T 17: Neutrino Astronomy I

Time: Monday 16:00–18:35 Location: Tq

Group Report T 17.1 Mon 16:00 Tq

KM3NeT: Status, results and science goals — •Matthias Bissinger for the ANTARES-KM3NeT-Erlangen-Collaboration — Erlangen Centre for Astroparticle Physics, Erwin-Rommel-Str. 1, 91058 Erlangen, Germany

The research infrastructure KM3NeT is currently under construction off shores of France and Italy. The two main objectives of KM3NeT are investigating fundamental aspects of neutrino physics as well as the discovery and analysis of the most powerful cosmic accelerators via their neutrino signal. The deep-sea Cherenkov detectors, ORCA and ARCA, consist of technically identical detector modules but with different instrumentation densities. KM3NeT/ORCA will allow us to determine the oscillation probabilities of GeV-scale neutrinos produced in Earth's atmosphere and thus to constrain the neutrino mass hierarchy. KM3NeT/ARCA's instrumented sea volume of one cubic kilometer is much larger compared to ORCA. ARCA will detect neutrinos of energies from TeV to beyond PeV and thus of galactic origin and way beyond. Combined with the existing neutrino telescopes KM3NeT will complete our neutrino field of view to the full sky. The talk will summarise the current construction status of KM3NeT, the results achieved by investigating the data recorded over the past years, and the scientific discovery potential of the upcoming years.

T 17.2 Mon 16:20 Tq

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

The KM3NeT neutrino detectors are currently under construction in the deep Mediterranean Sea. ORCA, the low-energy part of KM3NeT, is an underwater Cherenkov neutrino detector featuring a dense configuration of optical modules designed for the measurement of atmospheric neutrinos down to the low GeV energy regime. A very large sample of atmospheric muon events has already been recorded and can be used to study the detector performance. Located in a deep-sea environment, the detector performance depends on the optical water properties.

In this talk, atmospheric muon events are used to study the optical water properties with the ORCA detector. The focus is on the comparison between data and Monte-Carlo simulations with respect to the attenuation length.

T 17.3 Mon 16:35 Tq

Modeling Deep-Sea Bioluminescence — •Stephan Meighen-Berger[1] and Li Ruohan[2] — [1]Technische Universität München, James-Franck-Straße, 85748, Garching — [2]Ludwig-Maximilians-Universität München, Schellingstraße 4, 80799, München

We present a new modeling framework for simulating deep-sea organisms and their luminescence which is detectable by neutrino detectors, such as KM3Net, Antares, and P-ONE. This bioluminescence light is a unique background for deep-sea instruments, due to the emission spectra covering the expected Cherenkov peak. The emission itself is predominantly caused by the organisms' defensive response to turbulences caused by detectors' super-structures. Designed for a broad range of Reynold's numbers, the framework employs Monte Carlo methods to model individual organisms. It provides methods to solve the underlying Navier-Stokes equation, using Streamline Upwind Petrov Galerkin Method in the velocity equation to avoid instabilities. In this talk, we present the framework, lessons learned from this new exact modeling scheme, and unique signatures that can be used to identify the organisms, bridging the gap between physics and biology.

T 17.4 Mon 16:50 Tq

The Pacific Ocean Neutrino Experiment: site qualification — •Immacolata Carmen Rea and Christian Fruck — TUM Physics Department, Munich, Germany

The Pacific Ocean Neutrino Experiment (P-ONE) is a collaboration of Ocean Networks Canada (ONC), the Technical University of Munich (TUM), Germany, and other US and Canadian universities, with the goal of building a large volume neutrino telescope at 2600 m depth in the Cascadia Basin site (a heavily sedimented abyssal plain region 300 km west from Vancouver Island in the northern Pacific Ocean). Two pathfinder experiments have already been deployed there: STRAW (STRings for Absorption length in Water) in 2018 and STRAW-b in 2020. The main purpose of both is the optical qualification of the site placing a special focus on the absorption and scattering length measure and on the light background, mainly caused by bioluminescence phenomena.

STRAW is composed by a two strings array equipped with pulsed light sources, 3 POCAMs (Precise Optical CAlibration Modules) that are also under development for IceCube upgrade, and with custom developed light sensors, 5 sDOMs (STRAW digital Optical Modules). With this setup the light attenuation has been probed on different baselines and background rates have been recorded in several sensors over almost 2 years. We present the preliminary results of this first pathfinder mission and discuss the implications for a future neutrino telescope at this site.

T 17.5 Mon 17:05 Tq

The Pacific Ocean Neutrino Experiment: STRAW-b as a pathfinder — •Eva Laura Winter, Christian Spannfellner, and Elisa Resconi — Technische Universität München, Germany

The Pacific Ocean Neutrino Experiment (P-ONE) is a collaboration of Ocean Networks Canada (ONC), the Technical University Munich (TUM) and other Canadian/German institutes with the aim of building a large-scale neutrino telescope in the Northeast Pacific Ocean. Two pathfinders have been developed and successfully deployed, as part of the NEPTUNE observatory, established by ONC, at Cascadia Basin, which will also host P-ONE. The first pathfinder STRAW (STRings for Absorption length in Water) was deployed in June 2018 and has measured the optical properties of the deep Pacific Ocean. Moreover, it is also monitoring the in-situ background rates due to K40 decay and bioluminescence. Subsequently, the second pathfinder STRAW-b, deployed in September 2020, aims to further characterize the deployment site. For this, it is equipped with six specialized modules, two LiDARs, three spectrometers and one muon tracker. The talk covers technical details and will give an overlook of preliminary results of the pathfinders.

T 17.6 Mon 17:20 Tq

The Pacific Ocean Neutrino Experiment: the prototype line — Elisa Resconi and •Christian Spannfellner — Technische Universität München

The Pacific Ocean Neutrino Experiment (P-ONE) is a Canadian/German initiative, which aims to construct a new large volume astrophysical neutrino detector in the Northeast Pacific Ocean. P-ONE strives to complement the sky coverage of the existing or under development neutrino telescopes, as such it will be part of the NEPTUNE observatory, established by Oceans Networks Canada (ONC). This deepsea infrastructure provides power and data streams for various experiments. At the Cascadia Basin node, which will host P-ONE, two pathfinders were already initiated to characterize the site. The P-ONE prototype line, currently in its early concept phase, is planned as the successor of the pathfinders and will be the first installment of the P-ONE detector. The line will be comprised of P-ONE Digital Optical Receivers (P-DOR) to detect the emerging Cherenkov radiation and P-ONE Calibration Modules (P-CAL) to provide in-situ calibration. We will present the concepts of the planned optical sensors and calibration modules and give an outlook on the entire mooring.

T 17.7 Mon 17:35 Tq

PLEnuM: Prospects of a planetary neutrino observatory system — •Matthias Huber and Elisa Resconi — Technische Universität München, Fakultät für Physik, James-Franck-Str. 1, 85748 Garching, Deutschland

High-energy neutrinos, arriving at the Earth from the farthest reaches of the cosmos have long been thought to hold the key to resolving the cosmic ray riddle. While the first compelling evidence for a correlation between high-energy neutrinos and the blazar TXS 0506+056 was found in 2018, no sources of these neutrinos have been discovered yet. To bring rapid improvements in the sensitivity of cosmic neutrino studies, we propose to launch the Planetary Neutrino Monitoring System (PLEnuM). The concept of PLEnuM is based on the vision to operate a global-scale neutrino telescope network, integrating all neutrino telescopes in progress (KM3NeT, GVD, P-ONE, IceCube). By means of this collaboration, every direction of the Universe becomes observable with local improvements of the sensitivity of factors up to ~160 compared to IceCube. In this talk, I will outline the prospects of cosmic neutrino source searches on the basis of PLEnuM.

T 17.8 Mon 17:50 Tq

Development of an in-situ calibration device of ice properties for high-energy neutrino radio detectors in Antarctica — •Jakob Beise — Uppsala Universitet, Uppsala, Sweden — Humboldt Universität, Berlin, Germany

High-energy neutrino astronomy has become a powerful tool to explore the most extreme environments in our universe. High energy neutrinos (E>$10^{16.5}$ eV) are detected most efficiently via the Askaryan effect in ice, where a particle cascade induced by the neutrino interaction produces coherent radio emission. There are several pilot radio arrays at the moment, among them ARIANNA at the Ross Ice Shelf. In order to reconstruct the neutrino energy with high precision, the snow accumulation must be monitored in real time. Therefore, one ARIANNA station was extended with a radio emitter that allows the measurement of the snow accumulation with unprecedented precision. I will present 14 months of measured data that I analyzed using traditional and deep-learning techniques. Furthermore, I show how the measurement setup can be extended to also measure the change of the index-of-refraction with depth, another property relevant for reconstruction of the neutrino direction and energy.

T 17.9 Mon 18:05 Tq

Seasonal Variations of the Atmospheric Neutrino Flux Measured by IceCube — •Hannah Erpenbeck, Jakob Böttcher, Philipp Fürst, Simon Hauser, Jöran Stettner, and Christopher Wiebusch for the IceCube-Collaboration — RWTH Aachen University - Physics Institute III B, Aachen, Germany

Atmospheric muon neutrinos measured by the IceCube Neutrino Observatory originate from charged meson decays in cosmic-ray-induced air showers. The meson production and decay depend on the local atmospheric conditions. Therefore, one expects a correlation between the atmospheric temperature and the observed atmospheric neutrino flux. We have analyzed almost 6 years of IceCube neutrino data in conjunction with global atmospheric temperature profiles measured by the Atmospheric Infrared Sounder (AIRS) on the AQUA satellite, and the correlation is observed with high significance. In this talk, we present a binned χ^2 and an unbinned likelihood analysis of the correlation with focus on systematic checks of the results.

T 17.10 Mon 18:20 Tq

Seasonal Variations of the Unfolded Atmospheric Neutrino Energy Spectrum with IceCube — •Karolin Hymon and Tim Ruhe for the IceCube-Collaboration — TU Dortmund

The IceCube Neutrino Observatory is a detector array at the South Pole, with the central aim of studying high energy neutrinos of astrophysical origin. The majority of the detected neutrinos, however, are atmospheric neutrinos, caused by cosmic ray interactions in the atmosphere. The rate of atmospheric neutrinos undergoes a seasonal variation with indications that the rate changes with the temperature in the stratosphere. Possible implication of this variation on the shape of the atmospheric neutrino spectrum have not been studied so far. This talk will focus on the investigation of possible shape changes of the atmospheric neutrino spectrum, which will be analyzed using the Dortmund Spectrum Estimation Algorithm (DSEA).