EP 7: Astrophysics

Time: Wednesday 16:15–18:50 Location: EP-H1

EP 7.1 Wed 16:15 EP-H1

Comparison of HAWC's Eye data and Monte Carlo simulations — •Mark Meyers for the HAWC's Eye-Collaboration — Physics Institute III A, RWTH Aachen, Germany

HAWC's Eye is an array of Imaging Air-Cherenkov Telescopes which runs in coincidence with the High altitude water cherenkov observatory (HAWC), forming the first hybrid detector for cherenkov light, observing high energetic gamma rays and cosmic rays in the range of 100 GeV to 100 TeV. The goal is to enhance the performance, by improving the energy calibration and arrival direction reconstruction. In a Monte Carlo simulation, extensive air showers of protons and gammas are observed by an array of 55 telescopes. Properties of the produced detector images in the single telescopes are compared to those that have been produced in measurements, to verify the simulation. These measurements were obtained in stereo observations with two telescopes in three campaigns during the years 2019 and 2020. Potential ways to improve the simulation according to the obtained results will be investigated.

EP 7.2 Wed 16:30 EP-H1

Indication for a local source in the Northern Hemisphere from the joined energy spectrum and mass composition fit of the Pierre Auger Observatory and Telescope Array experiment — •Pavlo Plotko[1], Arjen van Vliet[1], Xavier Rodrigues[1], Domenik Ehlert[2], and Walter Winter[1] — [1]DESY, Platanenallee 6, 15738 Zeuthen, Germany — [2]Institutt for fysikk, NTNU, Trondheim, Norway

The Pierre Auger Observatory (PAO) and Telescope Array (TA) energy spectrum working groups report significant differences for the energy spectra above $10^{19.5}$ eV for the full fields of view of both experiments. In this work, we present a joined fit to the energy spectrum and mass composition measured by TA and PAO. Our fitting procedure includes the systematic uncertainty for both experiments. We carry out a detailed 3D model of UHECR sources that depends on the cosmological source evolution and a universal spectral power-law index and maximal rigidity. UHECR propagation is simulated within the "Propagation including Nuclear Cascade equations" (PriNCe) framework. Our fit results suggest that a local source in the Northern Hemisphere, that is only visible by the TA experiment, can reconcile PAO and TA measurements. For this proposed local source we discuss two possibilities: First, an object located at a few hundred Mpc with a heavy composition (corresponding to our best fit) and second a source at an even closer distance with a lighter composition (within the 1σ interval of our fit). Finally, we discuss possible source candidates taking into account the latest results of the TA hotspots.

EP 7.3 Wed 16:45 EP-H1

Measurement of the mass composition of ultra-high energy cosmic rays at the Pierre Auger Observatory using a novel model based on air-shower universality — Markus Roth, David Schmidt, •Maximilian Stadelmaier, and Darko Veberic — KIT, Karlsurhe, Germany

We present a model of extensive air showers that is based on the implications of air-shower universality. The model comprises the spatial and temporal densities of particles expected from extensive air-showers induced by cosmic rays. Therewith, the depth of the shower maximum and the relative muon content of an air shower can be reconstructed solely from data collected by the surface detector of the Pierre Auger Observatory and the upgraded AugerPrime. Using these two observables, the logarithmic atomic mass of cosmic rays can be reconstructed on an event-by-event basis with sufficient accuracy to discriminate light from heavy primary particles. The method is calibrated using hybrid measurements from the surface detector and the fluorescence telescopes of Auger. Furthermore, we present results on the mass composition of ultra high-energy cosmic rays as estimated using the universality-based reconstruction.

EP 7.4 Wed 17:00 EP-H1

Analytic examination of AGN variability in a two-zone model — •Vito Aberham and Felix Spanier — Institut für Theoretische Astrophysik, Albert-Ueberle-Straße 2, 69120 Heidelberg

The variability of active galactic nuclei is examined analytically using a two-zone model that injects particles in a monoenergetic fashion. The elemental PDEs of both zones are solved neglecting terms behaving as second-order Fermi acceleration. The time-dependent behavior of the obtained particle distributions is inspected by employing a variable source function. As time approaches infinity the steady state distribution functions are recovered displaying the expected spectral indices. Being typical for BL Lac objects parameter estimates from a model fitting the SED of the blazar TXS 0506+056 are incorporated. Corresponding photon and neutrino fluxes in both local jet and earth frame are determined and compared to observations. The general time-dependence of photon light curves in various bands and the neutrino flux is evaluated by implementing a time-dependent initial source function. The variability timescales of relevant quantities are ultimately inferred also considering the effect of different particle species. It is demonstrated how the analytical results can be utilized to cross-check results from numerical simulation as well as to interpret observational data collected at different times.

EP 7.5 Wed 17:15 EP-H1

ExHaLe-jet: An extended hadro-leptonic jet model for blazars — •Michael Zacharias[1,2], Anita Reimer[3], Catherine Boisson[1], and Andreas Zech[1] — [1]LUTH, Observatoire de Paris, Meudon, France — [2]Centre for Space Research, North-West University, Potchefstroom, South Africa — [3]Institut für Astro- und Teilchenphysik, Universität Innsbruck, Austria

Blazars – active galaxies with the jet pointing at Earth – emit across all electromagnetic wavelengths. The so-called tne-zone model has described well both quiescent and flaring states, however it cannot explain the radio emission. In order to self-consistently describe the entire electromagnetic spectrum, extended jet models are necessary. Notably, kinetic descriptions of extended jets can provide the temporal and spatial evolution of the particle species and the full electromagnetic output. Here, we present the initial results of a recently developed lepto-hadronic, extended-jet code. As protons take much longer than electrons to lose their energy, they can transport energy over much larger distances than electrons and are therefore essential for the energy transport in the jet. Furthermore, protons can inject additional leptons through pion production and decay, as well as Bethe-Heitler pair production, which can explain a dominant leptonic radiation signal while still producing neutrinos. We will present a detailed parameter study and provide insights into the different blazar sub-classes.

EP 7.6 Wed 17:30 EP-H1

Modeling the leptonic origin of the low-frequency emission from blazar PKS 1502+106 — •Frederike Apel — Ruhr-Universität Bochum

In this work, we model the multi-wavelength emission from the blazar PKS 1502+106. This object is a candidate source of a high-energy neutrino observed by the IceCube experiment in 2019. We show that the emission from the source in the range from radio to infrared can be well explained by radiative (synchrotron) cooling of electrons accelerated in the relativistic jet. First, we show how simple analytical considerations can be used to obtain a rough estimate of the physical parameters of the source. Then, using time-dependent numerical simulations, we obtain a more accurate result that reproduces the observed spectral energy distribution. This result sheds light on the physical properties of the source, and can be used in the future to better constrain its nature as a hadronic accelerator.

EP 7.7 Wed 17:45 EP-H1

Time-dependent simulations of a Blazar-Flare — •Maximilian Albrecht and Felix Spanier — Universität Heidelberg - ITA

Active galactic nucleis have been discussed as possible accelerators of high-energy cosmic rays for quite some time. When the Blazar TXS 0506+056 was identified as the source of the high-energy Muon neutrino (IceCube-170922A) detected by the IceCube telescope in 2017 as a result of a large-scale multimessenger campaign, it was a first indication of possible correlations of the increased spectral activity of such sources and their neutrino production. Studies of this correlation by simulating the acceleration processes taking place in the jet and their photon and neutrino emission therefore allow conclusions to be drawn about the composition of the jet plasma by comparing them

with the observed fluxes. In this talk, the two-zone model UNICORN-0d is used to perform a self-consistent modeling of the eruption of TXS 0506+056 in 2017 based on the existing multimessenger data. A special focus will be put upon the data in the very high energy regime. The importance of these data being taken simultaneously is discussed by using time-resolved simulations of an emission flare. In contrast to previous models this approach addresses the possibility that the data from 2017 might represent different emission-states of the Blazar.

EP 7.8 Wed 18:00 EP-H1

The candidate tidal disruption event AT2019fdr coincident with a high-energy neutrino — •Simeon Reusch — Deutsches Elektronen Synchrotron DESY, Platanenallee 6, D-15738 Zeuthen, Germany — Institut für Physik, Humboldt-Universität zu Berlin, D-12489 Berlin, Germany

The origins of the high-energy cosmic neutrino flux remain largely unknown. Last year, a high-energy neutrino was associated with the tidal disruption event (TDE) AT2019dsg.

In this talk we present AT2019fdr, an exceptionally luminous TDE candidate, coincident with another high-energy neutrino detected by IceCube. We will present observations that further support a TDE origin of this flare. These include a bright dust echo and soft late-time X-ray emission. The probability of finding two such bright events in neutrino follow-up by chance is just 0.034%.

Furthermore, we have evaluated several models for neutrino production and show that AT2019fdr is capable of producing the observed high-energy neutrino. This reinforces the case for TDEs as neutrino sources.

EP 7.9 Wed 18:15 EP-H1

Search for short time-scale transients from the Sculptor galaxy — •Annanay Jaitly — Humboldt-Universität zu Berlin, Berlin, Germany

Astrophysical sources show variability in their emissions over a range of time-scales. For short time-scale transients like fast radio bursts, no very-high-energy gamma-ray counterparts have been detected so far and there is a general lack of tools suited to search for such phenomena. We developed and tested a plugin for the gammapy python package. It is is a tool capable of searching gamma-ray telescope data for transient phenomenon over arbitrary timescales. It scans the given field of view for clusters of events within user-defined time and angular separation intervals. To test the performance of said tool, we studied the Sculptor galaxy (NGC 253); it was chosen because Fermi-LAT previously reported a magnetar giant flare near this source. In this contribution we present the main features of the developed software, and our results from searching the Sculptor galaxy for short-timescale candidates using it.

EP 7.10 Wed 18:30 EP-H1

Understanding the multi-wavelength variabilty of TeV blazar VER J0521+211 with high-energy particle interactions — •Anastasiia Omeliukh — Ruhr University Bochum, Faculty of Physics and Astronomy, Astronomical Institute, Universitätsstr. 150, 44801 Bochum, Germany

In spring 2020, the MAGIC collaboration detected photons with energies above 200 GeV from the source VER J0521+211 which provides evidence of efficient particle acceleration in a relativistic jet. The monitoring of the source's short-term variability in very-high-energy gamma rays is complemented by simultaneous data from other observatories in radio, optical, X-ray, and GeV gamma rays. We perform multi-wavelength modeling of this source with a fully self-consistent one-zone leptohadronic model to explain four different multi-wavelength data sets. While the radio and optical fluxes seem to originate from electron synchrotron emission, in this model the gamma-ray fluxes are well explained by electromagnetic cascades induced by proton interactions.

EP 7.11 Wed 18:40 EP-H1

Gravitation explained as a physical interaction instead of a geometric space-time model. — •Osvaldo Domann — Stephanstr. 42, 85077 Manching

GR is the theory of gravitation of the SM. It is a mathematical approach from 1915 based on geometric reflections, arriving to the wondrous concept of space-time curvature. GR resists all intents of integration into a unified field theory and is not compatible with quantum mechanics. An approach is presented for a gravitation theory that is based on the representation of a subatomic particle (SP) as a focal point of rays of Fundamental Particles (FPs) that move from infinite to infinite. The energy of a subatomic particle is stored at its FPs as rotation defining angular momenta. With this representation all SPs interact permanently through the angular momenta of their FPs. The approach explains gravitation as the result of the reintegration of migrated electrons and positrons to their nuclei. Gravitation is composed of a Newton and an Ampere component, with the Newton component dominant at sub galactic distances and the Ampere component at galactic distances. A positive Ampere component explains the speed flattening of galaxies and a negative Ampere component the expansion. Neither dark matter nor dark energy is required and the model is compatible with quantum mechanics. More at: www.odomann.com