T 10: Gamma astronomy 1

Time: Monday 16:00–18:00 Location: Geb. 30.22: kl. HS A

T 10.1 Mon 16:00 Geb. 30.22: kl. HS A

Background estimation for IACTs combining a run matching approach with a background template — •Tina Wach[1], Alison Mitchell[1], and Lars Mohrmann[2] — [1]Erlangen Centre for Astroparticle Physics (ECAP), Friedrich-Alexander-Universität Erlangen-Nürnberg — [2]Max-Planck-Institut für Kernphysik

Detecting large, extended gamma-ray structures using IACTs has been a major challenge due to their comparatively small field-of-view. In the case of large extended sources, the separation between background and source signal is challenging, since most techniques rely on the background signal evaluation from source-free regions within the field-of-view of the respective observation. This is however only possible if the gamma-ray emission is well contained within the field-of-view of the telescope array. One way to overcome this challenge is to estimate the background from a separate observation of a source-free region, although this can introduce large systematic uncertainties.

To decrease the systematic uncertainties and their correlation to the choice of the observation of the source-free region, we use the open-source tool gammapy to combine the ON observation / OFF observation method with a 3-dimensional background template, created from a large amount of archival data of the H.E.S.S. array. We then use data from the first public data release of the H.E.S.S. Collaboration to validate the technique and evaluate the systematic errors introduced. We show that this method is a stable approach to estimate the background rate in complicated regions of the sky where other approaches cannot be used.

T 10.2 Mon 16:15 Geb. 30.22: kl. HS A

Towards a multiwavelength analysis of Pulsar Wind Nebulae at gamma-ray and X-ray energies with Gammapy — •Katharina Egg and Alison Mitchell — Erlangen Centre for Astroparticle Physics (ECAP), Friedrich-Alexander-Universität Erlangen Nürnberg

Pulsar wind nebulae (PWNe) are structures produced by the outflow of highly energetic particles from pulsars. As regions harbouring extreme physical conditions, PWNe are possible PeVatron candidates (accelerators of particles to PeV energies). While many PWNe have been detected and even first discovered as sources of gamma-ray emission, the particle winds driving this process are expected to cause the emission of photons across the entire electromagnetic spectrum. Thus the study of PWNe in multiple energy bands is key to constrain their characteristics and environments.

In this vein, data from the eROSITA X-ray telescope, in conjunction with gamma-ray data from the H.E.S.S. telescope array, provides the opportunity of studying even very faint X-ray counterparts of PWNe on large scales. This analysis is undertaken using the Gammapy package that is developed for the handling of gamma-ray data in a Python framework. In this contribution, the capabilities of Gammapy in the combined handling of X-ray and gamma-ray data are explored and the process towards the goal of conducting a joint analysis of X-ray and gamma-ray data is showcased.

T 10.3 Mon 16:30 Geb. 30.22: kl. HS A

High-energy variability of the gravitationally lensed blazar PKS 1830-211 — •Sarah M. Wagner[1,2], Jeffrey D. Scargle[3], Greg Madejski[2], Andrea Gokus[4], and Krzysztof Nalewajko[5] — [1]Uni Würzburg, Germany — [2]Stanford University, USA — [3]NASA Ames, USA (retired) — [4]Washington University in St. Louis, USA — [5]Polish Academy of Sciences, Poland

Gravitational lenses can be used as microscopes to investigate the origin of the highly variable high-energy emission observed from blazar jets. We study the broad-band spectral properties and the multi-wavelength variability of the gravitationally-lensed blazar PKS 1830-211 to put constraints on the structure and relevant physics of its jet. We utilize Swift/XRT, NuSTAR, and Fermi-LAT observations from 2016 and 2019 to compare periods of low activity and high activity. Additionally, we introduce a novel method to observe short-timescale variability in unbinned NuSTAR data and present an extensive discussion on the gravitationally-induced time delay in the gamma-ray light curve observed with Fermi-LAT. Based on our analysis, we find a delay of ~22 days and illustrate that delicate methods are needed to reliably detect this. The detection of a consistent lag throughout the whole light curve suggests that the production site of the gamma-ray emission is spatially constant. When comparing the 2016 and 2019 datasets, the X-ray part of the SED is remarkably stable in comparison to the dramatic change in the gamma rays. We explain the differences in the activity observed in X-rays and gamma rays as arising due to a change in the break in the electron energy distribution.

T 10.4 Mon 16:45 Geb. 30.22: kl. HS A

Investigation of the influence of an updated model for the extragalactic background light on the multi-messenger signatures of Blazar 3C279 with CRPropa — •Yannick Schmidt[1,2], Lukas Merten[1,2], and Julia Becker Tjus[1,2,3] — [1]Theoretical Physics IV, Plasma Astroparticle Physics, Faculty of Physics and Astronomy, Ruhr-University Bochum, 44780 Bochum, Germany — [2]Ruhr Astroparticle and Plasma Physics Center (RAPP Center), Germany — [3]Department of Space, Earth and Environment, Chalmers University of Technology, 412 96 Gothenburg, Sweden

In order to come closer to understanding extragalactic sources of cosmic rays and their intrinsic mechanisms, the analysis of various multi-messenger signals has proven to be extremely promising in recent decades. Typically, numerical simulations are undertaken to investigate the validity of various astrophysical scenarios. Predictions considering photonuclear interactions depend significantly on the modeling of extragalactic photon fields. Therefore, in the present work an updated model of the extragalactic background light was implemented in the open-source code CRPropa 3.2 to investigate its effects on gamma-ray signals from blazar 3C279. In particular, the new model showed a higher prediction of produced photons by inverse Compton scattering when simulating electromagnetic cascades, while the opacity of the universe for gamma radiation was lower than in previous models.

T 10.5 Mon 17:00 Geb. 30.22: kl. HS A

Multi-Messenger Picture of J1048+7143 Consistent with a Supermassive Black Hole Binary Origin* — •Ilja Jaroschewski[1,2], Emma Kun[1,2,3,4], and Julia Becker Tjus[1,2,5] — [1]Theoretical Physics IV, Plasma Astroparticle Physics, Faculty for Physics and Astronomy, Ruhr University Bochum, 44780 Bochum, Germany — [2]Ruhr Astroparticle and Plasma Physics Center (RAPP Center), Germany — [3]Astronomical Institute, Faculty for Physics and Astronomy, Ruhr University Bochum, 44780 Bochum, Germany — [4]3CSFK, MTA Centre of Excellence, Hungary — [5]Department of Space, Earth and Environment, Chalmers University of Technology, 412 96 Gothenburg, Sweden

Until mid 2022, the Fermi-LAT gamma-ray light curve of the FSRQ J1048+7143 showed three distinct flares, each consisting of two subflares. These flares are accompanied by simultaneous flares in radio wavelengths, without a subflare structure. In a previous work, it was shown that these flares are consistent with a supermassive binary black hole origin and are caused by jet precession due to spin-orbit coupling of the leading jet. The occurrence of the fourth flare in gamma rays was predicted, which is observable in the latest gamma-ray light curve.

In this work, we show how the fourth flare in gamma rays was predicted and how the detection of it tightly constraints the mass ratio of the binary. Such a constraint allows to predict when the binary will merge. In addition, we highlight how jet precession provides an explanation for the subflare structure seen in the gamma-ray light curve.
*Supported by DFG (MICRO and SFB 1491)

T 10.6 Mon 17:15 Geb. 30.22: kl. HS A

Expanding the Multi-Messenger Picture of J1048+7143 with the Optical Light Curve* — •Johannes Just[1,2], Ilja Jaroschewski[1,2], Emma Kun[1,2,3,4], and Julia Becker Tjus[1,2,5] — [1]Theoretical Physics IV, Plasma Astroparticle Physics, Faculty for Physics and Astronomy, Ruhr University Bochum, 44780 Bochum, Germany — [2]Ruhr Astroparticle and Plasma Physics Center (RAPP Center), Germany — [3]Astronomical Institute, Faculty for Physics and Astronomy, Ruhr University Bochum, 44780 Bochum, Germany — [4]3CSFK, MTA Centre of Excellence, Hungary — [5]Department of Space, Earth and Environment, Chalmers University of Technology, 412 96 Gothenburg, Sweden

The gamma-ray and radio light curves of J1048+7143 reveal a pattern of quasi-periodic oscillations that can be explained by the existence of a supermassive binary black hole inspiral at its core. In such a model, the light curves are explainable via jet precession of the dominant supermassive black hole jet caused by spin-orbit coupling.

In this work, we add optical data in the V and G band to the multimessenger picture. We determine the duration and occurrence times of the flares with this new, optical data and predict the time of the next flare. With the results obtained using this optical data, we build a consistent model across the wavelengths. The Fermi-LAT gamma-ray and optical light curve of the blazar show a double flare substructure in the main flares while the radio light curve does not show this feature. In our model, we work out a scenario for which the different wavelengths can be explained consistently. *Supported by DFG (SFB 1491)

T 10.7 Mon 17:30 Geb. 30.22: kl. HS A

On the possible jet contribution to the γ-ray luminosity in NGC 1068 — •Silvia Salvatore[1,2], Björn Eichmann[1,2], Xavier Rodrigues[2,3,4], Ralf-Jürgen Dettmar[2,4], and Julia Becker Tjus[1,2,5] — [1]Theoretische Physik IV, Ruhr-Universität Bochum, Bochum, Germany — [2]RAPP-Center, Ruhr-Universität Bochum, Bochum, Germany — [3]European Southern Observatory, Garching bei München, Germany — [4]Astronomisches Institut (AIRUB), Ruhr-Universität Bochum, Bochum, Germany — [5]Department of Space, Earth and Environment, Chalmers University of Technology, 412 96 Gothenburg, Sweden

NGC 1068 is a widely studied Seyfert II galaxy with a broad energy band, from radio to gamma-ray emissions. A strong evidence for high-energy neutrino emission was recently discovered by IceCube. In this work, we focus on the gamma-ray emission and in particular we discuss whether the radio jet can be a source of the gamma rays between 0.1 and 100 GeV, as observed by Fermi-LAT. We include both leptonic and hadronic processes and use spatially resolved VLBA and ALMA observations of the radio knot structures to constrain our calculations. Our results show that the best leptonic scenario for the prediction of the Fermi-LAT data is provided by the radio knot observed at 15 pc from the central engine. For this knot, a magnetic field strength of about 1 mG is needed as well as a strong spectral softening of the relativistic electron distribution at 1-10 GeV. We show that both these conditions cannot meet and that there is no other jet emission scenario able to explain the gamma-ray signal in the entire Fermi-LAT band.

T 10.8 Mon 17:45 Geb. 30.22: kl. HS A

Spatially Coherent 3D Distributions of HI and CO in the Milky Way — •Laurin Söding[1], Philipp Mertsch[1], and Vo Hong Minh Phan[2] — [1]Institute for Theoretical Particle Physics and Cosmology (TTK), RWTH Aachen University, 52056 Aachen, Germany — [2]LERMA, Sorbonne University

The spatial distribution of the gaseous components of the Galaxy is of great importance for interpreting and modelling cosmic ray data and diffuse emission. Reconstructing interstellar gas from doppler-shifted line emission requires knowledge of gas velocities and generally suffers from distance ambiguities.

We overcome these issues by reconstructing the posterior distribution of 3D HI and CO gas densities and velocities in a common Bayesian inference scheme. We explicitly enforce a spatially coherent structure by means of modelling the 3D fields as correlated (log)normal random fields.

For the first time, we include the modelling of absorption effects, which are especially important for the usually optically thick CO emission lines. We also improve on previous reconstructions by promoting the galactic velocity field and the emission line widths to the set of reconstructed fields, and further constrain their values with complementary data from galactic masers.

We provide a spatially coherent large-scale picture of the 3D distribution of gas in the Galaxy and illustrate the value of these maps in predicting diffuse gamma-ray emission.