T 61: Gamma Astronomy I

Time: Wednesday 16:15–17:45 Location: KS 00.005

T 61.1 Wed 16:15 KS 00.005

MSH 15-52 in the high-energy regime: Exploring 3D eROSITA and H.E.S.S. data in a joint analysis with Gammapy — •Katharina Egg and Alison Mitchell for the H.E.S.S.-Collaboration — Erlangen Centre for Astroparticle Physics (ECAP), Friedrich-Alexander-Universität Erlangen Nürnberg

The pulsar wind nebula (PWN) MSH 15-52 is a fascinating system. It is not only a bright and prominent source in TeV gamma-rays, as seen by the H.E.S.S. telescope array, but is also visible in GeV gamma-rays with Fermi-LAT, as well as in X-ray data at keV energies. By characterizing the multiwavelength spectral energy distribution of MSH 15-52 we can draw conclusions about this PWN and its underlying physics.

In this vein, we present a multiwavelength analysis of MSH 15-52, using X-ray data from the eROSITA telescope, as well as H.E.S.S. data. Using 3D eROSITA data – comprising one spectral and two spatial dimensions – which we import into the open source analysis software Gammapy, enables us to conduct a joint analysis at photon event level over 12 orders of magnitude in energy, painting a comprehensive picture of this PWN in three dimensional data. We investigate different spectral and spatial models, test for energy-dependent morphology, and draw conclusions on the underlying particle spectrum of the source.

In this talk our current progress with the analysis will be illustrated and an outlook towards the future investigation of MSH 15-52 will be given.

T 61.2 Wed 16:30 KS 00.005

Searching for Ultra-High Energy Photons applying Convolutional Neural Networks Using the Surface Detector of the Pierre Auger Observatory — •Fiona Ellwanger, Ralph Engel, Markus Roth, Steffen Hahn, David Schmidt, Darko Veberic, and Pierre Auger Collaboration — Karlsruher Institut für Technologie, Karlsruhe, Germany

Identifying sources of cosmic rays is challenging, as the charged particles are deflected by magnetic fields and do not point back to their sources. Neutral particles, such as ultra-high energy (UHE) γs will point directly to their sources, unless they interact in the interstellar medium or are absorbed. Cosmic ray detectors such as the $3000\,\mathrm{km}^2$ surface array of the Pierre Auger Observatory are capable of observing UHE γs above 10^{18} eV. With increasing energy, their mean free path allows probing extragalactic sources up to a few Mpc. Different methods like BDTs and air-shower universality have been previously applied to the search of γs at different energy ranges. Although no UHE γs have been found, the obtained bounds of the fluxes provide crucial constraints on cosmic-ray acceleration models. Neural networks have the potential to improve discrimination, enhancing the sensitivity to even lower fluxes. In this work, we present a convolutional neural network designed to distinguish between simulated UHE photon and proton showers. We evaluate possible systematics due to the imperfect simulation of air showers and detector effects using an independent test set and a burn sample consisting of 2% of the available data. Steps for a future unblinding of the search sample are discussed.

T 61.3 Wed 16:45 KS 00.005

Shower based cross-calibration of swgo — •Florian Foith, Alison Mitchell, and Martin Schneider for the SWGO-Collaboration — ECAP, FAU Erlangen-Nürnberg

This work discusses the possibility of calibrating the effective efficiencies of Water Cherenkov detectors (WCDs) at the Southern Wide-field Gamma-ray Observatory (SWGO) by utilizing pairwise charge asymmetry parameters. These parameters are computed for single shower events and then averaged over all conducted simulations. The concept, originally proposed for Imaging Atmospheric Cherenkov Telescopes (IACTs), has proven successful for the Cherenkov Telescope Array (CTA) and is now being tested with two possible approaches for asymmetry parameter computation for SWGO. We found that following preliminary testing against grid anomalies, our method demonstrates promising accuracy within the limitations of WCD-based gamma-ray observatories.

T 61.4 Wed 17:00 KS 00.005

Effects of the geomagnetic field on IACT event reconstruction — •Matheus Genaro Dantas Xavier, Tim Unbehaun, Rodrigo Guedes Lang, and Stefan Funk — Erlangen Centre for Astroparticle Physics (ECAP), Friedrich-Alexander-Universität Erlangen-Nürnberg

The observation of astrophysical gamma rays by Imaging Atmospheric Cherenkov Telescopes (IACTs) is based on the detection and imaging of Cherenkov light produced along the development of extensive particle air showers. The recorded images are then analyzed to reconstruct fundamental information of the primary gamma ray, such as its energy and direction. Due to Earth's magnetic field, charged particles in the shower are deflected during their trajectory, broadening the lateral development of the shower and the distribution of Cherenkov light on the ground. Consequently, distortions in the camera image can lead to systematic effects in the reconstruction procedure. These effects are especially visible for low energy events (~ 100 GeV) and are believed to be significant when only one telescope is triggered (monoscopic reconstruction). In this work, we investigate the impact of the geomagnetic field on the largest H.E.S.S. telescope (CT5), based on simulations of gamma-ray-induced air showers. Due to its large light collection area and improved camera design, CT5 is crucial for lowering the energy threshold of observed sources. Therefore, to comprehend the geomagnetic field effects is especially important to quantify and possibly correct systematic errors present on the monoscopic analysis.

T 61.5 Wed 17:15 KS 00.005

Get More for Less - Adaptive Sampling in Event Simulations For the Cherenkov Telescope Array Observatory — •Tristan Gradetzke and Luca Di Bella — TU Dortmund University, Dortmund, Germany

Monte Carlo (MC) simulations of particle induced extensive air showers are crucial to the analysis of observational data taken by Imaging Air Cherenkov Telescopes (IACTs). They serve the purpose of training and test data for the algorithmic reconstruction of particle type, energy, and direction of the originating particle. The performance of this reconstruction on the Monte Carlo data is mathematically described by the Instrument Response Functions (IRFs). Their usage however, comes at the extensive cost of computational resources. Consequently, considerable effort has been invested in improving the efficiency of these MC simulations. The objective of this work is to investigate the potential of adaptive sampling-based methods, that focus on specific phase-space regions to enhance event statistics and, to a certain extent, possibly reduce uncertainties in the IRFs. Thus reducing the extent of Monte Carlo productions. Phase space in this context refers to, among others, detector field of view and primary particle energy . The main challenges arise from the definition of a metric, that is optimized by any given algorithm. Here, a simple event-per-bin based metric is adopted. Possible improvements in efficiencies and an overview of potential avenues for future research are presented.

T 61.6 Wed 17:30 KS 00.005

Determining Telescope Pointing Direction Using Stellar Projections — •Daniel Cecchin Momesso and Christopher van Eldik — Friedrich-Alexander-Universität Erlangen-Nürnberg, Erlangen Centre for Astroparticle Physics, Nikolaus-Fiebiger-Str. 2, 91058 Erlangen, Germany

This work presents a data-driven approach to improve the pointing accuracy of Imaging Atmospheric Cherenkov Telescopes (IACTs), such as those in the H.E.S.S. array. These telescopes detect Cherenkov light from gamma-ray-induced atmospheric showers, but are also sensitive to diffuse and stellar background light. This Night Sky Background (NSB) contains spatial information associated with the distribution of bright stars in the field of view. Based on stellar positions provided by catalogs, their projections onto the camera coordinates are compared with features observed in the NSB maps. This correspondence is the basis for correcting the pointing direction of the telescope and will be compared to the results of standard calibration methods.