T 141: Neutrino Astronomy V

Time: Thursday 17:30–19:00 Location: POT/0251

T 141.1 Thu 17:30 POT/0251

Study of the transport behaviour in blazars under the influence of hadronic and photohadronic interactions * — •Vladimir Kiselev[1,2], Marcel Schroller[1,2], Julia Becker Tjus[1,2], and Patrick Reichherzer[1,2] — [1]Theoretische Physik IV, Ruhr-Universität Bochum — [2]RAPP Center, Ruhr-Universität Bochum

Active Galactic Nuclei (AGN) are considered among the few possible sources of high-energy neutrino emission. Therefore, it is important to describe the temporal behaviour and their signal correctly in the multimessenger picture. The most commonly used approach to describe a blazar flare in the present work has been applied, where a population of high-energy primary protons enters a plasmoid, travelling along the jet axis. One such realisation is the modified version of the publicly available propagation framework CRPropa 3.2, which modular structure offers two different propagation approaches, i.e. the equation of motion (EoM) and the solution of the transport equation, under consideration of a broad network of interactions. Previously, it has been shown how, in the considered high-energy range of primary protons, a transition between ballistic and diffusive behaviour takes place, which influences the spectral energy distribution, as well as the light curve of flares. The present work is an extension of the aforementioned work, where the same energy range is considered. In this talk we investigate how the introduction of hadronic interaction modules influences the diffusive behaviour of protons and the transition between both propagation regimes. * Supported by DFG (SFB 1491).

T 141.2 Thu 17:45 POT/0251

Neutrino Cadence of TXS 0506+056 Consistent with Supermassive Binary Origin* — Julia Becker Tjus[1], •Ilja Jaroschewski[1], Armin Ghorbanietemad[1], Imre Bartos[2], Emma Kun[1,3,4], and Peter L. Biermann[5,6] — [1]Theoretical Physics IV, Ruhr University Bochum — [2]Dept. of Phys., Univ. of Florida, USA — [3]CSFK, MTA Centre of Excellence, Hungary — [4]Konkoly Observatory, ELKH Research Centre for Astr. and Earth Sciences, Hungary — [5]MPI for Radioastronomy, Bonn — [6]Dept. of Phys. & Astr., Bonn

In the past, two distinct flares of high-energy neutrinos have been detected by the IceCube neutrino observatory from the direction of the blazar TXS 0506+056. In de Bruijn et al. 2020, it was shown that these two neutrino emission episodes could be due to an ongoing supermassive binary black hole (SMBBH) merger where jet precession close to final coalescence leads to periodic emission. This model made predictions on when the next neutrino emission episode must occur. On September 18, 2022, a new alert by IceCube indicated that a high-energy neutrino arrived from the direction of TXS 0506+056, consistent with the model prediction.

In this work, we show that these three distinct flares of neutrino emission from TXS 0506+056 are consistent with a SMBBH origin and constrain the total mass as well as mass ratio for the binary. We make predictions on when the next neutrino flares should happen and, for the first time, calculate the characteristic strain of its gravitational wave emission. *Supported by DFG (SFB 1491)

T 141.3 Thu 18:00 POT/0251

Time and Density Dependent Modelling of Hadronic and Leptonic Processes in Blazar Jets* — •Marcel Schroller, Julia Becker Tjus, and Lukas Merten — Theoretical Physics IV, Ruhr University Bochum, Germany

Active galactic nuclei (AGN), and the accompanied jets, are some of the most luminous objects in the observable Universe. Both the active cores and their jets are candidates for the engine of ultra high-energy cosmic rays, gamma rays, and neutrinos with the highest energies measured on Earth. In 2017, IceCube recorded an extragalactic high-energy neutrino event with a strong hint of a directional coincidence with the position of a known jetted AGN TXS0506+056. A deep understanding of the processes related to jets will fuel the field of high-energy cosmic rays, fundamental plasma, astro, and particle physics. However, an AGN jet's physical and mathematical modelling is challenging, with ambiguous signatures that need to be understood by numerical simulations of cosmic ray transport and interactions. In this talk, we present a simulation framework for hadronic constituents and their interactions inside of a plasmoid propagating along the AGN jet axis, which is utilised to investigate the time- and density dependence of hadronic interactions in blazar jets and their effects on multimessenger spectra. Furthermore, we will provide deeper insights into the results of such simulations and discuss how to include non-linear leptonic radiation processes into our test particle simulation framework for a more complete, physical description of processes in AGN jets. *Supported by DFG (SFB 1491).

T 141.4 Thu 18:15 POT/0251

Seasonal Variations of the Atmospheric Neutrino Flux measured in IcCube — •Karolin Hymon and Tim Ruhe for the IceCube-Collaboration — Technische Universität Dortmund, Germany

The IceCube Neutrino Observatory measures high energy atmospheric neutrinos with high statistics. These atmospheric neutrinos are produced in cosmic ray interactions in the atmosphere, mainly by the decay of pions and kaons. The rate of the measured neutrinos is affected by seasonal temperature variations in the Stratosphere, which are expected to increase with the particle's energy. In this contribution, seasonal energy spectra are obtained using a novel spectrum unfolding approach, the Dortmund Spectrum Estimation Algorithm (DSEA+), in which the energy distribution is estimated from measured quantities with machine learning algorithms. The seasonal spectral difference to the annual average flux will be discussed based on preliminary results from IceCube's atmospheric muon neutrino data.

T 141.5 Thu 18:30 POT/0251

Search for the Prompt Neutrino Flux with IceCube — •Jakob Böttcher, Philipp Fürst, Erik Ganster, Matthias Thiesmeyer, and Christopher Wiebusch for the IceCube-Collaboration — III. Physikalisches Insitut b, RWTH Aachen University

For about a decade the IceCube Neutrino Observatory has been measuring a high-energy diffuse astrophysical neutrino flux. At these energies, an important source of background is prompt atmospheric neutrinos produced in decays of charmed mesons that are part of cosmic-ray-induced air showers. The production yield of charmed mesons in hadronic interactions, and thus the flux of prompt neutrinos, is not well known and has not yet been observed by IceCube. The analysis of up-going muon neutrino-induced tracks in IceCube provides a large sample of atmospheric neutrinos which likely includes prompt neutrinos. However, the measurement of a subdominant prompt neutrino flux strongly depends on the hypothesis for the dominating astrophysical neutrino flux. This makes the estimation of upper limits on the prompt neutrino flux challenging. We discuss the extent of this model dependency on the astrophysical flux and propose a method to calculate robust upper limits. Furthermore, a possible dedicated search of the prompt neutrino flux using multiple IceCube detection channels is outlined.

T 141.6 Thu 18:45 POT/0251

Search for up-going air showers and constraints of BSM particles with the Pierre Auger Observatory* — •Baobiao Yue for the Pierre Auger-Collaboration — Bergische Universität Wuppertal, Gaußstr. 20, 42119, Wuppertal, Germany

We report on the search for up-going air showers using data from the Pierre Auger Observatory. The observation of such kind of showers with energies above 10^{17} eV has been reported by the ANITA experiment but waits explanation. Using 14 years of available Auger data, the exposure to up-going showers after accounting for all cuts exceeds the one of ANITA by a large factor. Defining a data-blinded search strategy, only one event was found in the zenith angle range $[110°, 180°]$ to pass all cuts, which is consistent with a background expectation of 0.4 ± 0.2 events. The non-observation is used to derive stringent bounds on BSM particles that were discussed in the literature to explain the anomalous ANITA observation. These particles could be produced by high energy interactions within the atmosphere or the Earth and penetrate the Earth with only little absorption to eventually produce tau-particles initiating observable up-going air showers. We discuss the derived upper fluxes of such BSM particles as a function of their unknown cross section with matter and find the strongest bounds when it is at the level of 1% of the neutrino nucleon cross section at the same energy.

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