T 10: Neutrino Astronomy I

Time: Monday 16:45–18:30 Location: VG 1.105

T 10.1 Mon 16:45 VG 1.105

Classification of incoming neutrino events in IceCube using machine learning — •Sophie Loipolder, Rasmus Ørsøe, and Chiara Bellenghi for the IceCube-Collaboration — Technical University of Munich, Munich, Germany

In neutrino telescopes, event topologies differ depending on the neutrino flavor, the energy and the interaction type. For the reconstruction of the energy and direction of an incoming event, it is best to know the event type in advance to apply the suitable reconstruction algorithm for the respective topology.

This presentation discusses the development and implementation of a neural network-based classifier designed to improve the identification of event topologies in IceCube, a neutrino telescope located at the South Pole. Considering the continuous advances in machine learning, this approach aims to enhance the performance of existing methods currently in use for the classification of real-time neutrino event topologies.

T 10.2 Mon 17:00 VG 1.105

Machine Learning Tools for IceCube-Gen2 — •Francisco Javier Vara Carbonell and Alexander Kappes for the IceCube-Gen2-Collaboration — Universität Münster, Institut für Kernphysik

Machine learning tools, especially neural networks, have triggered a revolution in many areas, including neutrino astronomy. They have great potential for future neutrino telescopes such as IceCube-Gen2 with a large number of small photomultipliers. Neural networks are well suited to tackle high-dimensional problems and can naturally incorporate the segmentation of these new optical sensors. Moreover, they have a fast inference time compared to conventional algorithms, which enables the processing of the high event rates expected from IceCube-Gen2. This talk will present potential applications of neural networks in IceCube-Gen2 in areas such as simulation, event reconstruction and noise reduction, covering the current state of their development and implementation.

T 10.3 Mon 17:15 VG 1.105

Stacking Likelihood Analysis of Extreme Blazars with IceCube Public Data — •Juan Manuel Cano Vila[1,2], Chiara Bellenghi[1], and Paolo Padovani[3] — [1]Technical University of Munich, TUM School of Natural Sciences, Department of Physics, James-Franck-Straße 1, D-85748 Garching bei München, Germany — [2]Arnold Sommerfeld Center, Ludwig-Maximilians University, 80333 Munich, Germany — [3]European Southern Observatory, Karl- Schwarzschild-Straße 2, D-85748 Garching bei München, Germany

Since the confirmation of the existence of high-energy astrophysical neutrinos more than 10 years ago, researchers have been trying to identify which kind of objects emit them. The results have been limited, and the origin of the majority of this astrophysical neutrino flux remains unknown. For the last few years, IceCube has released several datasets to the public that allow any research group to test their hypothesis. One of the available tools designed to study this data is SkyLLH, an open source Python package that provides a framework for implementing custom likelihood functions and executing log-likelihood ratio hypothesis tests. In this project, we developed a new functionality to perform stacking log-likelihood analysis, where one studies the joint signal from multiple selected sources, which enhances the statistics by a population-wide study and allows to test different hypothesis by selecting the weights of each source of the population. We apply this tool to a selected population of blazars characterized by their extreme luminosities in radio and γ-rays.

T 10.4 Mon 17:30 VG 1.105

Investigating the connection of blazars to IceCube alert events with public data — •Julian Kuhlmann and Francesca Capel — Max-Planck-Institut für Physik, Garching, DE

The IceCube collaboration has recently found evidence for neutrino emission from TXS 0506+056. Different mechanisms in various emission regions have been invoked to explain the combined neutrino and multi-wavelength observations. Motivated by spatial associations of IceCube alert events with blazars, such as TXS 0506+056, we analyse a sample of similar blazars for neutrino emission, using a Bayesian hierarchical analysis framework. Utilising the framework's capability of handling many free parameters we go beyond power-laws and employ neutrino spectra typical of proton-gamma interactions. We further use priors on spectral parameters informed by lepto-hadronic modelling of multi-wavelength observations. Among the sample blazars, three sources stand out with considerable association probabilities to neutrino events. Unaccounted for systematics in event reconstruction, as well as limited simultaneous multi-wavelength data currently pose the largest restrictions on firmly identifying the sources of high-energy alert events.

T 10.5 Mon 17:45 VG 1.105

Determination of Systematic Uncertainties in Air Shower Production — •Celina Kortmann — Technische Universität Dortmund

In experimental astrophysics, physical quantities are estimated from measurements using various reconstruction techniques. The physical results can have large systematic uncertainties depending on the properties of the detectors, the analysis, and its underlying assumptions.

Our goal is to quantify and understand the systematic uncertainties associated with predictions based on Monte Carlo simulations in air shower physics. This study is of particular interest for neutrino experiments such as IceCube, whose background consists of atmospheric neutrinos and muons, and IACTs such as MAGIC, whose background contains protons and heavier nuclei, inducing air showers with a pattern similar to gamma rays. In the past, measurements of the atmospheric muon and muon-neutrino flux and of the proton flux have been made.

Using CORSIKA, a program for Monte Carlo simulations of air showers, we compare the fluxes resulting from the same showers to estimate the correlation between the muonic and electromagnetic components of air showers. The current state of the analysis is presented.

T 10.6 Mon 18:00 VG 1.105

Combined sensitivity of JUNO and Super-K on the Black Hole Fraction — •Tim Charissé[1,2], George Parker[2], David Maksimović[2], and Michael Wurm[2] — [1]Helmholtzzentrum für Schwerionenforschung, Planckstrasse 1, D-64291 Darmstadt, Germany — [2]Johannes Gutenberg-Universität Mainz, Institute of Physics and EC PRISMA+

The Diffuse Supernova Neutrino Background (DSNB) is the integrated signal of neutrinos emitted by all core-collapse supernovae (CCSNe) that occurred in the visible universe. Studying it offers insights into the inner workings of CCSNe as well as cosmological properties. The Jiangmen Underground Neutrino Observatory (JUNO), which will soon begin data taking, and the already established Super-Kamiokande (Super-K) detector are promising candidates to measure the DSNB in the near future.

While most CCSNe explode and leave behind a neutron star, an undetermined fraction of CCSNe do not explode due to prior black hole formation and hence cannot be seen by optical telescopes. However, these black hole-forming CCSNe still emit a massive amount of neutrinos which have a different spectral contribution to the DSNB than those emitted by exploding CCSNe. Therefore, the overall fraction of CCSNe that are black hole-forming might be inferred from a measurement of the DSNB spectrum. We are investigating the potential sensitivity of combined DSNB measurements by JUNO and Super-K to the black hole fraction.

T 10.7 Mon 18:15 VG 1.105

Search for the DSNB in JUNO: Development of new Methods for Background Event Identification — •Matthias Mayer, Lothar Oberauer, Hans Steiger, Simon Basten, Ulrike Fahrendholz, Meishu Lu, Konstantin Schweizer, Korbinian Stangler, and Raphael Stock — Physik-Department, TU München, James-Frank-Str. 1, 85748 Garching b. München, Deutschland

The diffuse supernova neutrino background (DSNB) describes the constant flux of neutrinos from past core-collapse supernovae over the entire visible universe. The Jiangmen Underground Neutrino Observatory (JUNO), a 20 kton liquid scintillator detector, expects to observe the DSNB through the inverse beta decay (IBD) detection channel. While other $\bar{\nu}_e$ sources will cause irreducible background in the IBD channel, we aim to reduce non-IBD backgrounds such as spallation-induced fast neutrons and atmospheric neutrino NC interactions by careful pulse-shape discrimination (PSD). For this talk, I compare the performance of different PSD techniques regarding the fiducial volume choice for the DSNB search and look at recent measurements for the energy dependence of the neutron fluorescence time profile in the JUNO scintillator. I will also give an outlook into our recent publication regarding the DSNB detection potential. This work has been supported by the Clusters of Excellence PRISMA+ and ORIGINS as well as the DFG Collaborative Research Center "NDM" (SFB1258) and the DFG Research Units 2319 and 5519.