T 99: Neutrino Astronomy 4

Time: Thursday 16:15–18:35 Location: T-H30

Group Report T 99.1 Thu 16:15 T-H30

Status of the KM3NeT experiment and contributions from ECAP — •Rodrigo Gracia-Ruiz for the ANTARES-KM3NET-ERLANGEN-Collaboration — Erlangen Centre for Astroparticle Physics, Erlangen, Germany

There are exciting times ahead for neutrino physics and neutrino astronomy! Despite the pandemic the KM3NeT detectors keep growing at two locations in the depth of the Mediterranean Sea. They currently host a total of 18 detection units, 10 for the ORCA detector in France and 8 for the ARCA detector off the coast of Sicily, with a total of more than 10000 photomultiplier tubes in 324 optical modules. Further significant extensions of the detector arrays are under way. This already enables sensitive investigations of GeV-scale atmospheric and TeV-to-PeV-scale cosmic neutrinos during the ongoing commissioning phase. We will report on the status of the KM3NeT detectors, first results on flavour oscillations, and the contributions from the ECAP team to these scientific endeavours.

T 99.2 Thu 16:35 T-H30

Studying optical water properties with atmospheric muon events in KM3NeT/ORCA — •Martin Schneider for the ANTARES-KM3NET-ERLANGEN-Collaboration — ECAP, Friedrich-Alexander-Universität Erlangen-Nürnberg

KM3NeT-ORCA is an underwater neutrino detector featuring a dense configuration of optical modules, designed for the detection of atmospheric neutrinos down to the low-GeV energy regime. Located in a deep-sea environment, the detector performance depends on the optical water properties. In this talk, a study of the optical properties of the sea water surrounding the ORCA detector is presented. For this, a sample of atmospheric muons is compared to sets of Monte Carlo simulations obtained by varying the light attenuation length.

T 99.3 Thu 16:50 T-H30

Energy spectrum unfolding for Supernova burst neutrinos in JUNO — •Thilo Birkenfeld for the JUNO-Collaboration — RWTH Aachen University

Since the detection of neutrinos emitted by the supernova SN 1987A, no neutrinos from other supernovae have been observed to date. The Jiangmen Underground Neutrino Observatory (JUNO) will measure the neutrino burst from a galactic supernova explosion. High statistics, a low detection threshold, and an excellent energy resolution will strongly constrain the details of the neutrino-driven supernova mechanism. JUNO will be sensitive to signals from all neutrino flavours via different detection channels. The reconstruction of their respective energy spectra requires an effective event classification, whose preliminary results will be presented in this talk. A subsequent bayesian-based energy spectrum unfolding method for reconstructing the initial neutrino energy distribution will also be presented.

T 99.4 Thu 17:05 T-H30

Constraining neutrino mass using black hole formation during supernova neutrino emission — •George Parker and Michael Wurm — Johannes Gutenberg Universität Mainz, Mainz, Germany

In this work, we study how neutrino emission from supernovae collapsing to black holes could be used constrain the absolute neutrino mass. In the case where a black hole forms during a core-collapse supernova, it would lead to a sharp cut-off in the neutrino flux. An abrupt drop-off in the neutrino emission offers a clear-cut stage to look for neutrino time-of-flight effects, allowing stricter constraints to be set on the neutrino mass compared to previous estimates. We focus on the possibility that supernova neutrinos are detected with the Jiangmen Underground Neutrino Experiment (JUNO), a next-generation neutrino experiment with enhanced flavour sensitivity, exceptional energy resolution and high statistics. Using three-dimensional core-collapse supernova simulations, the sensitivity of JUNO to the absolute neutrino mass is evaluated.

T 99.5 Thu 17:20 T-H30

Studies on Solar Be7 Neutrino Measurements and Applications in JUNO — •Sebastian Zwickel[1,2], Lothar Oberauer[1], Simon Csakli[1], Carsten Dittrich[1], David Dörflinger[1], Ulrike Fahrendholz[1], Florian Kübelbäck[1], Matthias Mayer[1], Vincent Rompel[1], Luca Schweizer[1], Konstantin Schweizer[1], Korbinian Stangler[1], and Raphael Stock[1] for the JUNO-Collaboration — [1]Technische Universität München — [2]Helmholtz Zentrum Dresden Rossendorf

Besides its major physics goal, the determination of the neutrino mass ordering, the upcoming Jiangmen Underground Neutrino Observatory (JUNO) will have a rich physics program. One part of this are solar neutrinos, where JUNO benefits the most from its large target mass of 20 kt liquid scintillator. In this talk the results of studies on searching for periodic flux variation, e.g. caused by solar g-modes, in the solar (Be7) neutrino flux, as well as the possible use of solar Be7 neutrinos for detector monitoring will be presented.

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T 99.6 Thu 17:35 T-H30

First Comparison of Ballistic and Diffusive Propagation in Flares of Blazar Jets - Implications for Neutrino Emission Models — •Marcel Schroller[1], Julia Becker Tjus[1], Patrick Reichherzer[1,2], and Mario Hörbe[1,3] — [1]Ruhr-Universität Bochum, Theoretische Physik IV — [2]IRFU, CEA, Université Paris-Saclay — [3]Oxford Astrophysics, University of Oxford

Active galactic nuclei (AGN), and the accompanied jets, are some of the most luminous objects in the observable Universe. Both the active cores and their jets are candidates for the engine of cosmic rays, gamma rays, and neutrinos with the highest energies measured at Earth. In 2017, IceCube recorded an extragalactic high energy neutrino event with a strong hint of a directional coincidence with the position of a known jetted AGN TXS0506+056. A deep understanding of the processes related to jets will fuel the field of high energy cosmic rays, fundamental plasma, astro, and particle physics. The physical and mathematical modelling of an AGN jet is challenging, with ambiguous signatures that need to be understood by numerical simulations of cosmic ray transport and interactions. Based on the work of Hoerbe et al. (MNRAS 2020), a simulation framework for hadronic constituents and their interactions inside of a plasmoid, propagating along the AGN jet axis, was made. For this talk, we tested several state-of-the-art simulation setups from the literature in this field with our framework to analyse the assumptions about propagation behaviour both ballistically and diffusively. We present the results and point out, where those assumptions cannot hold in a realistic setup.

T 99.7 Thu 17:50 T-H30

A new code for the modeling of multimessenger flares from blazars — •Leander Schlegel[1,2], Marcel Schroller[1,2], Mario Hörbe[1,2,3], and Julia Becker Tjus[1,2] — [1]Theoretische Physik IV, Ruhr Universität Bochum, Bochum, Germany — [2]RAPP-Center at Ruhr Universität Bochum, Bochum, Germany — [3]University of Oxford, Oxford Astrophysics, Denys Wilkinson Building, Keble Road, Oxford, OX1 3RH, United Kingdom

Since their discovery over a century ago, the origin of cosmic rays of the highest energies is still widely uncertain. While in the past much attention was paid to analyzing steady state source models, bursting sources that appear in quiescent and flaring states, like the class of Active Galactic Nuclei (AGN) seem to be a promising candidate for possible sources of ultra-high-energy cosmic rays (UHECR). The goal of this work is trying to understand the detailed behaviour of bursting sources by simulating the time resolved propagation of a plasma blob inside the jet of an AGN. For this purpose, a tool for cosmic-ray propagation in relativistic plasmoids of AGN jets has been developed and implemented into the open-source code CRPropa 3.1. With this framework, we will predict the multimessenger signatures of flaring sources, aiming to contribute to a more complete picture of the UHECR sky including the bursting sources and therefore also to a deeper understanding of the origin of the highest energetic charged particles. First results of the flaring behaviour from relativistic plasmoids are being presented.

T 99.8 Thu 18:05 T-H30

Investigation of the effect of elliptical orbits in supermassive

binary black holes at the example of the neutrino lightcurve of the blazar TXS0506+056 — •Johannes Just, Julia Becker Tjus, and Ilja Jaroschewski — Theoretische Physik IV, Ruhr-Universität Bochum

IceCube detections from 2014/15 and 2017 show two possible high-energy neutrino correlations with the blazar TXS0506+056, making blazars promising candidates for high-energy neutrino emission. Those neutrinos can be produced in *pp* or $p\gamma$ interactions of cosmic rays, making bazars possible sources of high energy cosmic rays. Two separate detections might imply a periodicity of the neutrino flux from TXS0506+056 at Earth.

Such a periodicity can be explained by a precession of the heavier super massive black hole jet in a merger of a super massive binary black hole (SMBBH), caused by a Spin-Flip of the Jet. Considering the post newtonian mechanics up to the 2.5 order, the Spin-Flip-Phenomenon is described with the Spin (and therefore the Jet) slowly aligning with the total angular momentum.

Assuming that TXS0506+056 is a SMBBH merger, this work predicts the upcoming neutrino flux as well as the observability of the emitted gravitational waves with LISA, taking different eccentricities of the SMBBH orbit into account. Several eccentricities, leading to differing periodicities and shrinking timescales, are discussed.

T 99.9 Thu 18:20 T-H30

A novel Machine Learning-approach for the detection of the DSNB — •David Maksimović[1], Michael Nieslony[2], and Michael Wurm[3] — [1]Johannes Gutenberg-Universität Mainz — [2]Johannes Gutenberg-Universität Mainz — [3]Johannes Gutenberg-Universität Mainz

The Diffuse Supernova Neutrino Background (DSNB) is the faint signal of all core-collapse supernovae explosions on cosmic scales. A prime method for detecting the DSNB is finding its IBD signatures in Gadolinium-loaded large water Cherenkov detectors like Super-Kamiokande(SK-GD). While the enhanced neutron tagging capability of Gadolinium greatly reduces single-event backgrounds, correlated events mimicking the IBD coincidence signature remain a potentially harmful background. Especially in the low-energy range of the observation window, Neutral-Current (NC) interactions of atmospheric neutrinos dominate the DSNB signal, which leads to an initial signal-to-background (S:B) ratio inside the observation window of about 1:10.

Here, we report on a novel machine learning method based on Convolutional Neural Networks (CNNs) that offer the possibility for a direct classification of the PMT hit patterns of the prompt events. Based on the events generated in a simplified SK-GD-like detector setup, we find that a trained CNN can maintain a signal efficiency of 96 % while reducing the residual NC background to 2 % of the original rate, corresponding to a final signal-to-background ratio of about 4:1. This provides excellent conditions for a DSNB discovery.

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