T 15: Neutrino astronomy 1

Time: Monday 16:00–18:00 Location: Geb. 30.23: 6/1

T 15.1 Mon 16:00 Geb. 30.23: 6/1

Directional solar neutrino analysis in JUNO — •Marco Malabarba[2,3,1], Livia Ludhova[1,3], Yury Malyshkin[2,1], Cristobal Morales Reveco[2,3,1], Mariam Rifai[1,3], Luca Pelicci[1,3], Hexi Shi[2,1], and Apeksha Singhal[1,3] — [1]Institut für Kernphysik, Forschungszentrum Jülich, 52425 Jülich, Germany — [2]GSI Helmholtzzentrum für Schwerionenforschung, 64291 Darmstadt, Germany — [3]III. Physikalisches Institut B, RWTH Aachen University, 52062 Aachen, Germany

JUNO (Jiangmen Underground Neutrino Observatory) is a multipurpose neutrino physics experiment currently under construction in China. Its target consists of 20 kton of organic liquid scintillator. The optical photons are collected by photomultiplier tubes (PMTs) which provide a geometrical coverage of 78%. Thanks to its unprecedented features, JUNO is a perfect candidate to study solar neutrinos. Solar neutrinos mainly interact through elastic scattering reactions with liquid scintillator electrons. Hence, all the beta-like decays of unstable nuclei are backgrounds. The Correlated and Integrated Directionality (CID) analysis, developed by Borexino, can be exploited to statistically separate signal and background events. CID relies on the directionality of the fast Cherenkov light: the PMT hits caused by Cherenkov photons exhibit a correlation with the Sun's position only for solar neutrino events. Our studies show that, in JUNO, the combination of the CID and the spectral analyses (which exploits the different energy spectral shapes of signals and backgrounds) could yield the most precise measurement of 7Be and CNO solar neutrinos ever achieved.

T 15.2 Mon 16:15 Geb. 30.23: 6/1

Improving DSNB Event Detection at JUNO: Advancements Through 3D Convolutional Neural Networks — •David Maksimović[1], Daniel Tobias Schmid[1], Dhaval J. Ajana[2], Michael Wurm[1], Marcel Büchner[1], Arshak Jafar[1], George Parker[1], Oliver Pilarczyk[1], and Tim Charisse[1] — [1]Johannes Gutenberg-University Mainz, Institute of Physics — [2]Department of Physics, Florida State University, Tallahassee, FL 32306, USA

The detection and analysis of the Diffuse Supernova Neutrino Background (DSNB) pose a significant challenge in neutrino astronomy, primarily due to backgrounds mimicking the Inverse Beta Decay (IBD) signature events. The Jiangmen Underground Neutrino Observatory (JUNO) uses a liquid scintillator to detect these neutrinos, especially challenged by Neutral-Current (NC) interactions of atmospheric neutrinos in the 12 to 30 MeV range.

In this talk, we introduce a novel method employing 3D Convolutional Neural Networks (3D CNNs) for better discrimination of DSNB events from these backgrounds. This technique analyses time-sequenced data from photomultiplier tube (PMT) hit patterns, arranged in frames like a movie, capturing the spatial-temporal dynamics of particle interactions. Simulation studies within the JUNO detector environment show our 3D CNN method significantly improves background reduction. Compared to previous applied machine learning methods, our approach shows a 30% reduction in background levels and a 17% improvement in detection accuracy.

T 15.3 Mon 16:30 Geb. 30.23: 6/1

Spectrum unfolding for Core-Collapse Supernova neutrinos in JUNO — •Thilo Birkenfeld, Achim Stahl, and Christopher Wiebusch — III. Physikalisches Institut A RWTH Aachen, Sommerfeldstraße 16, 52074 Aachen

Since the Supernova of 1987, no core-collapse supernova (CC-SN) has exploded close enough to be observed by terrestrial neutrino telescopes. The Jiangmen Underground Neutrino Observatory (JUNO) is a next-generation liquid scintillator detector with a large target mass of 20 kton. It will provide valuable insight into the details of the CC-SN mechanism by observing the neutrino burst of a galactic CC-SN with high statistics and an unpreceded visible energy resolution of 3 % @ 1 MeV. JUNO will be sensitive to signals from all neutrino flavors via different detection channels. We present a Bayesian-based energy spectrum unfolding for three effective neutrino flavors using an optimized event classification.

T 15.4 Mon 16:45 Geb. 30.23: 6/1

Detection of solar pp neutrinos with the OSIRIS upgrade — •Tim Charissé, Marcel Büchner, Arshak Jafar, George Parker, Oliver Pilarczyk, and Michael Wurm — Johannes Gutenberg-University Mainz, Institute of Physics and EC PRISMA+

The OSIRIS detector will monitor the radiopurity of the scintillator during the filling of JUNO. After it has fulfilled this purpose, it can be upgraded for the measurement of solar pp neutrinos on its own. Here, the comparatively small size of its scintillator volume poses an advantage, as it enables the use of a liquid scintillator with an ultra-low abundance of ^{14}C, the main background source in the pp neutrino energy region. Further upgrades include additional shielding, the use of a slow scintillator, additional PMTs and the installation of reflective light cones, which will result in an excellent photo electron yield. This talk will present the results of recent sensitivity studies on the feasibility of measuring pp neutrinos with the OSIRIS upgrade through a spectral fit and the analysis method called Correlated and Integrated Directionality. The latter makes use of the directional information of the Cherenkov light over a cumulative approach. The spectral fit is expected to yield a measurement of the pp neutrino rate with a sensitivity on the 3.5% level within 5 years, significantly better than the current best experimental measurements. This work is supported by the DFG Research Unit FOR 5519.

T 15.5 Mon 17:00 Geb. 30.23: 6/1

Development of the First Detector Line for the Pacific Ocean Neutrino Experiment — •Charlotte Eberhart, •Lea Ginzkey, Simeon Bash, Martin Dinkel, Vincent Gousy-Leblanc, Elisa Resconi, and Christian Spannfellner — Technical University of Munich, TUM School of Natural Sciences, Department of Physics, James-Franck-Straße 1, D-85748 Garching bei München, Germany

The Pacific Ocean Neutrino Experiment (P-ONE) aims to be a multi-cubic-kilometre neutrino observatory of the Northeast Pacific Ocean off the coast of Vancouver Island (Canada). P-ONE will measure high-energy astrophysical neutrinos and characterize the nature of astrophysical accelerators. Currently, its first detector line (P-ONE-1) is in production and planned to be deployed in 2025. The one kilometre long line consists of 20 optical and calibration modules and shall serve as a prototype line for the detector, and ultimately be the blueprint for the following detector lines. The optical modules (P-OMs) aim to detect bioluminescence and Cherenkov light with a multi photo-multiplier tube (PMT) configuration. The multi-PMT design of P-OM allows to cope with the high background rates in the depths of the Northeast Pacific Ocean, while their modular and minimal mechanical design makes them easily scalable in vision of the construction of the full P-ONE detector. In this contribution, we will present an overview over the P-ONE-1 design and the production process of the P-OMs.

T 15.6 Mon 17:15 Geb. 30.23: 6/1

Production of the Precision Optical Calibration Module (POCAM) — •Patrick Schaile, Leonhard Eidenschink, and Andrii Terliuk — Technical University of Munich, TUM School of Natural Sciences, Department of Physics, James-Franck-Straße 1, D-85748 Garching bei München, Germany

In the context of the IceCube Upgrade, which mainly aims to improve and extend the scientific capabilities of the IceCube Neutrino Observatory, a Precision Optical Calibration Module, the POCAM, has been developed. It is an isotropic, self-monitoring calibration light source, which will be deployed into the Antarctic ice as a new part of the detector and is meant to investigate and determine the optical detector systematics to high precision. The improved knowledge on parameters like absorption or scattering length will eventually lead to likewise improved detector sensitivity and data analyses. Currently the project is in the production and calibration stage, in which the necessary parts of the devices are either produced or combined respectively to its required functional units which are eventually tested and calibrated. In total there will be 21 POCAMs used in IceCube, while the first devices will be ready for deployment in 2024.

T 15.7 Mon 17:30 Geb. 30.23: 6/1

Searching for sub-TeV neutrino counterparts with IceCube for sub-threshold Gravitational Wave events — •Tista Mukherjee for the IceCube-Collaboration — Institute for Astroparticle Physics (IAP), Karlsruhe Institute of Technology (KIT), Hermannvon-Helmholtz Platz 1, 76344 Eggenstein-Leopoldshafen, Germany

The IceCube Neutrino Observatory, located in the Antarctica, has been actively participating in multi-messenger follow-up of Gravitational Wave events since the first observation run of the LIGO-Virgo collaboration. LIGO-Virgo now also provides sub-threshold gravitational wave (GW) candidate information publicly, since the release of the Gravitational Wave Transient Catalog GWTC-2.1. Using these sub-threshold GW candidates for multi-messenger studies complements the ongoing efforts to identify neutrino counterparts to GW events. Here, we present the current status of the ongoing archival studies with the sub-TeV neutrinos detected by the dense-infill array of IceCube, known as DeepCore. We have performed a selection of the sub-threshold GW candidates from GWTC-2.1 and GWTC-3. Neutrino counterparts are looked for using Unbinned Maximum Likelihood method. We report the 90% C.L. sensitivities and the 3σ discovery potential of this sub-TeV neutrino dataset for each selected sub-threshold GW candidate, considering spatial and temporal correlation between the GW and neutrino events within a 1000 s time window.

T 15.8 Mon 17:45 Geb. 30.23: 6/1

Gravitational Wave Follow-up of Ultra-High Energy Neutrinos with the Pierre Auger Observatory * — •Therese Paulsen for the Pierre-Auger-Collaboration — Bergische Universität Wuppertal, Gaußstraße 20, 42119 Wuppertal, Germany

Primarily designed to detect ultra-high energy (UHE) cosmic rays, the Pierre Auger Observatory also possesses excellent sensitivity to UHE neutrinos. The Surface Detector array is used to search for highly inclined neutrino-induced air showers, which, though not observed yet, have clear characteristic signatures. Follow-up searches of UHE neutrinos in Gravitational Wave (GW) events are of unique scientific interest.

The fourth observational run (O4) by the gravitational wave network LIGO-Virgo-KAGRA of interferometric detectors started in May 2023. With the substantial increase in sensitivity in the O4 run, a higher frequency of GW alerts is expected. This creates a need for the development of software to reply to the General Coordinates Network (GCN) circulars. This talk presents the work being done by the Pierre Auger Collaboration to get an automated response to these GCN notices. Following the alerts, a specific analysis is conducted to calculate a one-day fluence limit for a point source, in the case no neutrino candidate was identified.

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