NBIA Summer School on Neutrinos: Here, There & Everywhere

Report of Contributions

https://indico.nbi.ku.dk/e/2122

Contribution ID: **4** Type: **Oral**

Farewell & Intro of Niels Bohr Archive

Friday 11 July 2025 11:30 (30 minutes)

Contribution ID: **28** Type: **Oral**

Welcome

Monday 7 July 2025 09:15 (15 minutes)

Contribution ID: **107** Type: **Oral**

Prospects for detecting quark star features with IceCube

Monday 7 July 2025 14:36 (12 minutes)

This Master's Thesis explores the prospects of detecting the neutrino signal associated with a hadron-to-quark matter phase transition during core-collapse supernovae (CCSNe), a process that may lead to the formation of quark stars—compact and exotic objects composed of deconfined quark matter. By using state-of-the-art CCSN simulations that incorporate this first-order phase transition in the equation of state, the resulting neutrino emission was modelled. A particular focus is placed on the secondary burst of electron antineutrinos triggered by the transition that leads to a second collapse of the proto-neutron star into a quark star. A newly developed analysis framework is applied to assess the detectability of this feature using the IceCube Neutrino Observatory and its Gen-2 upgrade. Preliminary results, obtained using the ASTERIA simulation tool, show that this neutrino signal could be distinguished from background noise with high confidence, up to 5σ, for CCSNe occurring within the Milky Way and nearby galaxies such as the Large and Small Magellanic Clouds. These findings suggest that future neutrino observations could offer valuable insights into the QCD phase diagram and the internal composition of compact stellar remnants.

Primary author: DURÁN DE LAS HERAS, María (Uppsala University)

Presenter: DURÁN DE LAS HERAS, María (Uppsala University)

Session Classification: Student Talks

Contribution ID: **108** Type: **Oral**

Super-Kamiokande Strongly Constrains Leptophilic Dark Matter Capture in the Sun

Wednesday 9 July 2025 14:24 (12 minutes)

The Sun can efficiently capture leptophilic dark matter that scatters with free electrons. If this dark matter subsequently annihilates into leptonic states, it can produce a detectable neutrino flux. Using 10 years of Super-Kamiokande observations, we set constraints on the dark-matter/electron scattering cross-section that exceed terrestrial direct detection searches by more than an order of magnitude for dark matter masses below 100 GeV, and reach cross-sections as low as 4×10^{-41} cm^2.

Primary author: NGUYEN, Thong (Stockholm University)

Co-authors: WIDMARK, Axel (Stockholm University); CARENZA, Pierluca (Stockholm University); LINDEN, Tim (Stockholm University)

Presenter: NGUYEN, Thong (Stockholm University)

Session Classification: Student Talks

Contribution ID: **109** Type: **Oral**

Neutrino Astrophysics & Astronomy - Lecture I

Monday 7 July 2025 09:30 (1 hour)

Primary author: PETROPOULOU, Maria (National and Kapodistrian University of Athens)

Presenter: PETROPOULOU, Maria (National and Kapodistrian University of Athens)

Session Classification: Neutrino Astrophysics & Astronomy

Contribution ID: **110** Type: **Oral**

Neutrino Astrophysics & Astronomy - Lecture II

Tuesday 8 July 2025 11:00 (1 hour)

Primary author: PETROPOULOU, Maria (National and Kapodistrian University of Athens)

Presenter: PETROPOULOU, Maria (National and Kapodistrian University of Athens)

Session Classification: Neutrino Astrophysics & Astronomy

Contribution ID: **111** Type: **Oral**

Neutrino Astrophysics & Astronomy - Lecture III

Thursday 10 July 2025 11:00 (1 hour)

Primary author: PETROPOULOU, Maria (National and Kapodistrian University of Athens)

Presenter: PETROPOULOU, Maria (National and Kapodistrian University of Athens)

Session Classification: Neutrino Astrophysics & Astronomy

Contribution ID: **112** Type: **Oral**

Neutrino Cosmology - Lecture I

Monday 7 July 2025 11:00 (1 hour)

Primary author: POULIN, Vivian (Laboratoire Univers et Particules de Montpellier)

Presenter: POULIN, Vivian (Laboratoire Univers et Particules de Montpellier)

Session Classification: Neutrino Cosmology

Contribution ID: **113** Type: **Oral**

Neutrino Cosmology - Lecture II

Wednesday 9 July 2025 09:30 (1 hour)

Primary author: POULIN, Vivian (Laboratoire Univers et Particules de Montpellier)

Presenter: POULIN, Vivian (Laboratoire Univers et Particules de Montpellier)

Session Classification: Neutrino Cosmology

Contribution ID: **114** Type: **Oral**

Neutrino Cosmology - Lecture III

Friday 11 July 2025 09:30 (1 hour)

Primary author: POULIN, Vivian (Laboratoire Univers et Particules de Montpellier)

Presenter: POULIN, Vivian (Laboratoire Univers et Particules de Montpellier)

Session Classification: Neutrino Cosmology

Contribution ID: **115** Type: **Oral**

Neutrino Theory & Phenomenology - Lecture I

Tuesday 8 July 2025 09:30 (1 hour)

Primary author: TÓRTOLA, Mariam (IFIC/CSIC, Universitat de València)

Presenter: TÓRTOLA, Mariam (IFIC/CSIC, Universitat de València)

Session Classification: Neutrino Theory & Phenomenology

Contribution ID: **116** Type: **Oral**

Neutrino Theory & Phenomenology - Lecture II

Wednesday 9 July 2025 11:00 (1 hour)

Primary author: TÓRTOLA, Mariam (IFIC/CSIC, Universitat de València)

Presenter: TÓRTOLA, Mariam (IFIC/CSIC, Universitat de València)

Session Classification: Neutrino Theory & Phenomenology

Contribution ID: **117** Type: **Oral**

Neutrino Theory & Phenomenology - Lecture III

Thursday 10 July 2025 09:30 (1 hour)

Primary author: TÓRTOLA, Mariam (IFIC/CSIC, Universitat de València)

Presenter: TÓRTOLA, Mariam (IFIC/CSIC, Universitat de València)

Session Classification: Neutrino Theory & Phenomenology

Contribution ID: **118** Type: **Oral**

The ENUBET Demonstrator: beamtest characterization across the years

Tuesday 8 July 2025 14:12 (12 minutes)

The goal of ENUBET is to develop the first monitored neutrino beam for high precision cross section measurements, in which the neutrino flux in the Hyper-Kamiokande and DUNE energy range is inferred from the measurement of charged leptons in an instrumented decay tunnel. The systematic uncertainties that usually afflict the estimate of the neutrino flux are suppressed by measuring in an instrumental decay tunnel the associated charged leptons produced in the decay of the K.
The collaboration has recently completed the beamline design and tested the tunnel instrumentation technology with a large-scale prototype.
This talk will describe the Demonstrator, a large scale prototype of the instrumented decay tunnel (3 m long and 90° in the radial direction), consisting of a sampling calorimeter with longitudinal, azimuthal and radial segmentation and composed of iron and plastic scintillators, whose light is collected by WLS fibers and readout by SiPMs.
The first implementation, with 400 channels, has been tested at the T9 CERN-PS beamline in 2022. An upgraded prototype with 1200 readout channels has been successfully tested on the same beamline in 2023 and 2024. The results in terms of linearity and energy resolution will be described, together with the study of possible crosstalk effects, its PID capability and comparison with the MC simulations.
During the beamtests of 2023 and 2024 the Demonstrator has been tilted, in order to simulate the impinging of the charged leptons produced in the decay of the K and the results on the energy resolution will be presented.

Primary author: SAIBENE, Giosuè (Universita & INFN, Milano-Bicocca (IT))

Presenter: SAIBENE, Giosuè (Universita & INFN, Milano-Bicocca (IT))

Session Classification: Student Talks

Contribution ID: **119** Type: **Oral**

Prospect of GRB-Neutrino Detection with Enhanced Neutrino Detectors

Friday 11 July 2025 11:00 (30 minutes)

Primary author: AI, Shunke (Niels Bohr Institute, University of Copenhagen)

Presenter: AI, Shunke (Niels Bohr Institute, University of Copenhagen)

Session Classification: Topical Seminar

Contribution ID: **120** Type: **Oral**

Unlocking the Inelastic Dark Matter Window with Vector Mediators

Wednesday 9 July 2025 14:12 (12 minutes)

Despite robust cosmological and astrophysical evidence for the existence of non-baryonic Dark Matter (DM), its microscopic nature remains a mystery. Among the several possible scenarios, light DM candidates thermally produced in the early Universe are especially interesting, as they are both theoretically motivated and experimentally accessible. In this context, inelastic dark matter (iDM) models offer a compelling framework, since they can avoid cosmological bounds as well as indirect and direct detection searches. While most literature assume a secluded dark photon mediator, in this work we investigate the broader case of general vector mediators that can couple directly to baryon and lepton numbers. Notably, in scenarios involving couplings to lepton number, interactions with neutrinos open new invisible decay channels for the heavier dark fermion state, allowing the mass splitting to drop below the standard electron mass threshold. Besides, the neutrino decay modes significantly impact the cosmological evolution —by modifying kinetic equilibration and depletion rates —and alter experimental signatures —by shortening decay lengths and enhancing invisible signals. We demonstrate that such models, particularly those based on anomaly-free gauge groups with non-universal lepton couplings, open new windows of thermal DM parameter space previously unexplored by experiments. We also provide a numerical Python library to compute the relic densities for user-defined gauge charges.

Primary authors: FOGUEL, Ana Luisa (University of São Paulo); Dr REIMITZ, Peter (University of São Paulo); Dr ZUKANOVICH FUNCHAL, Renata (University of São Paulo)

Presenter: FOGUEL, Ana Luisa (University of São Paulo)

Session Classification: Student Talks

Contribution ID: **121** Type: **Oral**

Cosmology with the furthest binary black holes

Thursday 10 July 2025 13:30 (30 minutes)

Primary author: EZQUIAGA, Jose Maria (Niels Bohr Institute)

Presenter: EZQUIAGA, Jose Maria (Niels Bohr Institute)

Session Classification: Topical Seminar

Contribution ID: **122** Type: **Oral**

Prompt atmospheric leptons and the potential role of intrinsic charm.

Tuesday 8 July 2025 14:36 (12 minutes)

The all-sky very-high energy ($10^4 - 10^6$ GeV) atmospheric muon flux is most recently measured by IceCube, where in the higher energy range, the spectrum hardens indicating a prompt component. IceCube also measures the atmospheric muon neutrino flux at high energy. Since this is dominated by the astrophysical flux, they are only able to set an upper bound on the prompt atmospheric muon neutrino flux contribution. We provide a new evaluation of the prompt atmospheric muon flux including for the first time an intrinsic charm component to colliding nucleons. This increases forward production of $\bar{D}^0$, D^- and Λ_c which decay into final states that can contain muons and muon neutrinos. We show how the increase in the prompt muon flux due to intrinsic charm has an associated increase in the prompt muon neutrino flux. We consider two models for intrinsic charm production, the models of Brodsky-Hoyer-Peterson-Sakai and Regge ansatz, that we implement in MCEq used for the calculation of the lepton fluxes. We discuss the challenges of obtaining predictions that are simultaneously consistent with both IceCube's high energy atmospheric muon flux measurements and their upper bound on the prompt muon neutrino flux. We quantify the discrepancies.

Primary author: DAS, Laksha Pradip (University of Iowa)

Presenter: DAS, Laksha Pradip (University of Iowa)

Session Classification: Student Talks

Contribution ID: **123** Type: **Oral**

Transition-edge sensors to detect low-energy electrons: chasing the CvB and the neutrino mass

Monday 7 July 2025 15:00 (12 minutes)

The PTOLEMY collaboration aims to detect the Cosmic Neutrino Background (CνB) and measuring the neutrino mass. To do so, PTOLEMY plans to reconstruct the tritium beta decay and the cosmic neutrino capture on tritium: the electrons near the endpoint of the spectrum will be decelerated and then detected using an array of Transition-Edge Sensors (TES). To be sensitive to neutrino mass effects in the tritium spectrum and to cosmic neutrino captures, the energy resolution goal of PTOLEMY is a standard deviation of 50 meV on 10 eV electrons.
TES devices are superconductive detectors with high sensitivity, high energy resolution and low dark count rates, which have to be operated at cryogenic temperatures. They have been traditionally used as photon-number resolving detectors but they have recently accomplished electron detection. This research is carried out at INRiM (Istituto Nazionale di Ricerca Metrologica), in Italy, where the TESs are also fabricated.
To produce electrons directly inside the cryostat, vertically-aligned carbon nanotubes (CNTs) were chosen as cold electron source. In fact, applying a strong enough external electric field, they emit electrons through the quantum process of field emission, favored by their nanoscale tips which provide a high local field enhancement factor.
Applying a bias voltage to a CNT sample placed in front of a TES, electrons with a kinetic energy E_e ⊠ 100 eV were directed towards the TES to test its performance, focusing on the energy resolution.

Primary author: CORCIONE, Benedetta (Sapienza Università di Roma)

Presenter: CORCIONE, Benedetta (Sapienza Università di Roma)

Session Classification: Student Talks

Contribution ID: **124** Type: **Oral**

Search of Heavy Neutral Leptons with KM3NeT-ORCA

Wednesday 9 July 2025 14:48 (12 minutes)

KM3NeT is a next-generation neutrino telescope currently under construction in the Mediterranean Sea. The detector comprises two components, ARCA and ORCA, each equipped with optical sensors that detect Cherenkov light emitted by charged particles resulting from neutrino interactions in the surrounding medium. ARCA, sensitive to interactions in the TeV–PeV energy range, is designed to observe cosmic neutrinos, while ORCA focuses on studying atmospheric neutrino oscillations in the GeV range.

In this work, we investigate the potential signal produced by a Beyond Standard Model (BSM) particle commonly and generically referred to as the Heavy Neutral Lepton (HNL). This signal is particularly distinctive, as HNLs are expected to generate two spatially separated showers of light, an event topology not anticipated from any known particle within the same energy range. Using a novel simulation based on the SIREN lepton injector to model HNL signals in KM3NeT/ORCA-18, we evaluate the capability of Deep Learning algorithms such as ParticleNeT or DYNEDGE in combination with Boosted Decision Trees (BDTs) to reconstruct and isolate this unique signature.

Primary author: PRADO GONZÁLEZ, Jorge (KM3NeT - IFIC/CSIC - Universidad de Valencia)

Presenter: PRADO GONZÁLEZ, Jorge (KM3NeT - IFIC/CSIC - Universidad de Valencia)

Session Classification: Student Talks

Contribution ID: **125** Type: **Oral**

The GFU Program at Icecube. Current Developments and Future Perspectives

Monday 7 July 2025 14:00 (12 minutes)

The IceCube Neutrino Observatory is a unique astrophysical instrument located in the South Pole that operates continuously, detecting high-energy neutrinos from the entire sky. Among its core scientific capabilities is the real-time alert system, which enables rapid follow-up observations across the electromagnetic spectrum. Through the Gamma-ray Follow-Up (GFU) program, IceCube identifies significant neutrino events and issues alerts to partner observatories, helping to localize potential astrophysical sources.

GFU works on two main modes: The **Source List** mode, which focuses the search on the location of known sources of high energy emission; and the **All-sky** mode, which searches for exceptional neutrino emissions from any point in the sky. In recent work, we have focused on improving the quality and accesibility of these alerts. Moving towards alerts that are more robust and available for different kinds of multi-messenger observatories.

As part of this effort, we have worked on updating the probability density functions(PDFs) that underpin the reconstruction of events, using improved simulation to aid the accuracy in certain regions of the parameter space. Additionally, we are searching to develop a reliable method to report the angular uncertainty of "all-sky" alerts, so as to better localize emissions that might be interesting to follow-up campaigns.

Primary author: COLOMA BORJA, Diego Alberto (University of Padova)

Presenter: COLOMA BORJA, Diego Alberto (University of Padova)

Session Classification: Student Talks

Contribution ID: **126** Type: **Oral**

Galactic Neutrino Emission with IceCube

Tuesday 8 July 2025 15:00 (12 minutes)

Gamma-ray emission from the plane of the Milky Way is understood as partly originating from the interaction of cosmic rays with the interstellar medium. The same interaction is expected to produce a corresponding flux of neutrinos. In 2023, IceCube reported the first observation of this galactic neutrino flux, rejecting the null-hypothesis at 4.5σ. The analysis relied on spatial models –based on gamma ray observations –to model the expected neutrino emission from the galactic plane. Three signal hypotheses describing different possible spatial and energy distributions were tested, where the single free parameter in each test was the normalization of the neutrino flux.
The methods which enabled this high significance result will be explained and the implication on the physics will be discussed.
Finally, two different upcoming Galactic Plane analyses from IceCube will be presented. Results of these analyses will be presented at the ICRC the following week.

Primary author: NESTE, Ludwig (TU Dortmund University)

Presenter: NESTE, Ludwig (TU Dortmund University)

Session Classification: Student Talks

Contribution ID: **127** Type: **Oral**

Neutrino Oscillation Studies Using KM3NeT/ORCA

Tuesday 8 July 2025 14:00 (12 minutes)

The Kilometer Cubic Neutrino Telescope (KM3NeT) is one of the leading European experiments on neutrino physics. One of its building blocks - Oscillation Research with Cosmics in the Abyss (ORCA) - is optimized for studies on neutrino oscillations based on measurements of atmospheric neutrinos in the energy range of 1-100 GeV. Due to its high modularity, ORCA can already be operated during its construction, using only a fraction of its final volume. In this talk, I will explore the evolution of the capabilities of ORCA in the field of neutrino oscillations with time. The tau neutrino sector is of particular interest as ORCA will accumulate an unprecedented tau neutrino sample and thus allow for highly competitive oscillation studies related to the third lepton family.

Primary author: EL MENTAWI, Sharif

Presenter: EL MENTAWI, Sharif

Session Classification: Student Talks

Contribution ID: **128** Type: **Oral**

Neutrinos in Core-collapse Supernovae: The Role of Neutrino Flavor Evolution in the Explosion Mechanism

Tuesday 8 July 2025 13:30 (30 minutes)

Primary author: SHALGAR, Shashank (NBIA)

Presenter: SHALGAR, Shashank (NBIA)

Session Classification: Topical Seminar

Contribution ID: **129** Type: **Oral**

Neutrinos in Core-collapse Supernovae: Transport Schemes and Nucleosynthesis Outcomes

Wednesday 9 July 2025 13:30 (30 minutes)

Primary author: GOGILASHVILI, Mariam (Niels Bohr Institute, University of Copenhagen)

Presenter: GOGILASHVILI, Mariam (Niels Bohr Institute, University of Copenhagen)

Session Classification: Topical Seminar

Contribution ID: **130** Type: **Oral**

Search for decoherence due to quantum gravity with the IceCube Neutrino Observatory

Monday 7 July 2025 14:48 (12 minutes)

In order to develop a consistent quantum theory of gravity, we must understand whether spacetime exhibits fluctuations at the Planck scale. If these Planck-scale fluctuations exist, they may cause propagating particles to evolve in an apparently non-unitary manner. Neutrinos, which interact only via the weak force and gravity, maintain quantum coherence while propagating over large distances. Thus, neutrino oscillations serve as a precise interferometer to search for Planck-scale fluctuations of spacetime. The IceCube Neutrino Observatory is the world's largest neutrino telescope, located in the Antarctic glacier. We search the data on atmospheric neutrinos detected by IceCube in the energy range 0.5-100 TeV to test for neutrino decoherence. In this talk, we present the sensitivity of the analysis, which shows significant improvement compared to previous IceCube results as a result of improved reconstruction and a larger sample of events.

Primary author: KRISHNAN, Tanvi (Harvard)

Presenter: KRISHNAN, Tanvi (Harvard)

Session Classification: Student Talks

Contribution ID: **131** Type: **Oral**

Novel constraints on neutrino physics Beyond the Standard Model of elementary particles from the Conus and Conus+ experiments

Wednesday 9 July 2025 14:36 (12 minutes)

The CONUS experiment was located 17m from the core of the powerful nuclear power plant in Brokdorf (Germany) with the aim of detecting coherent elastic neutrino nucleus scattering (CEνNS) from reactor anti-neutrinos. The experiment ended operations in 2022 with the world-best limits on the detection of such events at nuclear reactors making way for the first detection of CEνNS at a nuclear reactor by its successor CONUS+ (situated in Leibstadt, Switzerland) in 2025. The data provided by both the CONUS and CONUS+ experiments proves to be extremely valuable for analyses of Beyond the Standard Model (BSM) effects, such as yet undetected neutrino channels and electromagnetic properties. In this talk new limits on BSM neutrino phenomenology from previously unanalyzed data from the CONUS experiment will be presented with an eye on the future analysis of the new CONUS+ data. Competitive bounds on vector NSIs as well as new light scalar and vector mediators are presented and put into the global context of efforts to find such new interactions.

Primary author: PIANI, Dario (Max-Planck-Institut fuer Kernphysik)

Presenter: PIANI, Dario (Max-Planck-Institut fuer Kernphysik)

Session Classification: Student Talks

Contribution ID: **132** Type: **Oral**

The puzzle of neutrinos on cosmic scales

Wednesday 9 July 2025 14:00 (12 minutes)

A key question in cosmology is whether massive neutrinos exist on cosmic scales. Current cosmological observations have severely compressed the viable range for neutrino masses and even prefer phenomenologically an effective negative mass. This poses a great challenge to the cosmological search for neutrinos. Based on current background and large scale structure data, taking a full redshift and/or scale tomography method, we obtain one beyond 5 sigma, two 3 sigma and two 2 sigma evidences of massive neutrinos, spanning both high and low redshifts, as well as both small and intermediate scales. Interestingly, these five neutrino masses are well consistent within 1 sigma confidence level, indicating a possible suppression of neutrino mass during the evolution of the universe. Using cosmic microwave background observations to constrain a redshift and scale dependent neutrino mass, we make the first neutrino mass map through the cosmic history and full scales for future high precision search.

Primary author: WANG, Deng (Instituto de Física Corpuscular (IFIC), CSIC-University of Valencia)

Presenter: WANG, Deng (Instituto de Física Corpuscular (IFIC), CSIC-University of Valencia)

Session Classification: Student Talks

Contribution ID: **133** Type: **Oral**

Studying Muon Bundles for Improved EHE Neutrino Identification in IceCube

Thursday 10 July 2025 14:00 (12 minutes)

At extremely high energies (EHE), i.e. from 1 PeV to 10 EeV, one of the main backgrounds in IceCube neutrino analyses comes from atmospheric muon bundles. These consist of several muons produced in the same cosmic-ray air shower that cross the detector simultaneously. Due to their combined energy loss and spatial distribution, bundles can mimic the signature of a single, high-energy muon from an EHE neutrino interaction.
This study aims to characterize the features that differentiate muon bundles from single muon tracks. Using simulated events from CORSIKA (for atmospheric background) and NuGen (for single muons), a range of observables are investigated, including bundle multiplicity, stochastic energy losses or lateral charge spread. The comparison of these features aims to highlight key differences that could be used to improve background discrimination at the reconstruction level. These insights are intended to support the development of more robust and machine learning based EHE event selection strategies.

Primary author: DELMEULLE, Thomas (IceCube)

Presenter: DELMEULLE, Thomas (IceCube)

Session Classification: Student Talks

Contribution ID: **134** Type: **Oral**

End-to-end optimization of in-ice radio neutrino detectors using differentiable programming

Thursday 10 July 2025 14:48 (12 minutes)

In-ice radio detection of neutrinos is a rapidly growing field and a promising technique for discovering the predicted but yet unobserved ultra-high-energy astrophysical neutrino flux. With the ongoing construction of the Radio Neutrino Observatory in Greenland (RNO-G) and the planned radio extension of IceCube-Gen2, we have a unique opportunity to improve the detector design now and accelerate the experimental outcome in the field for the coming decades. To achieve this goal, we have developed a fully differentiable end-to-end simulation, detection, and reconstruction pipeline that allows for efficient optimization of detector parameters with respect to a science outcome. In this presentation, I will discuss the prospects of measuring the ultra-high-energy neutrino flux with in-ice radio detectors, how we can optimize physics detectors with differentiable and GPU programming, and relate it to other applications in neutrino physics theory and analyses.

Primary author: RAVN, Martin

Co-authors: GLASER, Christian (Uppsala University); PILAR, Philipp (Uppsala University)

Presenter: RAVN, Martin

Session Classification: Student Talks

Contribution ID: **135** Type: **Oral**

Exploring High-Energy Neutrinos with the Trinity Demonstrator: Observations and Initial Analysis

Thursday 10 July 2025 14:36 (12 minutes)

The Trinity Demonstrator is an imaging atmospheric Cherenkov telescope (IACT) to observe air showers from Earth-skimming tau neutrinos originating from diffuse and point sources. The telescope is stationed on Frisco Peak, Utah. Since its first light on October 3rd, 2023, the telescope has been looking for 10 PeV to 1 EeV neutrinos within its 4° x 4° field of view. The Demonstrator serves as a proof of concept for utilizing air shower imaging as a valid method for detecting high-energy neutrinos. The telescope points in the direction of NGC1068 and TXS 0506+056, both recognized for their potential to produce high-energy neutrinos. This presentation delves into the operational aspects of the telescope and provides insights into the preliminary data analysis.

Primary author: STEPANOFF, Sofia (Georgia Institute of Technology)

Presenter: STEPANOFF, Sofia (Georgia Institute of Technology)

Session Classification: Student Talks

Contribution ID: **136** Type: **Oral**

Inelasticity reconstruction and neutrino-antineutrino separation for the IceCube Upgrade detector.

Tuesday 8 July 2025 14:24 (12 minutes)

Only left-handed particles and right-handed antiparticles participate in charged-current weak interactions. Because of spin effects, the energy fraction transferred to the target atom, called inelasticity, is on average larger for neutrino interactions than for antineutrinos. This allows a partial statistical separation between neutrinos and antineutrino events in a non-magnetized detector.

The future IceCube Upgrade will increase the instrumentation density in the bottom center of the current detector, which will improve the inelasticity reconstruction of moun (anti)neutrinos charged current interactions. This neutrino-antineutrino separation can be used for example to enhance the detector's sensitivity to the neutrino mass ordering.

Primary author: JACQUART, Marc (NBI)

Presenter: JACQUART, Marc (NBI)

Session Classification: Student Talks

Contribution ID: **137** Type: **Oral**

Radar echo signals in the RET-CR experiment

Thursday 10 July 2025 15:00 (12 minutes)

The Radar Echo Telescope (RET) collaboration aims to utilise in-ice radar techniques to detect ultra-high-energy (UHE) cosmic neutrinos, allowing insight into extremely energetic astrophysical processes. The current goal of the RET collaboration is to demonstrate the radar echo method in-situ with the Radar Echo Telescope for Cosmic Rays (RET-CR) experiment, situated in Greenland in 2023 and 2024. RET-CR targeted in-ice cascades produced by high-energy cosmic ray air showers impacting a high-altitude ice surface. These cascades resemble those produced by UHE neutrinos interacting in ice, allowing RET-CR to serve as proof of concept for the radar detection method. In this work, radar signals have been simulated with the semi-analytic simulation package MARES, using a detector setup resembling the RET-CR experiment. These simulations are then used to explore properties of the radar signal, including geometry-dependent features which can be characterised and linked to the arrival direction and energy of the cascade progenitor particles.

Primary author: LOUDON, Isha

Presenter: LOUDON, Isha

Session Classification: Student Talks

Contribution ID: **138** Type: **Oral**

Forecasting the Monogem TeV halo with CTAO

Monday 7 July 2025 14:24 (12 minutes)

The High-Altitude Water Cherenkov Telescope (HAWC) has detected TeV halos associated with two nearby pulsars and their pulsar wind nebulae (PWNe), Geminga and B0656+14, in the 8–40 TeV energy range. These TeV halos extend up to tens of parsecs from their central accelerators, indicating that the diffusion of electrons and positrons in the interstellar medium is suppressed by two orders of magnitude compared to typical Galactic values. Although Geminga and B0656+14 are at similar distances and located within the same field of view, they exhibit distinct evolutionary histories. Notably, B0656+14 likely remains within its parent supernova remnant, the Monogem Ring, observable in X-rays. In one of our previous works, we performed high-resolution simulations of the propagation of relativistic leptons around B0656+14 using a two-zone diffusion model within the GALPROP framework. These simulation results show that we need more robust GeV-TeV observations of this sky region to constrain TeV halo model parameters. In this project, we simulate observations of B0656+14 based on our theoretical predictions of the GeV–TeV gamma-ray spectrum and the CTAO instrumental response functions. These allow us to understand better the intrinsic properties of PWN such as the extent of the slow diffusion region around the PWN and its magnetic field strength. These properties are crucial for interprating cosmic ray (CR) propagation through the Galaxy and will provide new insights into the observed CR spectrum, particularly the electron and positron components.

Primary author: LI, Youyou (GRAPPA, University of Amsterdam)

Presenter: LI, Youyou (GRAPPA, University of Amsterdam)

Session Classification: Student Talks

Contribution ID: **139** Type: **Oral**

Ultra-high-energy neutrinos to look for super-heavy dark matter inside Earth

Thursday 10 July 2025 14:12 (12 minutes)

As the Earth travels across the Milky Way, it passes through the galactic halo of dark matter particles. Occasionally a dark matter particle could interact with the contents of the earth, scattering it to a lower energy, which can lead to it becoming gravitationally trapped inside the Earth. If these dark matter particles are self-annihilating, or decay, one possible final state product will be neutrinos, which would lead to a flux of neutrinos at the surface of the earth, coming from dark matter, thus enabling indirect dark matter detection. The work focuses on the specific case of super-heavy dark matter in the mass range 1e7 GeV to 1e9 GeV, and explores the possibility of detecting ultra-high-energy neutrinos in the planned IceCube-Gen2 detector, in the hopes that data in the next 10–15 years can either discover or set new limits on dark matter.

Primary author: VOSS JACOBSEN, Johannes

Co-author: BUSTAMANTE, Mauricio (Niels Bohr Institute, University of Copenhagen)

Presenter: VOSS JACOBSEN, Johannes

Session Classification: Student Talks

Contribution ID: **140** Type: **Oral**

Neutrino Detection Forecasts: Numerical Estimates for the Trinity Observatory

Thursday 10 July 2025 14:24 (12 minutes)

Neutrino astronomy has recently begun probing the PeV energy regime, yet observations remain severely limited by low event statistics. Upcoming neutrino telescopes predominantly utilize water Cherenkov and radio detection techniques, each targeting distinct portions of the neutrino spectrum and consequently leaving a critical observational gap from PeV to EeV energies. Trinity, an imaging air Cherenkov telescope designed to detect Earth-skimming neutrinos, aims to bridge this gap by providing sensitivity across these intermediate energies. Trinity's enhanced point-source sensitivity positions it as a powerful instrument in the search for astrophysical neutrino sources. Here, we present detection prospects, outlining expected event rates and highlighting Trinity's potential contributions to neutrino astrophysics.

Primary author: RAUDALES, David (Georgia Institute of Technology)

Presenter: RAUDALES, David (Georgia Institute of Technology)

Session Classification: Student Talks

Contribution ID: **141** Type: **Oral**

Neutrinos from AGN coronae: the case of TXS 0506+056

Monday 7 July 2025 14:12 (12 minutes)

The blazar TXS 0506+056 was the first astrophysical source associated with a high-energy astrophysical neutrino detection. Traditionally, this production has been attributed to processes in the powerful relativistic jet, but the recent observation of neutrinos from the AGN NGC 1068 suggests a production also in the core, non-jetted region. I will discuss whether the neutrinos from TXS 0506+056 can be associated with the core region, using plasma-physics-informed scenarios for particle acceleration, and observationally informed estimates for the X-ray luminosity of the core regions. I will show that the neutrino emission from the core is too low to explain the IceCube observations, and that the blazar jet remains the preferred location for neutrino production.

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Session Classification: Student Talks

Contribution ID: **143** Type: **Oral**

Bounds on Ultra Heavy HNLs

Wednesday 9 July 2025 15:00 (12 minutes)

Heavy Neutral Leptons (HNLs) are hypothetical particles that are able to explain neutrino oscillations. The presence of HNLs induces charged lepton flavor violating (cLFV) processes. Non-observations of these processes puts the strongest limits on parameters of HNL much heavier than the electroweak scale.
We demonstrate that for such HNLs, the branching ratio of cLFV processes is actually mass-dependent. Given this fact, we improve current bounds on HNL mass and mixing angle. Furthermore, we perform a perturbative unitarity analysis to identify the domain of validity of our results.

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Hunting for electron-lepton number crossings in core-collapse supernovae

Tuesday 8 July 2025 14:48 (12 minutes)

Neutrinos, despite their weak interactions, play an important role in core-collapse supernova evolution. In the supernova core, the neutrino number density is so high that the coherent forward scattering among neutrinos leads to flavor conversion, a phenomenon that can alter both the supernova explosion dynamics and nucleosynthesis. A necessary condition for the development of fast neutrino flavor conversion is the existence of crossings in the angular distribution of the electron neutrino lepton number. In this talk, I will discuss how to identify the necessary conditions for fast neutrino flavor conversion in core-collapse supernova simulations, and how they are affected by the presence of muons and convection.

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Session Classification: Student Talks