capture efficiency in both SK-VI and SK-VII using the NN, and obtained higher capture efficiency than the conventional method with low BG contamination. Using this NN, we have performed the first DSNB search analysis with SK-VII data and will show the results.

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Inclusion of Daya Bay results to constrain neutrino oscillation parameters in T2K analyses

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The Tokai to Kamioka (T2K) experiment is a long baseline neutrino experiment in Japan which aims to measure neutrino oscillation parameters and perform a search for CP violation in the lepton sector. One of the analysis packages used to perform the neutrino oscillation fits in T2K is the

Bayesian MaCh3 Markov Chain Monte Carlo package. As part of this package, external constraints can be used as inputs. In this poster, I will show how two-dimensional parameters released by the Daya Bay Collaboration correlating θ_{13} and Δm^2_{32}, depending on the mass ordering, can be used to potentially improve the constraints on the neutrino oscillation fit parameters from the Bayesian posterior distributions.

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Performance and opportunities of the trigger system for the ICARUS-T600 detector, exposed to the Booster and NuMI neutrino beams

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The ICARUS-T600 liquid argon time projection chamber (LArTPC) detector is currently taking data at shallow depth as the far detector of the Short Baseline Neutrino program at Fermilab, to search for a possible sterile neutrino signal at $\Delta m^2 \approx 1$
$textnormaleV^2$ with the Booster (BNB) and Main Injector (NuMI) neutrino beams.
The ICARUS trigger system exploits the coincidence of the 1.6 and 9.6 μs BNB and NuMI beam spills with the prompt scintillation light signals produced by ionizing particles in LAr and detected by 360 8" photo-multiplier tubes (PMTs).
Due to the 0–2 GeV (0–5 GeV) neutrino energy range of BNB (NuMI), neutrino interactions are on average contained in a 4-m length along the beam direction, motivating a trigger based on a PMT-multiplicity inside limited TPC regions.
The first trigger efficiency measurement leverages cosmic ray data collected with a minimum-bias trigger, without imposing any scintillation light requirement, and the timing from an external cosmic ray tagger system.
The efficiency with a highly-pure stopping muon sample saturates at $E_\mu \approx 300$ MeV, covering most of the BNB and NuMI charged-current neutrino interactions.
For the latest ICARUS run, the PMT-multiplicty threshold is being lowered to further improve the low-energy trigger detection efficiency.
Special *adder* boards, performing the analog sum of scintillation light signals in limited TPC portions, are being introduced as an additional trigger system to possibly recover low-energy neutrino interactions close to the PMTs.
Finally, the ns-scale timing resolution is being leveraged to reconstruct the bunched structures of the BNB and NuMI beams, with the aim of eventually introducing an off-line time-based trigger to cut in-between bunches, rejecting cosmic rays with high efficiency while retaining neutrino interactions with high purity.

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A minimalist flavour symmetry for neutrinos: modular S_3

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In the recent past, substantial effort has been devoted to exploring flavour symmetries to solve the flavour puzzle. However, traditional flavour symmetry models proved to be quite unsatisfactory. In 2017, a new 'bottom-up' approach based on modular invariance was suggested, wherein the Yukawa couplings of the Standard Model become modular forms. Within this framework, we addressed the following question: is it possible to employ the smallest and most minimal modular group S_3 to construct predictive neutrino mass models? As demonstrated in our work, the answer is affirmative if we assume a certain set of guiding principles that fully exploit modular invariance.

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KATRIN sterile neutrino analysis

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Light sterile neutrinos with a mass at the eV-scale could explain several anomalies observed in short-baseline neutrino oscillation experiments. The Karlsruhe Tritium Neutrino (KATRIN) experiment is designed to determine the effective electron anti-neutrino mass via the kinematics of tritium β–decay. The precisely measured β-spectrum can also be used to search for the signature of light sterile neutrinos. In this poster we present the status of the light sterile neutrino analysis of the KATRIN experiment. The analysis contains data from the first five measurement campaigns and the obtained sensitivity is compared to current results and anomalies in the field of light sterile neutrinos.
This work received funding from the European Research Council under the European Union Horizon 2020 research and innovation programme, and is supported by the Max Planck Computing and Data Facility, the Excellence Cluster ORIGINS, the ORIGINS Data Science Laboratory and the SFB1258.

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Probing generalized neutrino interactions with the DUNE Near Detector

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DUNE is a long-baseline neutrino oscillation experiment that will utilize a high-intensity, wide-band neutrino beam generated at Fermilab and traveling 1300 km to the Sanford Lab in South Dakota. It is a two-detector experiment with a 70 kt Liquid Argon Far Detector at Sanford Lab that will mainly study neutrino oscillations, and a Near Detector (ND) at Fermilab with a main purpose to study the unoscillated neutrino beam. However, the ND taking advantage of the most intense neutrino beam world-wide will be able to conduct a large suite of novel new physics searches. In this work, we explore the prospects of constraining general non standard interactions involving light mediators through elastic neutrino-electron scattering events at the DUNE ND. We furthermore explore. the sensitivity in light vector mediators motivated by several Beyond the Standard Model (BSM) models. The present analysis is based on detailed Monte Carlo simulations of the expected DUNE-ND signal taking into account detector resolution effects, realistic backgrounds as well as both On-Axis and Off-Axis neutrino spectra. We show that the high intensity neutrino beam available at Fermilab can place competitive constraints surpassing those of low-energy neutrino searches and direct detection dark matter experiments.

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Central Molecular Zone expectations using KM3NeT data

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The Central Molecular Zone is a specific region of few hundred parsecs in the centre of our Galaxy that has an estimated gas density two orders of magnitude larger than the galactic average one and represents 5% of the whole galaxy gas mass. It contains some of the most massive molecular clouds such as Sgr A, Sgr B, and Sgr C as well as potential local Pevatrons. These conditions underline a privileged target where to find out a signature of Galactic cosmic ray interactions.
A preliminary diffuse neutrino study from the Central Molecular Zone using KM3NeT data is reported. We show the level of the actual and future KM3NeT ARCA geometries for this source.

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The First Search for High-Energy Neutrino Emission from Galaxy Mergers

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The exact sources of high-energy neutrinos detected by the IceCube neutrino observatory still remain a mystery. For the first time, this work explores the hypothesis that galaxy mergers may serve as sources for these high-energy neutrinos. Galaxy mergers can host very high-energy hadronic and photohadronic processes, which may produce very high-energy neutrinos. We perform an unbinned maximum-likelihood-ratio analysis utilizing the galaxy merger data from six catalogs and 10 years of public IceCube muon-track data to quantify any correlation between these mergers and neutrino events. First, we perform the single source search analysis, which reveals that none of the considered galaxy mergers exhibit a statistically significant correlation with high-energy neutrino events detected by IceCube. Furthermore, we conduct a stacking analysis with three different weighting schemes to understand if these galaxy mergers can contribute significantly to the diffuse flux of high-energy astrophysical neutrinos detected by IceCube. We find that upper limits (at 95% c.l.) of the all flavour high-energy neutrino flux, associated with galaxy mergers considered in this study, at 100 TeV with spectral index $\Gamma = -2$ are 2.57×10^{-18}, 8.51×10^{-19} and 2.36×10^{-18} $\mathrm{GeV}^{-1}\,\mathrm{cm}^2\,\mathrm{s}^{-1}\,\mathrm{sr}^{-1}$ for the three weighting schemes. This work shows that these selected galaxy mergers do not contribute significantly to the IceCube detected high energy neutrino flux. We hope that in the near future with more data, the search for neutrinos from galaxy mergers can either discover their neutrino production or impose more stringent constraints on the production mechanism of high-energy neutrinos within galaxy mergers.

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Search for "mini-burst" supernova neutrinos in Super-Kamiokande

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Super-Kamiokande (SK) is known as the most sensitive detector to the supernova neutrinos originating in our galaxy.
SK also has a sensitivity to neutrinos from the extra-galactic supernova within 10 Mpc from Earth, called a "mini-burst", which is expected to occur once every few years. Recently, SN2023ixf, one of the mini-bursts, is recognized as the closest supernova in the last few years. Mini-bursts like SN2023ixf have been reported in worldwide telescopes in past decades. Therefore, we searched supernova neutrinos from the mini-burst from the time when SK started (1996) to the present (2024). This poster shows the search results of the "mini-burst neutrino"search and their detection probability, including extra-galactic regions, in SK.

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High Precision Reactor Antineutrino Oscillations in JUNO

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The Jiangmen Underground Neutrino Observatory (JUNO) experiment is a multipurpose neutrino experiment under construction in South China. This next-generation large-scale detector, featuring a 20-kiloton liquid scintillator target, is primarily designed to study reactor antineutrinos emitted from two nearby nuclear power plants.
JUNO sits at a baseline of approximately 52.5 km, corresponding to the first solar oscillation maximum, where the kinematic phase $\Delta_{21} \simeq \frac{\pi}{2}$. This medium baseline configuration allows for the exploration of three generation effects, making it the first experiment to simultaneously probe oscillations on both the solar and atmospheric scales.

JUNO's primary scientific objective is to determine the Neutrino Mass Ordering (NMO), a fundamental, yet unsolved, question in neutrino physics. Thanks to its strategic location and expected high energy resolution, JUNO is sensitive to the energy-dependent phase shift in the antineutrino oscillated spectrum arising from different mass orderings. This approach, based on vacuum-dominant oscillations, also offers a complementary perspective to Long Baseline (LBL) accelerator experiments, which instead leverage matter effects. Beyond its main goal, JUNO is projected to achieve subpercent precision for three oscillation parameters, Δm^2_{31}, Δm^2_{21}, and $\sin^2\theta_{12}$, already exceeding the current state-of-the-art in the early stages of data-taking. Such unprecedented precision offers the opportunity to test the standard 3-neutrino paradigm and potentially unveil new physics scenarios.

This poster will focus on JUNO's significant impact on the global neutrino oscillation physics landscape, opening a new era of high-precision measurements. In particular, it will cover JUNO's sensitivity to oscillation parameters, its synergy with LBL experiments for the NMO determination, and prospects to constrain the unitarity of the PMNS mixing matrix through a precise measurement of the Electron Row Unitarity (ERU).

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Searches for High-Energy Astrophysical Neutrino Sources in Super-Kamiokande

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In this study we present the results of the searches for high-energy astrophysical neutrino point sources in the energy region above GeV using Super-Kamiokande data taken from 1996 to 2019 with total live time exceeding 6,000 days. The searches include time-integrated and time-dependent full sky searches for both muon and electron neutrino sources and coincidence check with candidates including TXS 0506+056 and NGC 1068. The searches use unbinned maximum likelihood method, and test statistics is calculated to find signal excess over atmospheric neutrino background. The time-integrated search method is updated from a previous search by adding the neutrino energy distribution in the likelihood to consider different power-law emission spectra with varying spectral indices. This is the first time to perform the time-dependent search, which has a better performance in searching for neutrino emission in a short time, in Super-Kamiokande. Upper limits on neutrino flux or fluence are set for all searches.

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High-Angle TPCs for T2K ND280 Upgrade

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The T2K ("Tokai to Kamioka") experiment in Japan is a long baseline neutrino oscillation experiment, which studies the neutrino oscillation parameters using a beam of neutrinos. The experiment consists of two detector complexes, a near detector, ND280, to characterize the beam before oscillation and a far detector, SuperKamiokande, at 295km to measure the oscillated neutrino spectrum. One of the major goals of the T2K experiment is to measure the �CP violation term. The collaboration published in 2020 the first measurement of the leptonic CP violation, To increase the significance of the result to above 3sigma, it was decided to upgrade the neutrino beam and the ND280 detector. The latter consists of the installation of three new subdetectors in ND280: a 3-D plastic scintillator Super-Fine Grained Detector(SuperFGD), two High Angle-Time Projection Chambers (HA-TPC), and 6 planes of Time Of Flight (ToF) panels.
While the SuperFGD serves as the target for the neutrinos, the HA-TPCs are used to reconstruct the tracks leaving the SuperFGD, to measure the particle momenta, and to identify the particle types. These HA-TPCs have an overall dimension of 2 × 2 × 0.8 m3 each and each endplate is equipped with 8 Encapsulated Resistive Anode MicroMegas (ERAM) modules for gas amplification.
An overview of the work for the HA-TPCs will be shown, from studies using test beam data taken at CERN until the installation of the TPCs in ND280.

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Combined Pre-supernova Alert System with KamLAND and Super-Kamiokande

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As a pre-supernova star approaches the end of its life, neutrinos are emitted copiously with mounting energies. Although these neutrinos have a smaller luminosity compared to supernova neutrinos, they are potentially detectable by large-scale terrestrial detectors. In consideration of these neutrinos being a signal of the impending supernova, KamLAND and Super-Kamiokande have established pre-supernova alert systems in 2015 and 2021, respectively. Recently, through a joint study, Super-Kamiokande and KamLAND have developed a combined pre-supernova alert system, extending the warning time and coverage. The expected warning time and coverage for various of pre-supernova neutrino models are estimated. We present in detail the combined pre-supernova alert system, as well as the improvement on the sensitivities to pre-supernova neutrinos.

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Design and first tests of the MANGO scattering setup for characterization of liquid scintillators

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Detectors for low-energy particles (MeV) are often calibrated using gamma rays to induce electron-like signals. Yet the energies of standard calibration sources are often not sufficient. For instance, the JUNO reactor neutrino experiment requires excellent understanding of the energy response to energies of 8 MeV and higher. The MANGO experiment will use 9 MeV gamma rays from neutron capture on nickel to characterize scintillator samples. Neutrons are produced by a DD108 fusion generator, which creates mono-energetic neutrons of 2.45 MeV that can also be directly used for neutron irradiation of the detector. Using a secondary detector array of neutron and gamma detectors, the energy and momentum direction of the scattered particles can be determined. This additional information can help to relate the visible scintillation signal to the deposited energy and thus to investigate non-linearity or quenching of the scintillator response. This contribution presents the setup as well as first tests of the experimental components. Once MANGO is fully constructed and understood, it will be used for the characterization of the liquid scintillator of the JUNO neutrino detector.

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Evaluation of a new muon monitor sensor for the T2K experiment using the J-PARC neutrino beam

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The Tokai to Kamioka (T2K) experiment is a long baseline neutrino experiment in Japan. We measure neutrino oscillations in the T2K experiment by using an almost pure muon neutrino beam produced at J-PARC accelerator facility. In December 2023, J-PARC achieved operation at 760 kW, exceeding its original design power. The T2K experiment plans to further increase the proton beam power to 1.3 MW to increase the statistics.

The T2K has the muon monitor (MUMON) that indirectly monitors the neutrino direction and intensity. MUMON measures muons produced along with neutrinos in the decay of pions in real time. Although MUMON has successfully measured at the current beam intensity, we expect certain issues with MUMON senser in future operation with higher intensity beams such as radiation damage. Sensors that are more radiation tolerant are desired for future operation of MUMON. An electron multiplier tube (EMT) is one candidate. Previous beam tests and investigations using the prototypes installed at J- PARC have shown that the EMTs fulfill the requirements for MUMON at future beam intensity. Based on these results, seven EMTs were installed inside MUMON in January 2023. The results of muon beam measurements in T2K neutrino beam operation using these EMTs will be presented.

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A novel optical imaging system for the LAr detector GRAIN

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DUNE is a leading-edge experiment for neutrino oscillation physics and is currently under construction in the United States, between Fermilab, where neutrino beam is generated, and the SURF underground laboratory, in South Dakota, hosting the Far Detector at a depth of 4,850 mwe and at a baseline of nearly 1,300 km.
GRAIN (GRanular Argon for Interactions of Neutrinos) is the Liquid Argon detector of SAND (System for On-Axis Neutrino Detection), which is part of the DUNE Near Detector complex.
SAND is expected to significantly decrease uncertainties related to neutrino flux and cross-sections. Additionally, SAND will have the capacity to monitor the beam stability, and to investigate various neutrino interactions models, constraining at the same time nuclear effects. A key element of SAND is GRAIN, which will serve as a Liquid Argon target for detecting neutrinos and low-energy particles, ensuring cross-calibration with the other Near Detector components.
This poster will discuss the novel GRAIN system designed for reconstructing charged particle tracks in LAr. It is based on the detection of scintillation light by an optical system optimised for the Vacuum Ultra-Violet, coupled to SiPM matrices. Another research topic that will be described concerns the development of a cryogenic, 1024-channel ASIC, able to read 32x32 SiPM matrices.

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The SBND TPC Readout System

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The Short Baseline Near Detector (SBND) is a liquid argon time projection chamber (LArTPC) that works, effectively, as a high-resolution stereoscopic "video camera". The detector streams 3D images of ionization deposition from neutrino interactions within a large, uniform liquid argon volume. To achieve this, anode wire signals from these ionization electrons are turned into continuous digitized waveforms by cold electronics inside the detector. These waveforms are then passed to the (warm) TPC readout system outside the cryostat. The warm readout system was custom designed by Columbia University's Nevis Laboratories, based on the functionally identical and successful readout system for the MicroBooNE experiment. It responds to external triggers (e.g. beam triggers in coincidence with light information), to extract 1.8 ms'worth of waveform data that is losslessly compressed using Huffman encoding. This Huffman compressed data is then sent to the rest of the data acquisition system (DAQ) to be built into triggered "event records". The collection of high quality data during detector operation relies on thorough testing of the readout system under real data-taking conditions. In addition, understanding the performance of the readout system offers direction for future LArTPC readout and trigger development, facilitated by the integration of an independent stream of continuous data. In this poster, I will describe the SBND TPC readout system and present the status of readout commissioning, including testing of DAQ stability and the online TPC data-quality monitoring system.

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The SAND detector for the DUNE experiment

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The Deep Underground Neutrino Experiment (DUNE) is a next-generation project aiming to study several neutrino properties. It will feature two experimental setups: a near detector that will be installed at Fermilab, in proximity of the neutrino-production point, and a far detector at a distance of 1300 km and 1500 m underground, at the SURF laboratory. The DUNE design and configuration will allow the study of neutrino oscillation, astrophysical neutrinos, and beyond standard model physics. The near detector complex foresees three detectors to be installed. Among these, the System for on-Axis Neutrino Detection (SAND) will serve as on-axis beam monitor, reduce the systematic uncertainties for the oscillation analysis, and search for physics beyond the standard model. SAND will be composed of three sub-detectors, surrounded by a 0.6 T superconducting magnet. The outermost detector will be a lead/scintillating-fiber electromagnetic calorimeter while the inner volume will include a 1-ton liquid argon active target placed upstream followed by a target tracker system. The SAND detector and its goals will be shown in this poster.

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The SAND tracking system at the DUNE Near Detector

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Within the DUNE next-generation neutrino oscillation experiment, the Near-Detector complex has the main aim of constraining systematic uncertainties, in order to allow precise oscillation measurements. The SAND detector is one of the three components of the Near Detector complex. Its aim is to monitor the neutrino beam from an on-axis position and carry out neutrino cross section measurements on different target nuclei. SAND will leverage a 0.6 T superconducting magnet and a lead-scintillator fiber electromagnetic calorimeter. The inner magnetized volume of SAND will host a low-density tracker based on Straw Tubes (STT) and thin $(1-2\%\ X_0)$ passive target planes of various materials, capable of combining a relatively large mass (about 5 t) with high spatial and momentum resolution. Using alternating carbon and CH_2 targets, the STT will provide a high-statistics $\nu(\bar{\nu})-$ H CC ("solid hydrogen") interaction sample. This poster will present the physics program of the SAND tracker and the current status of the design and analysis activities, together with the R\&D on small scale prototypes.

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Detecting High-Energy Neutrinos from Galactic Supernovae with ATLAS

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ATLAS, a collider detector, can measure the flux of high-energy supernova neutrinos, which originate in the circumstellar medium from days to months after the explosion. Simulating predicted fluxes, we find at most around 0.1–1 starting events and around 10–100 throughgoing events from a supernova 10 kpc away. Possible Galactic supernovae from Betelgeuse and Eta Carinae are considered as demonstrative examples. We conclude that even with limited statistics, ATLAS has the ability to discriminate among flavors and between neutrinos and antineutrinos, making it a unique supernova neutrino observatory.

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Search for gravitational waves-neutrino correlations with KM3NeT using a binned likelihood framework

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Identifying cosmic objects that emit diverse messengers, such as photons, gravitational waves, and high-energy neutrinos, would provide unique insights into the properties and processes in the Universe and its active sources.
One of the most promising sources for common gravitational wave and neutrino emission are gamma ray bursts. From the release of a huge amount of energy in cosmic explosions in a short time and a small volume, relativistic jets of plasma are created. These jets are expected to emit neutrinos.
Such emission is likely associated to mergers of two neutron stars or neutron star-black hole mergers, but some models also predict that binary black hole mergers would have sufficient luminosity to power the acceleration of cosmic rays to the highest energies, providing neutrino emission.
KM3NeT is a deep-sea Cherenkov neutrino telescope currently under deployment in the Mediterranean Sea. It is playing an active role in multimessenger astronomy, owing to its sensitivity in an extended neutrino energy range (from MeV to PeV energies).
This contribution presents the general structure of a search for neutrino candidates in the KM3NeT data using a binned likelihood method. Interesting neutrino candidates must be spatially and temporally correlated with the gravitational wave events reported in the O4 catalogue by the LIGO-Virgo-KAGRA collaboration.

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Long-term performance and its stability of Hyper-Kamiokande PMTs in the SK water tank from 2018 to 2022

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For Hyper-Kamiokande(HK) experiment scheduled to be operational in 2027, HK PMTs are developed. For measuring the long-term variation of HK PMTs in water, 136 HK PMTs are installed in the Super-Kamiokande water tank which is suitable for realizing an environment close to HK. This poster presents long-term gain variations of HK PMTs from 2018 to 2022

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CUPID: a next-generation cryogenic $0\nu\beta\beta$ decay experiment

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CUPID (CUORE Upgrade with Particle Identification) is a next-generation experiment that will be located at the LNGS and will serve as an observatory for rare events. Its main goal is to search for

the neutrinoless double-beta decay of ^{100}Mo. It will include an array of around 1600 cubic $45 \times 45 \times 45$ mm^3 Li_2MoO_4 enriched crystals operating as scintillating cryogenic calorimeters inside the CUORE cryostat and infrastructure, now nearing the end of its data taking. The crystals, kept at around ∼15 mK and equipped with NTD thermometers, will allow for excellent energy resolution spectrometric measurements (heat channel). Each crystal, facing two Ge light detectors, will enable an active, event-by-event particle identification strategy by measuring the scintillation light emitted during each particle interaction (light channel). This double (heat + light) readout system ensures extremely low backgrounds in the region of interest (ROI) around the Q-value of ^{100}Mo (~ 3034 keV), significantly reducing the dominant background from degraded alpha particles originating from the decay of radioactive contaminants, currently the main source of background in the ROI for the CUORE experiment. The collaboration has already successfully operated a few demonstrators and prototypes and some more will be built in the near future. The experimental activity to validate and characterize the Li_2MoO_4 crystals is now ongoing and will provide very useful inputs for the finalization of the design of the CUPID detector.emphasized text

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Estimation of 85Kr background in the XENONnT using delayed coincidence count

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The dark matter direct detection experiment XENONnT searches for rare events such as dark matter recoils and solar pp neutrino signals. It requires accurate estimates of background events. The radioactive isotope 85Kr in the target material, liquid xenon, is one of background sources. To determine its abundance accurately, delayed coincidence counting of 85Kr has been introduced. This poster shows the details of this method, performance, and results.

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Shower Tagging and Energy Reconstruction in SND@LHC

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The Scattering and Neutrino Detector (SND@LHC) is a new experiment located in the TI18 tunnel at CERN, designed to measure neutrinos in an unexplored pseudo-rapidity region complementary to other experiments at the LHC. The detector consists of an 800 kg target of tungsten plates interleaved with emulsion and electronic trackers, followed downstream by a sampling calorimeter and a muon system. Its configuration allows for discriminating between all three neutrino flavours, which is particularly interesting for future circular colliders and predictions of high-energy atmospheric neutrinos. The first phase aims to run the detector throughout LHC Run 3 to collect 290 fb^{-1}.

The calorimetric information is crucial to estimate the energy of the shower produced by the incoming neutrino. For this reason, a dedicated test beam was used to compute the calorimeter response as a function of the hadron shower energy and of the shower origin in the target.

SND@LHC calorimeter is made of five Scintillating Fibers (SciFi) modules, interleaved with Tungsten walls (1.5 $_{int}$ total), and five Upstream (US) stations of scintillating bars, interleaved with Iron walls (9.5 $_{int}$ total).

This poster will present how the calibration was performed and the first application on physics data, estimating the shower energy of the first neutrino candidates identified.

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Search for time-dependent emissions of cosmic neutrinos with the KM3NeT/ARCA telescope

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The identification of astrophysical sources responsible for the high-energy cosmic neutrinos is a long-standing challenge. In this context, an important breakthrough was the observation of the blazar TXS 0506+056, which was found in an enhanced gamma-ray emission state spatially and temporally coincident with an IceCube high-energy neutrino event for the first time. Subsequently, IceCube archival data revealed a bright neutrino flare in 2014 without an electromagnetic counterpart. This suggests the search for flaring neutrino emissions, not necessarily associated to gamma-ray observations. A search for events clustering in space and time is being developed using data from the KM3NeT/ARCA (Astroparticle Research with Cosmics in the Abyss) undersea Cherenkov neutrino telescope. KM3NeT/ARCA is in construction in the Mediterranean Sea. It will have a volume of a cubic kilometer occupied by more than 4000 optical modules, distributed along 230 vertical detection units. The telescope will be sensitive to high-energy neutrino studies, from 100 GeV up to multi-PeV. Presently KM3NeT/ARCA is taking data with 28 detection units. The analysis approach outlined in this contribution exploits an unbinned likelihood framework, looking for a flare of astrophysical neutrinos possibly occurred during a set of search time windows. Data have been analyzed assuming a Gaussian-shape profile for the signal temporal emission.

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Investigating neutrino oscillation sensitivity using the 3D lepton momentum distribution

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One goal of DUNE is to precisely measure the ν oscillation parameters, with the aim of determining CP-violation in the lepton sector. To achieve this goal, it is vital to precisely reconstruct the neutrino energy, and to investigate the best projections and binning for DUNE to use. The 3D final state lepton momentum distribution can also be used to investigate oscillation sensitivity as a function of near/far projections and binnings that align with neutrino interaction systematic uncertainty group studies on DUNE.