T 53: Neutrino Astronomy III

Time: Wednesday 16:15–18:15 Location: VG 1.105

T 53.1 Wed 16:15 VG 1.105

A bayesian approach to study the multimessenger emission from AGN-starburst galaxies* — •Silvia Salvatore[1,2], Bjoern Eichmann[1,2], and Julia Becker-Tjus[1,2] — [1]Theoretische Physik IV, Ruhr Universität Bochum, Bochum, Germany — [2]RAPP-Center at Ruhr Universität Bochum, Bochum, Germany

Active Galactic Nuclei (AGN) and starburst galaxies are multimessenger sources in the Universe, emitting from radio/infrared energies to gamma-ray and neutrino energies. NGC 1068 is a Seyfert II galaxy with a starburst ring that has been proven to emit the neutrinos detected by Icecube through hadronic processes most likely happening in the AGN corona. Two high-energy neutrinos with high probability of being of astrophysical origin have recently been reported by IceCube from the direction of NGC7469 as well. In this presentation, we model the different environments of these AGN-starburst composite sources and constrain the main parameters for the AGN and starburst environments using a Monte Carlo bayesian approach, where we include the data from radio to TeV energies*Supported by DFG (SFB 1491).

T 53.2 Wed 16:30 VG 1.105

Constraining the contribution of Seyfert galaxies to the astrophysical neutrino flux using NGC 1068 as a benchmark — •Lena Saurenhaus[1], Francesca Capel[1], and Foteini Oikonomou[2] — [1]Max-Planck-Institut für Physik, 85748 Garching b. München, Germany — [2]Norwegian University of Science and Technology (NTNU), Institutt for fysikk, 7491 Trondheim, Norway

Recently, the IceCube Collaboration reported evidence for TeV neutrino emission from several nearby Seyfert galaxies, with the highest significance found for NGC 1068. The lack of observable gamma rays at TeV energies associated with NGC 1068 suggests that these neutrinos are likely produced in the AGN corona, which is opaque to high-energy gamma rays. Based on this assumption, we simulate the neutrino emission of Seyfert galaxies with different X-ray properties and fit the resulting neutrino spectrum for NGC 1068 to public IceCube data. Using the result of this fit as a benchmark, we extrapolate our model to an entire population of sources simulated based on the X-ray luminosity function of AGNs and estimate the resulting diffuse neutrino flux. By comparing our results with observations, we derive constraints on the neutrino emission properties of the source population and find that NGC 1068 has to be a particularly powerful Seyfert galaxy. In addition, we use our model to evaluate the detection prospects of other nearby Seyfert galaxies besides NGC 1068 in order to obtain a coherent picture of the contribution of these sources to astrophysical neutrino observations.

T 53.3 Wed 16:45 VG 1.105

IFT on ice: Utilizing numerical information field theory to reconstruct glacial ice parameters — •Matthias Hübl, Laurin Söding, and Philipp Mertsch — Institute for Theoretical Particle Physics and Cosmology (RWTH Aachen University)

Due to their small interaction cross-sections, the detection of high-energy neutrinos requires the use of large, natural detection volumes, like glacial ice in the case of the IceCube Neutrino Observatory. In order to extract precise information from the light that is produced by high energy neutrinos, it has to be calibrated as accurately as possible. This means in particular that the ice properties such as scattering and absorption lengths for propagating photons should be known with high accuracy and spatial resolution. Information Field Theory (IFT) adopts a Bayesian approach, building on methods from different fields of physics, especially field theory and statistical physics. The python package NIFTy (Numerical Information Field Theory) uses the concepts of IFT and implements a variational inference approach in order to reconstruct parameter fields. This is both more robust than maximum-likelihood methods and allows determining the uncertainties of the inferred fields at the same time. Here, we present two approaches for modelling the light propagation in ice that can be interfaced with NIFTy: a differentiable Monte Carlo simulation and a finite-difference code. We compare the performance of both methods and characterise the reconstruction of a mock ice model.

T 53.4 Wed 17:00 VG 1.105

Search for Ultra-High Energy Neutrinos from Gamma-Ray Bursts 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. Due to the null observation of UHE neutrinos, we can construct upper luminosity limits on each gamma-ray burst within the Observatory's field of view.

As the neutrino luminosity from these sources strongly depends on the modeled emission mechanisms and dissipative processes, we construct these upper limits using different neutrino spectra corresponding to distinct scenarios, for example, the one-zone fireball model. The spectra is constructed using the source code *Cosmic Ray Stochastic Interactions for Propagation* (CRISP), to compute quantities related to the propagation of heavier primaries within the source environment.

T 53.5 Wed 17:15 VG 1.105

Ultra-high-energy neutrino detection with radio antennas in the ground based observatory — •Baobiao Yue — Bergische Universität Wuppertal, Wuppertal. Germany

The detection of Ultra-High-Energy (UHE) neutrinos offers a unique opportunity to unravel the mysteries surrounding the astrophysical origins of the universe's most energetic cosmic rays. Radio detection provides significant advantages for detecting highly inclined air showers induced by UHE neutrinos, including a larger exposure range compared to particle detectors and a precise reconstruction. Furthermore, this technique improves the air shower longitudinal reconstruction, which can be used to identify neutrinos with their first interaction far below the top of the atmosphere.

The Pierre Auger Observatory is the largest instrument with radio antennas for measuring air showers produced by UHE cosmic rays and neutrinos. In this work, we use it as an example of a ground-based observatory to study UHE neutrino detection. We demonstrate how the integration of radio antennas enhances UHE neutrino detection capabilities and facilitates classification. Since shower reconstruction using radio emissions is central for neutrino identification in this work, we will emphasize the method developed for detecting inclined air showers induced by neutrinos. Finally, we present the expected neutrino detection sensitivity achievable with the radio antennas alone.

T 53.6 Wed 17:30 VG 1.105

Enhancing Sensitivity for Ultra-High Energy Down-Going Neutrino Detection with the Pierre Auger Observatory* — •Srijan Sehgal for the Pierre-Auger-Collaboration — Bergische Universität Wuppertal, Wuppertal, Germany

The Pierre Auger Observatory, originally conceived to study the properties of cosmic rays, also has the capability to identify neutrino-induced extensive air showers above 10^{17} eV by using its large Surface Detector (SD) array. Two new SD triggers, Time-over-Threshold-deconvolved (ToTd) and Multiplicity-of-Positive Steps (MoPS), installed in 2014, were shown to vastly increase the detection capability for the neutrino-induced air showers in the lower energy ($E < 10^{19}$ eV) regime.

This talk explores the role of newly implemented triggers in enhancing neutrino detection for zenith angles within the range $60° < \theta < 75°$. A novel neutrino identification method, which integrates MoPS and ToTd triggers, is developed and rigorously tested on simulated neutrino-induced air showers. The method is then applied to observational data to look for neutrino-like events using a *blind* search strategy. On the basis of the null observation new constraints to point-like sources of ultra-high-energy neutrinos will be presented for the angular range explored.

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T 53.7 Wed 17:45 VG 1.105

ML discrimination of atmospheric neutrinos for DSNB detection in JUNO — •David Maksimovic[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

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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 novel methods employing 3D Convolutional Neural Networks (3D CNNs) and Convolutional LSTMs (ConvLSTMS) for better discrimination of DSNB events from these backgrounds. These techniques 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 promising background reduction capabilities.

T 53.8 Wed 18:00 VG 1.105

Detecting Distant Supernovae Using Log-Likelihood Ratios

— •Kashish Gupta, Thilo Birkenfeld, and Achim Stahl — Lehrstuhl für Experimentalphysik III B

The Jiangmen Underground Neutrino Observatory (JUNO) offers a robust platform for observing Core-Collapse Supernovae through neutrino emissions. In this study, the inverse beta decay (IBD) is used for Supernova search, where an electron antineutrino interacts with a proton, producing a positron and a neutron signal. The IBD channel's high cross-section and distinct event signature are particularly beneficial for detecting distant supernovae. A likelihood ratio test is applied to identify IBD events caused by a Supernova from background events dominated by reactor antineutrinos. In the first method, events are considered only within a time window corresponding to the CCSNe duration, achieving a false alert rate (FAR) of 0.4/year for 2 IBD events and near-zero FAR for 3 IBD events.

A second method that treats arbitrary numbers of events on an equal footing is presented to improve sensitivity further.