T 67: Neutrino astronomy III

Time: Wednesday 16:00–18:30 Location: Tq

T 67.1 Wed 16:00 Tq

A new and improved IceCube point-source analysis — Chiara Bellenghi[1], Theo Glauch[1], Christian Haack[1], •Tomas Kontrimas[1], Hans Niederhausen[1], Martin Wolf[1], and Rene Reimann[2] for the IceCube-Collaboration — [1]Technische Universität München — [2]RWTH Aachen

The IceCube Neutrino Observatory is a one cubic kilometer neutrino telescope deployed deep in the Antarctic ice at the South Pole. The general aim of IceCube is to investigate high energy astrophysical phenomena by studying the corresponding high energy neutrino signal. One of the main goals is to identify the sources of the diffuse astrophysical neutrino flux, that IceCube discovered in 2012. We present a new method to search for neutrino point-sources that improves the accuracy of the likelihood function description in the low energy regime, where the usual Gaussian approximation of IceCube's point spread function breaks down. The new method includes multidimensional kernel density estimation (KDE) based probability density functions, angular error estimates using a boosted decision tree (BDT) classifier, and a new deep neural network (DNN) energy estimator. In this talk we will present the final performance estimates of the improved analysis.

T 67.2 Wed 16:15 Tq

The SkyLLH framework for IceCube point-source search — •Tomas Kontrimas and Martin Wolf for the IceCube-Collaboration — Technische Universität München

The hypothesis tests with unbinned log-likelihood (LLH) functions are a common technique used in multi-messenger astronomy, including IceCube's neutrino point-source searches. We present the general Python-based tool "SkyLLH", which provides a modular framework for implementing and executing log-likelihood functions to perform data analyses with recorded multi-messenger astronomy data from multiple experiments. Specific SkyLLH framework features for a new and improved IceCube point-source analysis are highlighted, including the support for kernel density estimation (KDE) based probability density functions. In addition, the future development goals of the SkyLLH framework as a common analysis tool for the multi-messenger community will be discussed.

T 67.3 Wed 16:30 Tq

Constraining populations of astrophysical neutrino sources with IceCube — •Chiara Bellenghi — Technische Universität München, Physik-Department, James-Franck-Str. 1, 85748 Garching

The IceCube neutrino telescope has provided precise measurements of the diffuse flux of high-energy astrophysical neutrinos. However, the sources of this signal have not been identified yet. The effort to identify point-like neutrino sources recently resulted in the development of a new analysis method that improves the accuracy of the search in the low-energy regime. In addition to the point-source search, the sky can also be tested for a significant excess of events from a population of sub-threshold sources. Such a signal from multiple weaker sources would be missed by analyses aiming at pointing only to the most significant one. The presentation will focus on the performance of this "hotspot population analysis".

T 67.4 Wed 16:45 Tq

Future Sensitivity of the Astrophysical Neutrino Flux Measurement in IceCube: Improved Energy Estimation and Uncertainties — •Philipp Fürst[1], Jakob Böttcher[1], Erik Ganster[1], Christian Haack[2], Jöran Stettner[1], and Christopher Wiebusch[1] for the IceCube-Collaboration — [1]RWTH Aachen University - Physics Institute III B, Aachen, Germany — [2]TU München

The IceCube Neutrino Observatory has measured a diffuse flux of high-energy astrophysical neutrinos in multiple detection channels. We focus on the channel of neutrino-induced muon tracks where the astrophysical signal is measured by an excess of high-energy events above the background of atmospheric neutrinos. The uncertainty of such a measurement depends on the systematic uncertainties of the detector and background predictions, and particularly on the resolution of the energy estimate of the muon in the detector. Several methods for the energy estimation already exist - here, we present a new energy estimator with increased resolution which is based on a combination of these previous estimation methods. We present possible sensitivity gains from increasing the energy resolution and compare them to the influence of the other systematic uncertainties. Combining all this information with increased detector livetime, we give an outlook towards feasible future sensitivity gains.

T 67.5 Wed 17:00 Tq

Search of BSM Particle STau in IceCube — •Jan-Henrik Schmidt-Dencker, Stephan Meighen-Berger, Christian Haack, and Elisa Resconi for the IceCube-Collaboration — Technische Universität München

The supersymmetric partner of the Tau lepton, the STau, appears in some models as the next-to lightest and therefore a long-lived particle. In this scenario its signature is a long-dim minimally ionizing track when travelling through the IceCube detector. The STau tracks, independent of their primary energy, seem like low energy muons for the detector and will appear as an excess on the muon tracks by atmospheric neutrinos. In our analysis we focus on the region around the horizon as we expect the ratio between STau signal and atmospheric muons to be best there. We then calculate the sensitivity to constrain the mass of the STau using the IceCube detector.

T 67.6 Wed 17:15 Tq

Investigation of the Neutrino Emission from Supermassive Black Hole Mergers and Starburst Galaxies — •Ilja Jaroschewski[1], Julia Becker Tjus[1], and Peter L. Biermann[2,3,4,5] — [1]Theoretische Physik IV, Ruhr-Universität Bochum — [2]MPI for Radioastr., Bonn — [3]Dept. of Phys., Karlsruhe Inst. for Tech. — [4]Dept. of Phys. & Astron., Univ. Alabama, Tuscaloosa, AL, USA — [5]Dept. of Phys. & Astron., Univ. Bonn

The first detection of non-terrestrial, high-energy neutrinos by IceCube in 2013 as well as the high-probability association of such a neutrino to the blazar TXS 0506+056 in 2017 are fundamental achievements in neutrino astronomy. Along with the successful detection of gravitational waves in September 2015 by LIGO and the clear identification of the binary neutron star merger GW170817, these detections opened both new branches in multi-messenger astrophysics. With over a dozen binary black hole mergers already documented and more to come, there are strong indications that supermassive black holes in galaxy centers also merge and have had at least one merger in their lifetime.

Such a merger is almost always accompanied by a change of the jet direction leading to interactions of the jet with molecular clouds and therefore neutrino productions.

In this work, the connection between the radiated gravitational wave energy of supermassive black hole mergers and the diffuse astrophysical neutrino flux that is measured by IceCube is investigated. It is estimated whether these mergers contribute to the diffuse neutrino flux and how much starburst galaxies can contribute.

T 67.7 Wed 17:30 Tq

Die Suche nach versteckten Supernovae mit dem IceCube Neutrinoteleskop — •Alexander Fritz und Lutz Köpke für die IceCube-Kollaboration — Institut für Physik, JGU Mainz, Deutschland

IceCube ist mit 1 km^3 das weltweit größte Neutrinoteleskop und nimmt am Südpol Daten rund um die Uhr mit mehr als 99 % Verfügbarkeit. Im Falle einer Supernova messen die 5160 optischen Module einen Überschuss in der Rauschrate, welche sonst durch das Dunkelrauschen dominiert wird, und bieten die beste Zeitauflösung der Neutrinolichtkurve für galaktische Supernovae. Rund ein Drittel der Supernovae in benachbarten Galaxien könnten durch Staub mit optischen Methoden unerkannt bleiben, ähnliches gilt für Supernovae, die in schwarzen Löchern enden. Erste Ergebnisse zur Bestimmung einer oberen Grenze auf die Rate galaktischer Supernovae anhand von 11 Jahren IceCube-Daten werden präsentiert. Das effektive Volumen für einen Stern mit 20 Sonnenmassen ist in 10 kpc Enfernung zwei Größenordnungen höher als das von Super-Kamiokande. Für die leichtesten möglichen Vorläufersterne sind die effektiven Volumina vergleichbar. Zudem wird eine Suche nach möglichen periodischen Signalen - versteckt in der IceCube-Dunkelrauschrate - mit Hilfe der Lomb-Scargle Transformation demonstriert.

T 67.8 Wed 17:45 Tq

Mean Supernova Neutrino Energy Reconstruction with IceCube — •David Kappesser and Lutz Köpke for the IceCube-Collaboration — Johannes Gutenberg-Universität, Mainz

The IceCube Neutrino Observatory is capable of detecting supernova neutrinos with energies around 10 MeV by observing a significant excess in the overall raw rate of the detector above noise rate. This method allows for a particularly precise measurement of the supernova neutrino lightcurve. Due to IceCube's sparse Instrumentation with Digital Optical Modules (DOMs), only in rare cases, more than one Cherenkov photon is detected per supernova neutrino interaction. Still, the number of coincidences is sufficiently large in order to estimate the average neutrino energy by analyzing the energy dependent rate increase of coincidences between neighbouring DOMs. A Geant4 based Monte Carlo was developed and tested to calibrate and evaluate such a measurement. Further Geant4 simulations were used to study the passage of positrons through ice, their production of secondary particles, and the Cherenkov photons being emitted. I will present a Likelihood approach for the analysis of this simulated data and to account for the different combinations of noise and supernova signal events leading to coincidences in the detector.

T 67.9 Wed 18:00 Tq

Particle identification by high resolution convolutional neural networks for the DSNB detection in next generation neutrino experiments — •David Maksimovic, Michael Nieslony, and Michael Wurm — Johannes Gutenberg-Universität, Mainz, DE

An important physics goal of next generation neutrino experiments is the search for the Diffuse Supernova Neutrino Background (DSNB), which is an isotropic neutrino signal composed of all the supernova explosions that occurred throughout the observable universe. Through the addition of Gadolinium to water Cherenkov detectors, many of the single-event backgrounds that were problematic in earlier analyses can be suppressed, generating a possible detection window from 10 to 30 MeV. Within this window, neutral current (NC) events of atmospheric neutrinos are the main remaining background. This talk presents the application of convolutional neural networks (CNN) for the identification and rejection of such atmospheric NC background events in future DSNB searches. The developed CNNs show very promising results and could prove to be of high relevance for measuring this signal in next generation neutrino experiments.

T 67.10 Wed 18:15 Tq

Ordinal Classification in DSEA — •Jan Philipp Jäkel — Technische Universität Dortmund

DSEA+, or Dortmund Spectrum Estimation Algorithm, is an improved version of the original DSEA algorithm built for unfolding energy distributions in the area of neutrino astronomy. It interprets deconvolution as a multinomial classification problem enabling reconstruction of binned spectra. Several classification models can be embedded for this purpose, but all of them treat the energy bins and their associated reconstructed values as unrelated quantities, leading to loss of generality. The need for ordinal classification arises, that preserves the ordinal inherent nature of the energy spectra. In this talk, we propose a built on version of DSEA+ utilizing this approach with the result of refined reconstruction and the capability of inspecting probability distributions of individual events detected.