The Second LHAASO Collaboration Conference in 2023

Friday, November 24, 2023 - Wednesday, November 29, 2023

Tianfu Cosmic Ray Research Center

Book of Abstracts

Contents

2

Closing of this collaboration conference

Plenary talks / 3

Report of the Publication Committee

Author: Siming Liu[1]

[1] *Southwest Jiaotong University*

Corresponding Author: liusm@swjtu.edu.cn

I will report work of the EB.

4

The Scientific Significance and Research Plan of the Detection of the ultra High Energy Cosmic Rays（UHECR）

Author: 国丽 Guoli 柳 Liu[1]

[1] 郑州大学

Corresponding Author: guoliliu@zzu.edu.cn

We first briefly introduce the UHECRs and detection situation, especially with space-based telescopes. In the following, we discusses the theoretical and scientific significance of detection. The fourth part describes the scientific objectives of detection, and finally we provides a theoretical research plan based on LHASSO detection data.

Plenary talks / 5

Status of Joint Analysis between LHAASO and the Other Collaborations

Author: Xinhua MA[1]

[1] *Institute of High Energy Physics, CAS*

Corresponding Author: maxh@ihep.ac.cn

Up to now, the LHAASO collaboration have signed ten Memorandum of Understandings (MoUs), including seven international ones and three domestic ones, with the other collaborations on joint analysis. The facilities of The joint collaborations include ground radio, gamma ray, neutrino telescopes and observatories on satelites, so that the joint field covers multi-waveband astronomy and multi-messenger astronomy. Several joint analysis working groups (JAWGs) were orgnized to proceed joint analysis on various gamma ray sources discovered by LHAASO. I will report status of joint analysis and give a discussion and expectation on it.

conference contributions / 6

Progress of ENDA

Author: Xinhua MA[1]

[1] *Institute of High Energy Physics, CAS*

Corresponding Author: maxh@ihep.ac.cn

Under Chinese-Russian cooperation, electron-neutron detector array (ENDA) makes progresses during the last half an year: ENDA has been extended from ENDA-16 to ENDA-64, covering area about 1000 m2. ENDA-64 is running smoothingly and sand cubes are being added into one cluster (16 detectors). In 2023, we got supports from both NSFC Major International Joint Research Project and NSFC General Program on ENDA data analysis and detector study. Analysis of data of ENDA-64 and coincident events between ENDA and LHAASO is proceeded. Meanwhile, some results of Monte Carlo simulation on ENDA are obtained which indicate that with 2-3 years data, ENDA-64 can obtain energy spectrum of cosmic ray light component at the knee region.

conference contributions / 8

Data transfer updates and status

Author: 珊曾 [1]

[1] 高能所

Corresponding Author: zengshan@ihep.ac.cn

Introduce the data transfer updates and status for KM2A/WCDA/WFCTA/GRB

9

Discovery of Multi-TeV Gamma-Ray Emissions from the Compact Symmetric Object NGC 4278 by LHAASO

Authors: Min ZhaN[one]; Zhiguo YaoN[one]; Shicong HuN[one]; Guangman XiangN[one]; Liang ChenN[one]

The 508 days observation by LHAASO/WCDA presents a significant detection with test statistic is TS ~8 with best-fit photon spectral index Γ = 2.81 ± 0.15 and a flux F>0.5TeV approximately ~ 30% of the Crab Nebula. The best fit position of the TeV source is compatible with the young radio galaxy, the compact symmetric object (CSO) NGC 4278 within ~ 0.03 degree. Variation analysis presents only moderate variability on timescale of months at TeV band, which is consistent with low frequency observations. The weak radio emission (~ 10ˆ38−39 erg sˆ−1), small jet size (~ 3 pc) and kinematic age (< 100 yr) make NGC 4278 and establish the very compact and young CSOs as capacity to produce TeV emissions, and yield insight on the physical process in the compact radio jets and the interaction with the interstellar medium of the host galaxy.

10

Search for VHE Gamma-Rays from the Northern Fermi Bubble with LHAASO-WCDA

Author: 思达李 [1]

[1] 中科院上海天文台

Corresponding Author: sidali@shao.ac.cn

The Fermi Bubbles are a pair of bubble-like structures symmetric to the galactic center, which are assumed to be morphologically formed by strong energy releasing events happened million years ago. Regarding the emitted Gamma-Rays, high energy radiation processes like hadronic or leptonic emissions accompanying the outflows are responsible for the origin of the emission. As predicted by theoretical works, the difference between hadronic and leptonic emission models locates over TeV bands in the Gamma-Ray spectrum, which is luckily detectable for LHAASO and thus an interesting topic. In this talk, we are going to report the preliminary results on the observed Gamma-Ray flux upper limits with LHAASO-WCDA.

11

Performance and meteorological effects with KM2A in Scaler mode

Author: Kejun Guo[1]

Co-authors: Xunxiu Zhou ; Daihui Huang ; Xuejian Chen ; Ci Yang ; Tian Zhou

[1] 西南交通大学

Corresponding Author: 1102193931@qq.com

In the ground-based cosmic ray experiments, there are two common independent data acquisition systems, corresponding to the shower and scaler operation modes. In the scaler mode, it is not necessary for too many detectors to be hit within a fixed time window. The energy threshold of the experiment can be greatly lowered. In this work, the performance of the KM2A array operating in scaler mode was described. The KM2A-ED array is divided into 61 clusters. For one cluster (composed of 64 EDs), the event rates of showers having a number of fired EDs = 1, 2, 3 and ≥4 (in a time coincidence of 100 ns) are recorded every 0.1 s. The scaler mode began acquiring data on June 21, 2023. By analyzing the scaler data with KM2A in fair weather, the detector stability over short time periods (half an hour) was studied. To study the effects of environmental parameters (such as atmospheric pressure, temperature) on the scaler data, the event rate distributions with different multiplicities over long time periods (for 24 hour of data accumulation) were analyzed. These counting rates showed clear diurnal distributions and were also correlated to meteorological parameters. Finally, we analyzed the event rate variations in scaler mode during a thunderstorm that occurred on July 17, 2023, and found the counting rate increased significantly in electric fields.

12

Thunderstorm effects on shower rate with KM2A

Author: Ci YangN[one]

Co-authors: Xunxiu Zhou ; Daihui Huang ; Xuejian Chen ; Tian Zhou ; Kejun Guo

The high-altitude location and the frequent occurrence of thunderstorms make LHAASO suitable to study the effects of thunderstorm electric fields on cosmic ray air showers. In this work, the thunderstorm episodes in 2022 are studied. According to the electric field structure, three typical types of thunderstorms are found at LHAASO site. By analyzing the KM2A data in shower mode, the variations of shower rates during thunderstorms without nearby lightning flashes are studied in detail. During a thunderstorm, the noise trigger recorded by the detector will increase, resulting in the change of the trigger rate. To better study the field effects on the flux variations of shower events, the noise during thunderstorm needs to be considered. After considering the interference of noise,

we get a clear thunderstorm-related cosmic ray air shower variation. The variations of trigger rates are found to be correlated to the strength and polarity of electric field, and also strongly dependent on the primary zenith angle. Due to the acceleration/deceleration and deflection by the atmospheric electric field, the number and space-time of secondary particles with energy above the detector threshold are modified, leading to the changes in shower detection rates in KM2A. Our results are useful in the study of atmospheric physics and cosmic rays.

conference contributions / **13**

The status of LHAASO computing platform

Author: Haibo LI[1]

[1] 高能所

Corresponding Author: lihaibo@ihep.ac.cn

This presentation will talk about the status of lhaaso computing platform in 2023.

15

Discrimination of Proton/Gamma Cosmic Ray using LHAASO-KM2A

Authors: Yanhong YuN[one]; Yusheng Wu[1]; Zhijie Li[2]; ruizhi yang[3]

[1] *University of Science and Technology of China*

[2] *U*

[3] *purple mountain observatory*

Corresponding Author: lzj27618349@mail.ustc.edu.cn

We studied some topological variables used in proton/gamma identification and tested how much they improve R-cut results.

16

The flaring activities observed by LHAASO-WCDA from misaligned radio galaxies object NGC 1275

Author: 冉王 [1]

Co-authors: 敏查 [2]; 存峰冯 [1]; 初源杨

[1] *SDU*

[2] *IHEP*

Corresponding Author: wangran@ihep.ac.cn

We report the detection of flaring activity in the high-energy gamma-ray emission from the Fanaroff-Riley I radio galaxy NGC 1275 using the LHAASO-WCDA detector, following an alert from the MAGIC Collaboration (ATel #15820). The observation were performed between 2022 November 28 and 2023 January 29, as part of a monitoring program. Two flares in the light curve of NGC

1275 have been identified using the Bayesian block algorithm, with a false alarm rate of 5%. The first flare occurred from December 20 to December 22, 2022, and the second flare occurred from January 6 to January 14, 2023. The γ – ray spectra of the two flaring intervals can be adequately described by a simple power-law spectrum, with photon indices α of 3.39 ± 0.52 and 3.39 ± 0.29 respectively. This suggests that the energy distribution of the radiation in these two bursts exhibits similar characteristics, which may indicate that the physical mechanisms of the burst events are similar or generated by similar acceleration mechanisms. To explain these observations, we propose that the gamma-ray flares are caused by the injection of high-energy electrons into the jet, while the X-ray emission is a result of the combined effects of various regions. To demonstrate the viability of these scenarios, we fit the spectral energy distribution data of the two flaring intervals using a one-zone synchrotron self-Compton (SSC) model.

conference contributions / **17**

Observation of the γ-ray Emission from the W43 Direction with LHAASO

Authors: 川东高 [1]; 广威王 [2]; 睿智杨 [2]

[1] *Shandong University*

[2] *University of Science and Technology of China*

Corresponding Author: wangguangwei@mail.ustc.edu.cn

In this presentation we report the very-high-energy (VHE) to ultra-high-energy (UHE) \gray emission detected by the Large High Altitude Air Shower Observation (LHAASO), from the direction toward the young star-forming region W43. The extended \gray source is detected with a significance of $\sim 23\,\sigma$ with KM2A and a significance of $\sim 27\,\sigma$ with WCDA. The angular extension of this \gray source is about 0.6 degrees, which corresponds to a physical size of about 50 pc. Together with the multiwavelength data we discuss the origin of the \gray emission and possible CR acceleration in the W43 region. The spatial and spectral features reveal that W43 is likely another young star cluster that can accelerator CRs.

18

Searching for neutrino signals correlated with LHAASO diffuse Galactic emission

Authors: 文莲李 N[one]; 天奇黄 N[one]; 东莲徐 N[one]; 会海何 N[one]

Corresponding Author: wlli@ihep.ac.cn

The diffuse Galactic γ-ray emission is produced from the interaction of cosmic rays and interstellar medium or radiation fields in the Galaxy, where neutrino production is also expected. Recently, the Large High Altitude Air Shower Observatory (LHAASO) reported the measurements of the diffuse γ-ray from the Galactic plane with energies above 10 TeV. In this study, we construct the neutrino emission template based on LHAASO ' s observation and search for diffuse neutrinos accompanying the LHAASO diffuse Galactic γ-ray emission using ten-year IceCube track events. In the absence of significant signals, we set upper limits at the 90\% confidence level for each flux template, resulting a neutrino flux of $\mathrm{d}\phi_\nu/\mathrm{dE}_\nu = 1.42 \times 10^{-14}(\mathrm{E}_\nu/25\mathrm{TeV})^{-2.99}\mathrm{TeV}^{-1}\mathrm{cm}^{-2}\mathrm{s}^{-1}$ for the diffuse γ-ray flux template with a 1.5σ significance threshold.

conference contributions / **19**

Measurement of the muon content in EAS with muon detectors of LHAASO-KM2A

Author: 晓婷丰 [1]

Co-authors: Hengying Zhang [2]; Cunfeng feng [3]; lingling Malingling_ 马玲玲 _ 羊八井 [4]

[1] 山东大学

[2] *Shandong University*

[3] *shandong university*

[4] *ihep*

Corresponding Author: 3225673610@qq.com

High-energy cosmic rays interact with the atmosphere, generating extensive air showers. Measuring the evolution of muon content in EAS is of profound significance for the research of interaction models. This report is based on the data samples recorded by LHAASO-KM2A of 2022 with zenith angle $\theta \leq 40^{\circ}$, which energy is estimated around $10^{14} - 10^{16.7}$ GeV. The Monte Carlo samples are produced for five cosmic ray components using CORSIKA for air shower simulation and GEANT4 for KM2A detector response simulation. Both hadronic interaction models EPOS-LHC and QGSJET-II-04 of CORSIKA are utilized. We conducted a comparative analysis of the relationship between the average muon number per energy and energy in both observed data and simulations, revealing a shift towards lighter composition in the data after reaching 1 PeV. In addition, we measured the attenuation length of muon content within air showers using a constant-intensity-cut method. We present the variation of attenuation length with reconstruction energy, demonstrating a increase from 100 TeV to 10 PeV. Remarkably, simulation predictions and experimental measurements are in good agreement within the margin of error. Notably, at 20 PeV, the attenuation length for muon number closely resembles the predictions from KASCADE simulations, as opposed to the experimental results.

20

Development of a lake array proposal for SWGO

Author: Tianyang Li[1]

[1] *Shanghai Jiao Tong University*

Corresponding Author: litianyang202110@163.com

The Southern Wide-field Gamma-ray Observatory (SWGO) is a proposed next-generation gamma-ray survey experiment that will cover the southern sky with high sensitivity and a wide field of view. It will be built in South America to complement HAWC and LHAASO in the Northern Hemisphere. We designed a lake array proposal for SWGO to record particles from extensive air showers initiated by high energy gamma-rays. The proposed lake array would consist of two types of detectors: surface detectors and muon detectors. Surface detectors will be placed on the lake for the detection of electromagnetic particles. They are small tanks filled with water and equipped with a photomultiplier tube (PMT) at the bottom. Muon detectors will be deployed underwater, where lake water will be a natural filter to absorb electromagnetic components while allowing the measurement of muon particles. A lake array is being proposed for SWGO motivated by some potential advantages over ground-based arrays, such as lower cost, fewer constraints on the detector shape, and electromagnetic component rejection for muon detectors, which create more possibilities to optimize detectors and the array. A number of technological solutions are being proposed for the implementation of SWGO, including both lake- and ground-based arrays, and a final decision on the adopted technology is expected for 2024, with the conclusion of the project's R&D phase.

21

LHAASO Observations on Pulsar Wind Nebula and TeV Halo

Authors: 子维区 [1]; 浩周 [1]

[1] 上海交通大学李政道研究所

Corresponding Author: ouziwei.astro@outlook.com

Extended TeV sources associated with pulsars can be divide into two categories: pulsar wind nebula with TeV emission originating in the zone dominated by the pulsar; TeV halo with escaped particle diffusing into the ISM. The First LHAASO Catalog of Gamma-ray Sources found 35 sources with pulsar association. Based on it, we unveil the correlation between LHAASO sources and associated pulsars by spectral and morphological analysis. The observed properties of a PWN/TeV halo can be used to constrain the physical characteristics of the pulsar and surrounding environment. The spectral evolution of PWN/TeV halo shows that peak energy increase with pulsar age. Nebula and halo are explained in a unified scheme.

22

LHAASO 对 Geminga 脉冲星晕的观测进展

Authors: 鸿飞张 [1]; 浩周 [1]

[1] 上海交通大学

Corresponding Author: 1498942851@qq.com

脉冲星通常被认为是高速旋转的中子星，具有强磁场，并向星际空间释放大量正负电子，被认为是轻子宇宙线的主要来源之一。这些正负电子在星际空间中扩散，并通过逆康普顿散射的方式产生高能伽马射线，形成一类尺度很大的天体，称为脉冲星晕。研究脉冲星晕的形态有助于了解银河系内粒子的扩散过程。Geminga 是离地球最近、形态最清晰的脉冲星晕，利用它，我们可以更加细致地研究星际空间的扩散过程，包括扩散系数的空间依赖以及随能量的变化等。本报告将介绍利用这一高海拔宇宙线观测站 LHAASO 对 Geminga 脉冲星晕的观测进展。

23

Low energy reconstruction of GRB221009A with LHAASO-WCDA

Author: 睿仪唐 [1]

[1] *B*

Corresponding Author: 201711140150@mail.bnu.edu.cn

GRB221009A produced fruitful data on WCDA. In WCDA trigger mode (TM), 2000-ns data around the trigger time are packed as raw events. Those raw events will then be processed through the noise filter software, which keeps the 200-ns data around the pre-reconstructed shower front as reduced events. Those data dropped in the noise filter process are a sample of triggerless data, which are clean of large showers and potentially contain small showers. We reconstructed those data with known direction (the GRB direction) and stricter trigger condition to resolve low-energy events below the current TM threshold.

24

Status and Prospect of cosmic rays iron spectrum with energy from 100 TeV to 10 PeV measured by LHAASO

Authors: Liqiao YinN[one]; Suhong ChenN[one]

Corresponding Author: yinlq@ihep.ac.cn

The direct measurements of the proton spectrum show a softening at E ≈ 13 TeV and a similar softening at E ≈ 34.4 TeV on helium spectrum. Whether and where a softening on iron spectrum is very important to study the origin of cosmic rays. LHAASO hybrid observation can select the iron showers with 90% purity. The selection efficiency is 40%. It is expect to complete the measurement of iron spectrum next year.

25

Observation of a TeV Source in the Vicinity of PSR J1915+1150 by LHAASO

Author: 凯汪 [1]

Co-authors: 海明张 [2]; 若愚柳 [1]; 祥玉王 [3]; 世聪胡 [4]

[1] *Nanjing University*

[2] *N*

[3] 南京大学

[4] 高能所

Corresponding Author: k-wang@smail.nju.edu.cn

We report the discovery of an γ-ray source in the Galactic plane named LHAASO J1914+1150 with a significance of 10.3σ at 2-20 TeV and 12.5σ above 25TeV. The best-fit position is R.A. = $288.72^\circ \pm 0.3^\circ$ and decl. = $11.79^\circ \pm 0.03^\circ$. Due to the significant diffuse radiation in the Galactic plane, we used a dust template for evaluation. We tested two methods: one with adjustable parameters like normalization factor and spectral index, and another with these parameters fixed as in the First LHAASO catalog. The former approach fails to discern the ductility of LHAASO J1914+1150 due to the stronger diffuse radiation, whereas the latter approach yields an angular size of $0.44^\circ \pm 0.05^\circ$ (for WCDA) and $0.22^\circ \pm 0.06^\circ$ (for KM2A). The source is proximal to a high-luminosity pulsar, PSR J1915+1150, with an angular separation of approximately 0.11 degrees. This indicates that the TeV emission is likely a consequence of the lepton process in the vicinity of the pulsar, potentially originating from the PWN or pulsar halo.The observations from LHAASO are consistent with the scenario wherein VHE electrons have escaped from the pulsar, diffused into the interstellar medium, and subsequently scattered the interstellar radiation field. Given the substantial distance to the pulsar, the interpretation of the TeV emission within the framework of the pulsar halo scenario necessitates a significant diffusion coefficient to account for the observed size of the LHAASO detection.

26

The recent results from micro-quasar Cygnus X1&X3

Author: UNKNOWN LI Cong[1]

[1] 高能所

Corresponding Author: licong@ihep.ac.cn

The ultra-high energy gamma signal from micro-quasar is of great interest because it can provide us crucial information about the acceleration of particles in this kind of super accelerator. Cygnus

X1 and X3 are two similar and famous micro-quasars located at Cygnus region. LHAASO-KM2A has detected a signal with more than 5sigma from Cygnus X3 and marginal signal from Cygnus X1. This talk will give a detailed introduction about the recent results from these two sources.

27

Galactic Ridge flux in LHAASO

Author: Dmitri Semikoz[1]

Co-authors: Andrii Neronov ; Denys Savchenko [1]

[1] *APC, Paris*

Corresponding Author: semikoz@apc.in2p3.fr

Galactic Ridge is brightest central part of Milky Way Galaxy with $|l| < 30^\circ$.
It was detected by Fermi LAT in gamma-rays up to 3 TeV. Recently it was detected by ANTARES and IceCube in neutrinos. Here we study flux of Galactic Ridge in LHAASO km2a data.

We show that the total flux measured by LHAASO km2a above 10 TeV lies exactly at the extrapolation of the Fermi/LAT Galactic Ridge spectrum. This indicates a very good cross-calibration between the two instruments. The Fermi/LAT + LHAASO/km2a measurements are consistent with the ANTARES and IceCube neutrino
flux estimate, which indicates that the gamma-ray flux is dominated by the pion decay emission from proton interactions. The model fit suggests that the proton spectrum has cut-off at the PeV energies and that the spectrum of the cosmic
rays in the inner Galaxy is harder (slope Γ ⊠ 2.4) than the locally measured spectrum (slope Γ ⊠ 2.7)

28

The end-to-end Calibration of LHAASO-WFCTA based on Nitrogen Laser System

Author: Qinning SunN[one]

Co-authors: Fengrong Zhu ; Hu Liu ; Shoushan Zhang ; Zhen Min

Corresponding Author: sunqn@ihep.ac.cn

The Wide Field-of-view Cherenkov Telescope Array (WFCTA) of Large High Altitude Air Shower Observatory (LHAASO) is designed to perform nearly calorimetric measurements of extensive air showers induced by cosmic rays with energies between 10^{13} eV - 10^{18} eV. In order to achieve an end-to-end calibration of WFCTA and investigate properties of the atmospheric aerosol, five laser systems have been operated at LHAASO, including 3 nitrogen and 2 Nd:YAG laser devices. This work presents an overview of the laser signals received by the telescope and the monitoring of geometric information related to nitrogen laser events. Additionally, it introduces the simulation method for the LHAASO-WFCTA laser calibration system. Through prolonged and stable operation, a substantial amount of data has been accumulated, requiring further data analysis for the calibration of the telescope's absolute gain and measurement of aerosol extinction coefficients.

29

Discovery of a giant peanut-shaped PeVatron below the Galactic plane

Author: 哲李 [1]

[1] 高能所

Corresponding Author: lizhe@ihep.ac.cn

Here we report the discovery of a giant enigmatic extended source peanut-shaped source (PEANUT) emitting UHE γ rays with LHAASO. Observed spatial morphology and energy spectrum suggest a common origin of PEANUT substructures. The spectrum is described with a power-law with index of −1.92 ± 0.13 and an exponential cutoff at 229 ± 59 TeV,implying a total luminosity of ⍰ 7.04 × 1032 (D/3 kpc) erg s−1. The absence of a spatial correlation between this LHAASO PEANUT and interstellar gas makes it unlikely that the observed signal is caused by hadronic γ radiation. The inverse Compton(IC) scattering from a luminous millisecond pulsar (MSP) J0218+4232 is more compelling. These findings suggest that MSPs have the potential to act as PeV accelerators (PeVatrons) of the Milky Way.

30

王璐瑶

Author: 璐瑶王 N[one]

Corresponding Author: lywang@ihep.ac.cn

An indirect measurement of the antiproton flux in cosmic rays is possible as the particles undergo deflection by the geomagnetic field. This effect can be measured by studying the deficit in the flux, or shadow, created by the Moon as it absorbs cosmic rays that are headed towards the Earth. The shadow is displaced from the actual position of the Moon due to geomagnetic deflection, which is a function of the energy and charge of the cosmic rays. The displacement provides a natural tool for momentum/charge discrimination that can be used to study the composition of cosmic rays.I will use the data from the LHAASO-WCDA experiment to measure the ratio of positrons to antiprotons in the future.
Dark matter is a highly significant and fascinating subject in the field of new physics. LHAASO is expected to serve as a powerful tool for indirect detection of dark matter. In the future, WCDA will join this collaborative group, and I will participate in the data analysis of WCDA. It is anticipated that the inclusion of WCDA will provide results in the lower energy range and offer more comprehensive findings.

32

Synchrotron Radiation Dominates the Extremely Bright GRB 221009A

Author: 彬彬张 [1]

[1] *Nanjing University*

Corresponding Author: bbzhang@nju.edu.cn

The brightest gamma-ray burst, GRB 221009A, has spurred numerous theoretical investigations, with particular attention paid to the origins of ultrahigh-energy TeV photons during the prompt phase. However, analyzing the mechanism of radiation of photons in the ˜MeV range has been difficult because the high flux causes pileup and saturation effects in most GRB detectors. In this Letter, we present systematic modeling of the time-resolved spectra of the GRB using unsaturated data obtained from the Fermi Gamma-ray Burst Monitor (precursor) and SATech-01/GECAM-C (main emission and flare). Our approach incorporates the synchrotron radiation model, which assumes an expanding emission region with relativistic speed and a global magnetic field that decays with radius, and successfully fits such a model to the observational data. Our results indicate that the

spectra of the burst are fully in accordance with a synchrotron origin from relativistic electrons accelerated at a large emission radius. The lack of thermal emission in the prompt emission spectra supports a Poynting flux-dominated jet composition.

33

Finding pulsar TeV halos among LHAASO sources

Authors: Dong Zheng[1]; Zhongxiang Wang[2]; Yi Xing[3]

[1] *ynu*

[2] *Yunnan University*

[3] 上海天文台

Corresponding Author: zhengdong@mail.ynu.edu.cn

TeV halos, as a new type of Very-High-Energy (VHE) sources recently identified from VHE observations and intensively followed with theoretical studies, are extended gamma-ray emissions around middle-aged pulsars. They are suggested as a common phenomenon associated with middle-aged pulsars, while only several of them have been identified and studied. The full operation of LHAASO WCDA and KM2A and significant detections of Galactic sources turn out to have offered a great opportunity for finding this new type of sources. Here we report our very recent published results that show the identification of three candidate TeV halos among the first LHAASO catalog of gamma-ray sources. Detailed multi-energy-band properties for these three sources and their associated pulsars will be presented. Combining the previously well-studied TeV halo cases with our findings, a possible correlation between VHE luminosities (at 50 TeV) of the TeV halos and spin-down rates of the corresponding pulsars is found. In addition, the energy conversion efficiencies of the pulsars' spin-down energies to their TeV halos appear as a constant, no sign of showing the dependence on the properties of the pulsars such as their ages. On the basis of these study results, we speculate that more candidate TeV halos remain to be found among the LHAASO sources.

34

Multiwavelength study of blazars

Authors: Guohai Chen[1]; Xiangtao Zeng[1]; Jingtian Zhu[1]; zhiyuan Pei[2]

Co-author: Junhui Fan [1]

[1] *Guangzhou University*

[2] *Guangzhou Univsity*

Corresponding Author: pmnjggsdw@163.com

We make use of a supervised machine-learning algorithm based on Logistic Regression (LR) to select TeV blazar candidates from the 4FGL-DR2/4LAC-DR2, 3FHL, 3HSP, and 2BIGB catalogs. LR constructs a hyperplane based on a selection of optimal parameters, named features, and hyperparameters whose values control the learning process and determine the values of features that a learning algorithm ends up learning, to discriminate TeV blazars from non-TeV blazars. The second work is about SED. Major Atmospheric Gamma Imaging Cherenkov Telescopes (MAGIC) published a dataset collected through an extensive multi-wavelength campaign organised between 2016 December and 2017 June for Mrk 421. A VHE flare observed on MJD 57788 (2017 February 4). In this work we used one-zone SSC model, two-zone model and Spine/Layer model to discuss the origin of this VHE flare. The results show that this γ-ray flare can be reproduced by seed photons (produced from the layer/spine) being IC scattered by the nonthermal electrons within the spine/layer.

35

Detection of γ-ray emission from CTA1 by LHAASO

Authors: Ben LiN[one]; Chen SongzhanN[one]; Li YizuoN[one]; UNKNOWN 席绍强 N[one]; yong HuangN[one]

Corresponding Author: xisq@ihep.ac.cn

We report the VHE-to-UHE gamma-ray source (LHAASO J0007+7303) detected by the LHAASO-WCDA and LHAASO-KM2A detector, located at the center of shell-type radio supernova remnant CTA 1. Above 25 TeV emission of LHAASO J0007+7303, detected by LHAASO KM2A detector, shows an extended morphology approximated by a 2D-Gaussion with a 39\% containment radius $\approx$ 0.16 $^\circ$. The photon spectrum of LHAASO J0007+7303 is well described by logparabola ($[dN/dE = N_0 \left(E/20\ \mathrm{TeV}\right)^{-(\alpha+\beta \ln(E/20\ \mathrm{TeV}))}]$), with a differential spectral index $\alpha \approx 1.74$ and $\beta \approx 1.23$, and normalization $N_0 \approx 2.54 \times 10^{-15}\ \mathrm{cm}^{-2}\ \mathrm{s}^{-1}\ \mathrm{TeV}^{-1}$.The size and spectrum are coincident with the known TeV-PWN VER J0006+729 discovered by VERITAS gamma-ray observatory. We argue that the VHE-to-UHE gamma-ray emission of LHAASO J0007+7303 are originated from the leptonic emission of the relativistic particles within the PWN around PSR J0007+7303. The sizes are plausible to be evolution with photon energies, which favors that the convection transport of relativistic particles is dominant in this PWN.

36

A new model for VHE CRs in our Galaxy and their diffuse gamma-ray emission

Authors: Gwenael Giacinti[1]; Dmitri Semikoz[2]; Sergey KoldobskiyN[one]

[1] *Tsung-Dao Lee Institute, Shanghai Jiao Tong University*

[2] *APC, Paris*

Corresponding Author: gwenael.giacinti@mpi-hd.mpg.de

The origin of the knee in the cosmic ray (CR) spectrum is still unknown after 65 years of studies. Here, within the framework of anisotropic CR diffusion models, we show that the knee is a time-dependent feature, and that the flux in this region contains major contributions from one or a few nearby recent CR sources. We calculate the propagation of CRs in the Jansson-Farrar galactic magnetic field model, after injecting them at discrete sources in the disc of the Galaxy. Anisotropic diffusion plays a key role in reconciling the large diffusion coefficient required for CR escape from the Galaxy with the measured value of the Galactic magnetic field. The main difference with the isotropic diffusion case is a significant reduction of the number of sources that contribute to the CR flux in any given location in the Galaxy. As a result, few sources dominate the local flux at the knee. We then calculate the resulting diffuse gamma-ray emission at Very High Energies, and compare our results to the data of gamma-ray observatories.

37

external inverse Compton emission from multi-episode GRBs: the case of GRB 221009A

Author: 晓红赵 [1]

Co-authors: Jirong Mao [2]; Binbin Zhang [3]; Zhenyu Yan [3]; Chuyuan Yang [2]; Jun Yang [3]

[1] *ynao*

[2] *Yunnan observatories, CAS*

[3] *Nanjing university*

Corresponding Author: zhaoxh@ynao.ac.cn

The detection of ultra-high energy TeV photons from the brightest gamma-ray burst (GRB), GRB 221009A, has attracted intense investigations on its emission mechanism. Here we propose a general scenario of external inverse Compton (EIC) to explain observed very high energy emission from GRBs. GRBs are generally composed of multiple episodes, attributed to intermittent GRB central engine activities. Ejecta from a central engine due to its early activities (including a precursor), will run into a circumburst medium and decelerate, generating an afterglow shock. Accelerated electrons in the shock will possibly up-scatter the prompt photons in late episodes to very high energies. We find for not extreme parameters, TeV photons due to this EIC mechanism can be detected by the current instruments, such as LHAASO, MAGIC, and HAWC. We also find this scenario can be as an origin for the detected very high energy photons from GRB 221009A.

38

”Mirages” and large offsets in the data as a result of asymmetric CR diffusion

Authors: Gwenael Giacinti[1]; Yiwei Bao[2]; Haiming Zhang[3]; Ruoyu Liu[3]; Yang Chen[4]

[1] *Tsung-Dao Lee Institute, Shanghai Jiao Tong University*

[2] *TDLI Shanghai & Nanjing University*

[3] *Nanjing University*

[4] *Department of Astronomy, Nanjing University*

Corresponding Author: gwenael.giacinti@mpi-hd.mpg.de

We show that a large asymmetric halo may be misidentified as multiple “mirage” sources, and that asymmetric diffusion could lead to a very large offset between the injection site and the identified halo. We add background noise into the region and try to identify the sources. We utilize the concept of asymmetric diffusion to elucidate several observed sources that were previously challenging to interpret. Our model offers intuitive explanations for these observations and has the potential to help identify a broad range of sources in the future.

conference contributions / 39

Temporal structure of secondary particles during thunderstorms with KM2A

Author: 学健陈 [1]

Co-authors: 勋秀周; 慈杨; 代绘黄

[1] 西南交通大学

Corresponding Author: 1374185926@qq.com

The arrival time distribution of secondary particles from an extensive air shower is one of the important parameters to reconstruct the information of primary particles. Due to the acceleration/deceleration and deflection by the thunderstorm electric field, the number and space-time of the ground-level particles are altered, resulting in a variation of the shower detection and reconstruction. In this work, the temporal structure of secondary particles is studied by analyzing the KM2A data in 2022. The arrival time variation is found to be correlated to the thunderstorm electric fields, and the lightning flashes. During a thunderstorm, the arrival time distribution becomes wider, and the change amplitude is not only dependent on the electric field strength, the core distance, and also strongly dependent on the primary zenith angle. The particle flux variations within different

time windows during thunderstorms are also studied. Our results are useful in understanding the change of shower rate detected by KM2A, and will also provide important information for shower reconstruction during thunderstorms.

40

LHAASO detection of a new pulsar halo LHAASO J0248+6021

Authors: Bing LiuN[one]; Ruizhi YangN[one]; Wenyu CaoN[one]; 艳红于 [1]

[1] *Shandong University*

Corresponding Author: yuyh@mail.sdu.edu.cn

Electrons and positrons escaping from pulasar wind nebulae (PENe) generated an extended gamma-ray structures and considered as a new class of gamma-ray sources - pulsar halo. We report the detection of an extended very-high-energy (VHE) gamma-ray source coincident with the locations of middle-aged (62.4 kyr) PSR J0248+6021, by using the LHAASO-WCDA data of live 784 days and LHAASO-KM2A data of live 1216 days. A significant excess of gamma ray-induced shower is observed both by WCDA in energy bands of 2-30 TeV and KM2A in energy bands of $>$ 25 TeV with 6.3 σ and 11.6σ. The best-fit position given by WCDA is R.A. = 42.14 $\pm$ 0.17° and DEC. = 60.25$\pm$0.12° and by KM2A is R.A.= 42.29$\pm$0.13° and DEC. = 60.38$\pm$0.07° . No clear extended multiwavelength counterpart of the LHAASO source has been found from radio band to GeV band. If the LHAASO obervations are consistent with the pulsar halo scenario, the diffusion coefficient of this source is consistent with LHAASO J0622+ 3749.

Plenary talks / 41

Update on the analysis of the SNR G150.3+4.5

Authors: Hanrong WuN[one]; Houdun Zeng[1]; Yingying GuoN[one]; Qiang YuanN[one]; Siming LiuN[one]; Yang SuN[one]; Yi ZhangN[one]

[1] *PMO*

Corresponding Author: zhd@pmo.ac.cn

Based on the results of SNR G150.3+4.5 at the 38th International Cosmic Ray Conference (ICRC2023), we updated several main results: (1) Using the updated data, we obtained two Gaussian distributions, which basically corresponded to the energy segments of WCDA and KM2A by conjoint analyzing WCDA and KM2A data; (2) Using CO data from the Milky Way Imaging Scroll Painting survey (MWISP), it is found that the KM2A region is in good agreement with the molecular cloud, and combined with Gaia data, the distance of the SNR G150.3+4.5 is accurately obtained, about 740pc; (3) Obtain radio flux in 4.8 GHz and 1.4 GHz of the whole of SNR G150.3+4.5; (4) Using the data of FAST observation in the KM2A region for about 0.5 hours, no pulse signal was found. Our results imply that The VHE emission (KM2A) almost comes from the hadronic origin and the HE emission (WCDA) comes from lepton origin of SNRs.

42

Updated KM2A results of Geminga and Monogem

Author: Ensheng Chen[1]

Co-authors: Kun Fang ; Qiang Yuan [2]; Siming Liu [3]; Xiaojun Bi [4]; Yi Zhang ; Yingying Guo ; hongbo HU Hongbo [1]

[1] *IHEP*

[2] *Purple Mountain Observatory*

[3] *Southwest Jiaotong University*

[4] *IHEP, CAS*

Corresponding Author: chenes@ihep.ac.cn

In this study, We analyzed the data from KM2A to study the gamma-ray halos surrounding the nearby pulsars, Geminga and Monogem. We have precisely measured the morphologies and spectra of the gamma-ray halos,extending beyond the energy of 100 TeV. We report the first detection of significant asymmetry in the morphologies of the two halos, which has substantial implications for the properties of the interstellar medium. Moreover, our data reveals a distinct exponential cutoff in the gamma-ray spectrum of the Geminga and Monogem.

43

Possible observation on the 2024 outburst of recurrent nova T CrB with LHAASO

Authors: JIAN LI[1]; 广威王 [2]; Ruizhi YangN[one]; Wenyu CaoN[one]; Yanhong YuN[one]

[1] *University of science and technology of China*

[2] *University of Science and Technology of China*

Corresponding Author: wangguangwei@mail.ustc.edu.cn

T Coronae Borealis (T CrB), located at R.A. = $239.88°$, Dec = $25.92°$, is a famous recurrent novae, with two recorded fast nova eruptions in 1866 and 1946. In the 1946 eruption, the magnitude of T CrB peaks at 2.0^{m}, which is the brightest nova event from 1943–2022. Recently, Schaefer (2023) observed the long-term monitored magnitude had a pre-eruption dip starting March/April 2023 and predicts that the eruption date would be $2024.4 + -0.3$ if the dip is similar to that in 1945. Maslennikova et al. (2023) predicts January 2024 with further 2023 photometry.

Inspiring by the previous observations of the very-high-energy gamma-rays from novae and the maximum particle energy estimated under physical conditions, taking the extreme brightness of its last eruption, the position close to the zenith of LHAASO and a distance of only $0.9\mathrm{kpc}$ into consideration, we may have chance to observe the TeV emission from the next outburst of T CrB with the extraordinary sensitivity of LHAASO. We propose to monitor T CrB's 2024 outburst in TeV with LHAASO.

44

Hourly measurement of cosmic ray anisotropy by WCDA around and above 1 TeV: Transient effects of an interplanetary flux rope during 2021 November

Author: David Ruffolo[1]

Co-authors: Kritsanon Koennonkok [1]; Nutthanon Ruangpongsiri [1]; Warit Mitthumsiri [1]; Wei Liu [2]

[1] *Mahidol University*

[2] *IHEP*

Corresponding Author: ruffolo.physics@gmail.com

Interplanetary coronal mass ejections (ICMEs) are known to affect the intensity and large-scale anisotropy of Galactic cosmic rays of energies up to ~100 GeV, but such effects at higher energies have never been reported. Here we analyze data from LHAASO-WCDA since its full operation began in March 2021. We select events within 45 degrees of the zenith and normalize cosmic ray skymaps at each zenith range relative to a monthly average. We calculate and subtract out the known sidereal anisotropy and calculated Compton-Getting effect as transformed to horizontal coordinates. The excess anisotropy relative to these known effects is interpreted as a transient anisotropy. For each hour of data, we express the transient cosmic ray anisotropy in terms of the gradient of the excess cosmic ray rate over the FOV. For the ICME passage of 2021 Nov 4-5, a strong anisotropy was recently reported in data from muon detectors and neutron monitors. We present evidence for an enhanced anisotropy in LHAASO-WCDA data during that time period, for primary cosmic ray energy ranges both around and above 1 TeV.

45

Constraints on heavy dark matter from LHAASO gamma ray observations

Authors: Dylan LeungN[one]; Weizhen ZhangN[one]

Co-authors: Luyao Wang ; Xiaohao You

LHAASO KM2A and WCDA are two detectors used to detect gamma rays for different energy range: greater than 10 TeV for KM2A and less than 10 TeV for WCDA. These detectors can be utilized for searching for dark matter. Decaying dark matter and annihilating dark matter can potentially result in a gamma ray excess compared to the background. In our study, we first performed data analysis to distinguish gamma rays from cosmic ray signals and then combined the Monte Carlo (MC) results to determine the gamma ray flux. We carefully selected five regions of interest to subtract the background, based on valid reasons. Our analysis of KM2A results revealed no excess of decaying dark matter signals. Consequently, we established constraints on the lifetime of heavy dark matter particles with masses ranging from 10ˆ4 to 10ˆ9 GeV. Moving forward, our future work aims to investigate the WCDA component and explore the search for annihilation dark matter.

46

Analysis of the Halo Candidate 1LHAASO J0359+5406 Based on LHAASO Observations

Author: UNKNOWN 徐仁峰 [1]

[1] 高能所

Corresponding Author: xurenfeng@ihep.ac.cn

Due to significant improvements in observatory sensitivity, numerous halo-like sources have been identified. It appears that TeV halos commonly exist around powerful middle-aged pulsars. In this study, we present an observation of 1LHAASO J0359+5406 conducted by LHAASO. By applying a mask to the region above 1LHAASO J0359+5406, our fitting results reveal that it is an extended source with an extension of approximately 0.3 degrees, located at (RA=59.72 deg, Dec=54.18 deg), and exhibits a significance of TS=456.1. The spectrum displays a logparabola shape, characterized by a norm of 4.54 x 10ˆ{-16} TeVˆ{-1} cmˆ{-2} sˆ{-1}, alpha=2.72, and beta=0.82. Through an examination of the extended model fixed at Pulsar J0359+5414 and B0355+54, we find contrasting evidence to that of the HAWC Collaboration, suggesting that 1LHAASO J0359+5406 is more likely to originate from Pulsar B0355+54 with a ΔTS value of 10.8.

47

用高斯过程研究活动星系核喷流光变的模式和起源

Authors: Haiyun Zhang[1]; Dahai Yan[1]; Li Zhang[1]

[1] *Yunnan University*

Corresponding Author: zhanghy@ynu.edu.cn

高斯过程（GP）方法是一类基于概率论和贝叶斯分析技术的统计模型，是一个强大的数据分析方法，可以有效地帮助我们理解数据背后的物理。我们的研究以时域分析为基础，利用 GP 方法对活动星系核（AGN）的长期光变和准周期振荡现象开展了研究，探寻了 AGN 的光变模式和起源。主要内容如下。

AGN 中高能伽马射线长期光变的研究。基于 Fermi-LAT 第四期源表的伽马射线数据，我们选取了 23 个具有高置信度和显著光变的 AGN，将 GP 方法应用于它们～ 12.7 年的光变曲线分析中。具体采用了随机驱动的阻尼简单谐振子（SHO）模型和阻尼随机游走（DRW）模型对这些长期光变曲线进行建模。我们发现，SHO 和 DRW 模型都能很好地描述 23 个 AGN 的长期光变，但相比于 DRW 模型，SHO 模型没有明显改善拟合且参数约束较差。这表明，DRW 模型就可以描述 AGN 伽马射线长期光变，而不需要复杂的 SHO 模型。我们从 DRW 模型的拟合中提取了 23 个 AGN 的特征阻尼时标，发现在光变特征时标（静止坐标系下）和黑洞质量关系图中，我们得到的伽马射线特征阻尼时标与类星体吸积盘中光学光变特征时标占据相同的区域，且与吸积盘的热不稳定性时标一致。这说明伽马射线长期光变可能与吸积盘中的热不稳定性有关。

AGN 中多波段长期光变的研究。我们用 GP 方法的 DRW 模型分析了耀变体在射电、光学、X 射线和伽马射线波段的长期光变。结果表明，多波段的长期光变可以用 DRW 模型成功地描述。38 个耀变体的非热光学特征阻尼时标、22 个耀变体的伽马射线特征阻尼时标以及来自类星体吸积盘的光学特征时标具有一致性，且都与吸积盘热不稳定性时标一致。另外，同步辐射和逆康普顿散射的功率谱密度（PSD）都是典型的 DRW 型 PSD，表明喷流长期光变与辐射机制无关。我们还发现单个源（3C 273、PKS 1510-089 和 BL Lac）的非热光学、X 射线和伽马射线时标在误差范围内一致，而射电光变时标太大没有被数据限制。我们的结果表明非热光学、X 射线和伽马射线的长期光变起源都与吸积盘的热不稳定性有关；非热光学、X 射线和伽马射线辐射发生在喷流中相同的区域，该区域位于射电核心上游且远离射电核心。

弱相对论喷流中准周期振荡（QPO）的发现。弱相对论喷流中准周期振荡（QPO）的发现。AGN 的 QPO 现象与吸积盘、喷流物理有密切的联系，但是观测到的伽马射线 QPO 都发生在强相对论喷流中，性质单一且置信度受到质疑。我们基于 Fermi-LAT 2008 年 8 月到 2021 年 3 月的数据，采用类傅里叶变换和 GP 方法对非耀变体 AGN PKS 0521-36 的伽马射线 QPO 进行了搜寻。我们在两次大耀发中间的～ 5.8 年时间里发现了约为 1.1 年的高置信度（～ 5σ）QPO 信号，且所有方法得到的结果一致。这是在弱相对论性喷流中发现的第一个伽马射线 QPO，该性质否定了喷流多普勒因子调制的起源，使其更倾向于内禀起源，例如吸积盘、双黑洞系统等。

Plenary talks / 48

LHAASO observation toward the SNR-HII complex G35.6-0.4

Authors: Xiao Zhang[1]; Wenjuan Zhong[2]; Yang Chen[1]; Songzhan Chen[3]; Shicong Hu[3]; Shaoqiang xi[3]

[1] *Nanjing University*

[2] *Nanjing university*

[3] *IHEP*

Corresponding Author: xiao.zhang001@outlook.com

It is difficult to identify hadronic PeVatrons (the PeV particle accelerator) from the ultra-high-energy (UHE, E>100TeV) gamma-ray sources, which is however crucial in revealing the origin of cosmic

rays. As an endeavor in this regard, we focus in this work on the UHE gamma-ray source 1LHAASO J1857+0203u, which may associate with the supernova remnant (SNR) G35.6−0.4 and H II region G35.6−0.5. We analyze LHAASO KM2A and WCDA data, and report the point-like nature with a significance of 10.1σ above 100 TeV revealed by KM2A. While in 1-30 TeV band, the energy window of the WCDA detector , it shows extension with $r_{39} = 0.18$ deg. The spectra measured by WCDA and KM2A can be smoothly connected, with a flux F(>1 TeV)=5.2e-12 erg/cm2/s. Based on the calculation, it is unlikely that the gamma-rays are from clouds illuminated by protons escaped from SNR G35.6-0.4. In the scenario that HII region can accelerate particles to the UHE band, the spectra is well explained by the hadronic process with an index of ˜2.0 and a cutoff energy of 260 TeV. However, the putative PWN model can not be ruled out.

49

First observation of the moon shadow caused by the heavy cosmic ray nuclei

Author: lingling Ma[1]

[1] *ihep*

Corresponding Author: llma@ihep.ac.cn

Thanks to the huge effective area and strong composition discrimination of KM2A, the moon shadow cuased by the heavy cosmic ray nuclei have been observated with -14sigma by using 2022, 2023 KM2A data in the energy range about 50TeV. The westward shift of the shadow is about 0.4 degree, while the shift in the north-south direction is about 0.06 degree. In this poster, the details including the mean energy, the mean z and its application will be introduced.

50

Observation on SNR G065.1+00.6 region

Authors: 宇罗 N[one]; 艳红于 N[one]; 子维区 N[one]; 浩周 N[one]

Here we report observation on SNR G065.1+00.6 region using LHAASO data. By perfoming likelihood tests, multiple sources overlapping each other are resolved. Independent fittings have been done by using WCDA data and KM2A data respectively, and the results are consistent in general. In the vicinity of the resolved sources, pulsars or supernova remnants are present, which are likely contributing to the TeV emissions detected by LHAASO.

51

Analysis of Galactic diffuse gamma-ray emission from ˜1TeV to 20TeV with LHAASO-WCDA

Author: UNKNOWN 张佩佩 N[one]

Corresponding Author: zhangpeipei@ihep.ac.cn

Galactic diffuse gamma ray emission (GDE) is introduced by the galactic cosmic rays (CR) interacting with the interstellar medium (ISM) and radiation fields (ISRF). The GDE is a very important probe of CR propagation and interaction. Different from the measurements of CR particles in the local

vicinity, the GDE enables a direct measurement of CR distribution in the Milky Way, and can thus provide much more important information of the production and propagation of CRs.

52

Mirror facets alignment calibration in WFCTA telescope

Authors: changxu zhouN[one]; 玉东王 [1]; shoushan zhangN[one]; wei liuN[one]

[1] 高能所

Corresponding Author: wangyd89@ihep.ac.cn

The wide field of view Cherenkov telescope array (WFCTA) is one part of large high-altitude air shower observatory (LHAASO), its main scientific goal is to detect the single component of the cosmic rays energy spectrum around the knee with other parts of LHAASO. There are 18 telescopes in WFCTA and each telescope consists of 5 square meters sphere reflector which is made of 25 mirror facets. The alignment quality of 25 mirror facets will influence the properties of the telescope. After three years operation, the reflector of each telescope needs to be calibrated and aligned. However, the telescope cannot track the stars, meanwhile the conditions on site is very terrible, the traditional method cannot be adopted. We put up forward one new method to calibrate the reflector based on the Unmanned Aerial Vehicle (UAV). The UAV can fly with a light in the field of views in the long distance from 300 meters to 600 meters. At the same time, the camera and the white board are installed in the telescope to record the light spot. According to the shape of the spot, we can calibrate the directions of 25 mirror facets in each telescope. Based on the method above, we calibrate the reflectors of 18 telescopes and the sizes of light spots are all below 1 pixel, meeting the specifications.

53

Performance of LHAASO-KM2A on large zenith angles

Authors: 文莲李 N[one]; 绪强董 N[one]; 骢李 N[one]; 会海何 N[one]

Corresponding Author: wlli@ihep.ac.cn

The Large High Altitude Air Shower Observatory (LHAASO) has been operating with a zenith cut of 50°, limiting its field of view (FOV) from declination -21° to 79°. However, expanding the FOV to include crucial regions such as the Galactic center for gamma-ray research and providing increased exposure to sources at large zenith angles, such as the Fermi Bubble and gamma-ray binaries like LSI +61303 and LS 5039, requires studying the detector's performance at large zenith angles. This expansion enhances multi-messenger studies and aids in the search for Galactic PeVtrons. In this proposal, we intend to investigate the performance of event core, angular, and energy reconstruction at large zenith angles and compare it with events at small zenith angles. We aim to assess the detector's performance at large zenith angles with the standard candle of Crab Nebula and optimize event selection and reconstruction processes accordingly.

54

TeV emission toward SNR G57.2+0.8 (1LHAASO J1937+2128)

Authors: HouDun Zeng[1]; PeiPei Zhang[2]; Qiang Yuan[1]; Rui Zhang[1]; Yang Su[3]; Yi Zhang[1]; YuLiang Xin[4]

[1] *PMO*

[2] *IHEP*

[3] *Purple Mountain Observatory*

[4] *SWJTU*

Corresponding Author: yangsu@pmo.ac.cn

We studied the TeV emission toward 1LHAASO J1937+2128. PSRs in the FOV may contribute to parts of VHE in the whole region, while SNR G57.2+0.8 is another candidate of the PeVatrons based on multi-wavelength studies and SED fitting.

55

OBSERVATION OF GAMMA-RAY EMISSION FROM THE GALAXIES M 87 AND 3C 264 ABOVE 1 TeV WITH LHAASO

Author: Hai-Ming Zhang[1]

Co-authors: Kai Wang ; Shicong Hu [2]; Ruoyu Liu [1]; Xiangyu Wang

[1] *Nanjing University*

[2] *IHEP*

Corresponding Author: zhanghming@foxmail.com

The giant radio galaxy M 87 with its proximity (16 Mpc), famous jet, and very massive black hole ($(3-6)\times10^9 M_\odot$) provides a unique opportunity to investigate the origin of very high energy (VHE; E > 0.1 TeV) gamma-ray emission. It has been established as a VHE gamma-ray emitter since 2004. But the origin of the gamma-ray emission from M 87 is currently a matter of debate. Here we report the detection of gamma-ray emission above 1 TeV from M 87 with LHAASO. The gamma-ray emission is measured to be point-like with TS=28.45. The differential energy spectrum is fitted well by a power-law function with a photon index $\alpha = -2.77 \pm 0.21$. We find that a lepto-hadronic model is able to explain the VHE emission detected by LHAASO of M 87. Also, we report a radio galaxy 3C 264 with a marginal detection (TS=23.34) by LHAASO.

conference contributions / 56

Measurement of the cosmic ray proton spectrum around the knee region with LHAASO

Author: 智勇游 N[one]

Corresponding Author: youzhiyong@ihep.ac.cn

The origin of the knee in the all-particle energy spectrum is still unknown. One of the most important issues in cosmic ray physics is the measurement of the knee in the energy spectrum of individual components. LHAASO is made up of three detector arrays, which are the wide field-of-view Cherenkov telescope array (WFCTA), the kilometer square array (KM2A) and the water Cherenkov detector array (WCDA). The three detector arrays can achieve hybrid observation, so several Extensive Air Shower (EAS) observables sensitive to mass compositions can be measured simultaneously. In this work, the data between November 2020 and March 2021 with the shower core located in KM2A are used to obtain the proton energy spectrum. By using ROOT-TMVA package in combination with various component-sensitive parameters, we selected proton events with purity above 90 percent. The uncertainties from the proton selection, absolute energy determination, and interaction models will be discussed.

57

Search for dark matter gamma-ray emission from the Andromeda Galaxy with LHAASO Observations

Authors: Jun LiN[one]; Kang JiaN[one]

Co-authors: Chengguang Zhu ; Xiaojun Bi ; Xiaoyuan Huang

Corresponding Author: jiakang@mail.sdu.edu.cn

The Andromeda Galaxy (M31) is a nearby (~780 kpc) galaxy similar to our own Milky Way. Observational evidence suggests that it resides in a large halo of dark matter (DM), making it a good target for DM searches. We present a search for gamma rays from M31 using data from the LHAASO Observations. With its wide field of view and constant monitoring, LHAASO is well-suited to search for DM in extended targets like M31. No DM annihilation or decay signal was detected for DM masses from 10 TeV to 1 EeV in the $b\bar{b}$, $t\bar{t}$, $\tau^+\tau^-$, $\mu^+\mu^-$ and W^+W^- channels. Therefore we present our preliminary limits on those processes.

conference contributions / **58**

Measurement of the Proton and Helium spectrum with KM2A and WFCTA of the LHAASO experiment

Authors: Shoushan Zhang[1]; 利苹王 [2]; lingling Malingling_ 马玲玲 _ 羊八井 [3]

[1] *Institute of High Energy Physics*

[2] *IHEP*

[3] *ihep*

Corresponding Author: wanglp@ihep.ac.cn

We report on the measurement with high statistics of the energy spectrum of light component (Proton plus Helium nuclei) in cosmic rays by Large High Altitude Air Shower Observatory (LHAASO) around the knee region. LHAASO is a composite cosmic ray observatory, which consists of three detector arrays, including the square meter Kilometer Array (KM2A), the Water Cherenkov Detector Array (WCDA), and the Wide Field of View Cherenkov Telescope Array (WFCTA). The LHAASO experiment with multiple types of detectors can achieve the multi-parameter measurement of the cosmic ray air shower, the parameters including N_e, N_μ, which are sensitive to the component of the cosmic ray were defined and can be used for the mass separation.
The data used in this work were taken from Nov 1, 2020, to Mar 31, 2021. During that period the LHAASO consisted of the first six WFCTA telescopes, the first half KM2A array, and the first water pool of WCDA. The analysis was performed using only information from combined observations of WFCTA and KM2A.

59

On a possibility to record neutrino events with LHAASO

Authors: Anatoly Butkevich[1]; Yuri Stenkin[1]; Xinhua Ma[2]

[1] *INR RAS*

[2] *IHEP CAS*

Corresponding Authors: stenkin.yv@phystech.edu, maxh@ihep.ac.cn

Astrophysical neutrinos have been observed in the TeV to PeV energy range and are expected to be observable at several orders of magnitude higher still. These energetic neutrinos acts as probes of new physics models at energy scale well beyond the center-of-mass energies of current terrestrial

experiments. Flavor ratios, and in particular, observations of tau neutrinos are important observable for constraining new physics. Our simulations show that existing LHAASO detectors, namely WCDA and Km2A, could be used to identify neutrino events using their specific signature at energy range ˜0.5 PeV-1 EeV. Moreover, the signatures of the events make it possible to separate the events produced by neutrinos of different flavor, i.e. by electron-, muon- or tau-neutrinos.

conference contributions / 60

Observation of LHAASO J1843-0338 : implication for the origin of its UHE gamma-ray emission

Authors: Chuandong GaoN[one]; Haoning HeN[one]; Rui Zhang[1]

Co-authors: Youliang Feng ; Chong Ge ; Yunzhi Shen ; Yuliang Xin ; Min Zha ; Ping Zhou ; Xin Zhou

[1] *pmo*

Corresponding Author: zhangrui@pmo.ac.cn

We analyze the LHAASO-KM2A data updated to 2023-07-31 and LHAASO-WCDA data updated to 2023-05 to study the morphological and spectral features of this source. Adopting the millimeter data from a multi-CO line survey towards LHAASO J1843-0338, we find a superbubble associated with the gamma-ray emission detected by LHAASO. Our further morphological and model studies on this source, suggest that its very-high-energy gamma-ray emission likely originates from the superbubble. This provides evidence of Superbubbles as potential PeVatron Candidates.

61

Measurements of cosmic-ray anisotropies using LHAASO-WCDA

Author: Wei LIU[1]

Co-authors: Dong-xu Sun [2]; Dan Li [3]; Hong-bo Hu ; Qiang Yuan [2]; Yi-Qing Guo [3]

[1] 高能所

[2] *PMO*

[3] *IHEP*

Corresponding Author: liuwei@ihep.ac.cn

Since March 2021, WCDA has been in full operation with three ponds. In this contribution, we present the measurements of the CR anisotropy from ~1 TeV to ~150 TeV using two years of WCDA data. We have checked the stability of azimuth distribution of events with time. When adopting more stable data, the sidereal anisotropy at ˜130 TeV is compatible with other measurements. And the amplitudes of solar anisotropy less than tens of TeV is more consistent with the expectation.

62

Search for the Anisotropy of cosmic ray electrons using LHAASO-WCDA

Authors: 东旭孙 [1]; 丹李 [2]; 义庆郭 [2]; 伟刘 [2]; 强袁 [3]; 红波胡 [2]

[1] *University of Science and Technology of China*

[2] 中科院高能物理研究所

[3] 中科院紫金山天文台

Corresponding Author: sundx@pmo.ac.cn

Understanding the behavior of cosmic ray electrons is crucial for unraveling fundamental physics questions regarding the origin, acceleration, and propagation of cosmic rays. The theoretical hypothesis of nearby sources naturally explains the bumps observed in the cosmic ray energy spectrum around the hundred TeV range, as well as the reduction in amplitude and phase reversal of anisotropy. Due to processes like inverse compton scattering, high-energy cosmic ray electrons tend to rapidly lose energy during their journey, making them superior messengers compared to other cosmic ray components when it comes to reflecting the characteristics of nearby sources. In recent years, several experiments have detected a distinctive bump structure in the electron energy spectrum at TeV energies. Theoretical calculations also indicate that, assuming the existence of nearby sources, this bump corresponds to an electron anisotropy amplitude of approximately 0.01 at TeV energies, offering a promising opportunity for observation by LHAASO WCDA. This poster provides a concise overview of our progress in analyzing the anisotropy data of cosmic ray electrons. Additionally, preliminary results of analyzing cosmic ray electrons anisotropy using LHAASO-WCDA data are shown.

Poster / **63**

Angular power spectrum of the TeV-PeV cosmic ray anisotropy

Authors: 稳懿边 [1]; Gwenael Giacinti[2]

[1] *Shanghai Jiao Tong University*

[2] *Tsung-Dao Lee Institute, Shanghai Jiao Tong University*

Corresponding Author: bianwenyi@outlook.com

Propagating individual cosmic rays in synthetic three-dimensional Kolmogorov turbulence, we calculate their anisotropy at the location of an observer. These are the first calculations of the cosmic ray anisotropy down to TeV energies for values of the turbulence coherence length that are realistic for the interstellar medium. We calculate the power spectrum ⊠⊠, of the cosmic ray anisotropy for different observer locations, and compare with observations. We also decompose the anisotropy onto spherical harmonics, and show that an important distinction should be made between higher order multipoles that are aligned with the local direction of the magnetic field at the observer’s location, and those that are not.

64

Varlations of small-scale CR Anisotropies with Time and Energy

Authors: 稳懿边 [1]; Gwenael Giacinti[2]

[1] *Shanghai Jiao Tong University*

[2] *Tsung-Dao Lee Institute, Shanghai Jiao Tong University*

Corresponding Author: bianwenyi@outlook.com

The arrival directions of TeV cosmic rays on the sky display an anisotropy at the 0.1 percent level. This anisotropy contains a dipole and higher order multipoles. Small-scale anisotropies should contain important information about the properties of the turbulent magnetic fields in the interstellar

medium. These anisotropies have been predicted to vary on a time-scale of a decade at TeV energies. To date, no time variation has been detected. Whether experiments can detect such time variations or not depends on their energy resolutions (▵⊠/⊠). Finite energy resolutions can result in substantial changes of the anisotropy at small scales. Compared to previous works on this topic, we consider here the effect of the energy resolution on the detectability of time variations. We use the code of this work. We find that the amplitude of the difference between two instants in time will be smaller than in calculations where the energy resolution is not taken into account. We also study in detail the energy dependence of the small-scale anisotropies. We find that the amplitudes of the observed small-scale anisotropy structures are larger with a better energy resolution.

65

VHE Galactic diffuse gamma-ray emission from discrete distributions of CR sources

Author: Samy Kaci[1]

Co-author: Gwenael Giacinti [2]

[1] *Shanghai Jiao Tong University*

[2] *TDLI & SJTU*

Corresponding Author: samykaci@sjtu.edu.cn

We present our new model for the description of the $\mathrm{PeV} - \mathrm{TeV}$ Galactic gamma-ray emission assuming discrete distributions of cosmic-ray sources. Based on this model, we investigate the impact of the discreteness of the locations of the cosmis-ray sources and of the diffusion mechanism responsible for the propagation of cosmic rays on the morphology of the VHE Galactic diffuse gamma-ray emission. We notably find that many features potentially observable by LHAASO arise at VHE. In particular, the gamma-ray flux tends to be more clumpy and deviates from the distribution of the interstellar gas, especially for configurations for which only a small subset of all the cosmic-ray sources are PeVatrons. We also discuss the detectability of hadronic PeVatrons in our Galaxy and elaborate a possible interpretation of their number compatible with the LHAASO catalog. Finally, we constrain the fraction of Galactic cosmic-ray sources that are PeVatrons depending on the diffusion mechanism responsible for their propagation and expect that near-future observations will help discriminate between theoretical models.

66

The Fermi and eROSITA Bubbles

Author: Fulai Guo[1]

[1] *Shanghai Astronomical Observatory*

Corresponding Author: fulai@shao.ac.cn

The Fermi bubbles are a pair of enormous gamma-ray-emitting bubbles discovered in 2010 in the inner Galaxy by the Fermi gamma-ray space telescope. In 2020, eROSITA X-ray telescope discovered a pair of even larger bubbles surrounding the Fermi bubbles in the soft X-ray band. The edges of these two bubble pairs may correspond to shock fronts, which could potentially accelerate cosmic ray particles. I will give a brief overview of these two bubble pairs and talk about the prospect and ongoing efforts to observe them with LHAASO.

67

Discovery of the Ultra-High-Energy gamma-ray source LHAASO J2002+3238 spatially associated with SNR G69.7+1.0

Author: 博文侯 [1]

Co-authors: Songzhan Chen [2]; Haoning He ; Rui Zhang [3]; Shaoqiang xi [2]

[1] *ihep*

[2] *IHEP*

[3] *PMO*

Corresponding Author: houbw@ihep.ac.cn

The origin of Galactic PeV cosmic rays is still under debate. Shell-type supernova remnants (SNRs) are proposed to be one of the candidate sources of Galactic PeV cosmic rays, but observational evidence is lacking. Here we report LHAASO's detection on a point source J2002+3238 with a significance of 5.8 sigma above 25 TeV and 6.8 sigma above 100 TeV. The spectrum is consistent with a power-law spectrum with no cutoff. Inside the error region of the source, a shell-type SNR G69.7+1.0 is found locating only 0.07◦away from the best-fit location of the source, suggesting a strong association between the UHE gamma-ray source and the SNR. This provides strong evidence on SNRs as possible PeV accelerators.

68

Searching for Transient Gamma-ray Sources with LHAASO-KM2A

Author: 家俊黄 [1]

[1] 中国科学院高能物理研究所

Corresponding Author: huangjj@ihep.ac.cn

The LHAASO (Large High Altitude Air Shower Observatory), with wide field of view and high duty cycle, coupled with the strongest detection sensitivity in the TeV-PeV energy range, offers a unique opportunity to unbiased search for and study the transient sources, such as GRBs, AGNs, XB, and other unforeseeable new astronomy phenomena in the universe. In this study, we all sky survey for possible transient sources with various time scale from seconds to months using data from LHAASO-KM2A.

Poster / **69**

Progress report on nuclei flux measurement

Author: Hu Liu[1]

[1] *Southwest Jiaotong University*

Corresponding Author: huliu@swjtu.edu.cn

The knee of cosmic ray spectra may reflect the maximum energy accelerated by galactic cosmic ray sources or the limit of the galaxy's ability to bind cosmic rays. Measurements of individual energy spectra are a crucial tool to understand the origin of the knee. One of the main scientific goals of Large High Altitude Air Shower Observatory (LHAASO) is measuring the cosmic ray energy spectra and composition from 10 TeV to ∼ EeV. In this study, the density of electromagnetic particles measured by electromagnetic detectors (ED) and the density of muons measured by muon detectors

(MD) of LHAASO are used to measure the energy and composition of the primary particle. Individual nuclei flux measured with KM2A data will be presented.

70

Progress of thunderstorm effects on cosmic rays with LHAASO

Authors: Tian ZhouN[one]; Xunxiu ZhouN[one]; Daihui HuangN[one]; Ci YangN[one]; Xuejian ChenN[one]; Kejun GuoN[one]

The interaction between secondary particles from cosmic ray air showers and electric fields in thundercloud is one of the hottest topics in high-energy atmospheric physics. Owing to the large active area and high-altitude location with frequent thunderstorms, LHAASO is suitable to study the correlation between thunderstorms and variations in cosmic rays. Based on the experiment data with LHAASO-KM2A in Shower mode, and combined with Monte Carlo simulations, the cosmic ray air shower variations are studied. During thunderstorms, the shower rate changed significantly. The variation amplitude is found to be related to the electric field intensity, and also strongly dependent on the primary zenith angle. With nearby lightning flashes, the shower rate variations are terminated sharply. During a thunderstorm occurred on 16 June, 2022, the downward TGF-like events, in coincidence with strong lightning strikes, are detected by LHAASO-KM2A. To improve the accuracy of the reconstructed shower ' s primary information and understand the shower rate variations during thunderstorms, changes of characteristic parameters (such as shower size, temporal structure and lateral distribution) are studied. At the same time, the performance of LHAASO-KM2A operating in Scaler mode is studied, and the variations of counting rates with different multiplicities during thunderstorms are analyzed. Due to the acceleration/deceleration and deflection by the electric field in thundercloud, the cosmic ray variations are easily to understand.

71

Deciphering the Dual Components of LHAASO J2032

Authors: Chao-Ming Li[1]; Cong Li[2]; Chuan-Dong GaoN[one]; Ruo-Yu LiuN[one]; Felix Aharonian[3]

[1] 南京大学天文与空间科学学院

[2] *IHEP*

[3] *MPIK/DIAS*

Corresponding Author: mg21260008@smail.nju.edu.cn

LHAASO J2032 is an ultra-high-energy extended gamma-ray source, one of the twelve first reported by LHAASO in 2021. It is potentially linked to the gamma-ray binary system J2032+4127. With four years data from the LHAASO, we have now resolved two distinct components within this source. The first is a compact source situated close to the binary system, exhibiting an exceptionally hard spectrum—likely a result of inverse Compton scattering. Besides, the sharp cutoff of SED indicates a super-exponential cutoff power-law electron spectrum, imposing significant constraints on theories of particle acceleration mechanisms. The second is an extended source characterized by a comparatively soft spectrum. Intriguingly, both components demonstrate a cutoff energy at nearly 30 TeV.

72

Study of Mrk501 with LHAASO-WCDA

Author: 迪泫肖 N[one]

Co-authors: 树旺崔 [1]; Xinhua MA [2]; Min Zha [3]

[1] 河北师范大学

[2] *Institute of High Energy Physics, CAS*

[3] 高能所

Corresponding Author: dfxiao@ihep.ac.cn

Mkn501, one of the brightest TeV blazars, is renowned for its significant temporal variability, which has provided valuable constraints for AGN models and contributed to research on the origins of gamma rays.

To further study the energy distribution spectrum (SED) and light curves of Mkn501, we leverage the advantages of the LHAASO-WCDA, which include its all-weather capability, wide field of view (FOV), and high sensitivity.

Based on our findings, Mkn501 exhibited a period of high activity starting on April 26th, 2021, and transitioned to a period of low activity on May 13th. During this flare, we conducted a study on the energy distribution spectrum (SED) and temporal features.

Poster / **73**

The precision measurements of all-particle energy spectrum and mean logarithmic mass of cosmic rays using LHAASO-KM2A

Author: Hengying Zhang[1]

Co-authors: Huihai He [2]; Cunfeng Feng [3]

[1] 高能所

[2] *IHEP*

[3] *SDU*

Corresponding Author: hyzhang@ihep.ac.cn

Understanding the origin of the knee in terms of the energy spectrum is often considered fundamental for determining the origin of cosmic rays. The kilometer-square array (KM2A) of the Large High Altitude Air Shower Observatory (LHAASO) simultaneously measures air shower sizes of both electromagnetic particles and muons with high precision at 4410 m a.s.l. where cosmic ray air showers with primary energies in the knee region reach approximately maximum resulting in the least fluctuations. This enables the primary energy being measured in a calorimetric way from a new variable $N_{e\mu}$ by combining the number of muons and electromagnetic particles, which shows very weak dependency on primary compositions. We present the measurement of all-particle cosmic ray energy spectrum with unprecedented accuracy in 0.3-30 PeV with KM2A data collected from September 2021 to December 2022, while the mean logarithmic mass in the same energy range is measured.

74

Searching for UHECR-associated gamma-ray sources with LHAASO-WCDA

Authors: Xishui TianN[one]; Qinyuan ZhangN[one]; Shicong HuN[one]; Guangman XiangN[one]; Min ZhaN[one]; Zhuo LiN[one]

The origin of ultra-high-energy cosmic rays (UHECRs; >10 EeV) is unknown. Gamma-rays and neutrinos produced in CR-induced hadronic interactions can serve as the smoking gun pointing back

to sources. Motivated by the fact that IceCube-measured diffuse TeV neutrino flux is comparable to Waxman-Bahcall bound derived from the detected UHECR flux, we assume a common origin of UHECRs and TeV neutrinos, and expect TeV hadronic gamma-rays associated with UHECRs as well, the detection probability of which depends on UHECR source density. Here we use LHAASO-WCDA to search for TeV gamma-rays associated with UHECRs. A detailed data analysis based on LHAASO-WCDA sky map and UHECR events detected by Telescope Array results in non-detection of gamma-ray signals. A lower limit is put on the source number density, $n_s > 10^{-3.5}\,\mathrm{Mpc}^{-3}$, with 95% C.L.

Poster / **75**

Study the variance of the mean logarithmic mass of cosmic rays in the knee region using LHAASO-KM2A

Author: Hengying Zhang[1]

Co-authors: Lingling Ma [1]; Huihai He [1]

[1] *IHEP*

Corresponding Author: hyzhang@ihep.ac.cn

Utilizing the unique advantages of the LHAASO experiment, we have achieved a high-precision measurement of the muon content generated by cosmic rays in the knee region of atmospheric showers. The first measurement of σ_{lnA} in the knee region using LHAASO-KM2A, combined with $\langle \ln(A) \rangle$, provides experimental evidence for major physical issues such as the origin of the knee region and the origin of cosmic rays.

76

Correlation between the gamma-ray spectral index and density of the background in SNRs

Authors: 源李 [1]; Gwenael Giacinti[2]; Siming Liu[3]

[1] *Shanghai Jiao Tong University*

[2] *TDLI & SJTU*

[3] *Southwest Jiaotong University*

Corresponding Author: 1244827172@qq.com

The gamma-ray spectral indexes of SNRs have a bimodal distribution. It has been suggested that the hard gamma-ray spectrum is produced via the inverse Comptonization processes of high-energy electrons in a low-density environment while the soft gamma-ray spectrum is dominated by pion decays produced via inelastic hadronic collisions in a high density region, the so-called leptonic and hadronic scenarios for the gamma-ray emission, respectively. In this paper, we show that SNRs usually evolve in an inhomogeneous environment. For several SNRs, including HESS J1912+101, RX J1713.7-3946, Puppis A, and G150.3+4.5, it is found that the gamma-ray spectrum in the half sphere correlated with molecular clouds or higher density background is softer than the other half-sphere. However, we suggest that this spectral difference is likely caused by the difference in the distribution of emitting particles intrinsic to the particle acceleration process instead of a change of dominance of different emission processes.

77

Updated observations of unidentified UHE source LHAASO J1908+0621

Author: 世聪胡 [1]

Co-author: Sha Wu

[1] 高能所

Corresponding Author: hushicong@ihep.ac.cn

With emission extending beyond 100 TeV, the gamma ray source MGRO J1908+06 is one of the Galactic PeVatron candidates. The nature of MGRO J1908+06 remains unrevealed and a single accelerator cannot explain the whole set of multiwavelength data. We observed the MGRO J1908+06 using LHAASO. A significant excess of gamma ray excesses above 100 TeV is detected with 30σ. The measured energy spectrum can be extend to 500 TeV. Using the results, the emission mechanisms is discussed.

78

Constraining the jet composition of GRB 221009A with the prompt TeV emission limit

Author: 粹远戴 [1]

[1] *N*

Corresponding Author: cuiyuan_dai@163.com

Recent LHAASO observations of the prompt emission phase of the brightest-of-all-time GRB 221009A imposes a stringent limit on the flux ratio between the TeV and MeV emissions, $F_{\rm TeV}/F_{\rm MeV} \leq 2 \times 10^{-5}$, during the period $220 - 230\,{\rm s}$ after the trigger. This period covers the peak of the main MeV burst and is just before the TeV afterglow emerges. Within the framework of internal shocks, we study the internal $\gamma\gamma$ absorption in GRB 221009A by generating a set of synthetic bursts in a simulation that reproduces the observed feature of GRB 221009A. We find that the $\gamma\gamma$ absorption does not lead to an exponential cutoff, but rather a power-law spectrum, consistent with previous works. We further find that the attenuation due to $\gamma\gamma$ absorption alone cannot explain the flux limit ratio of GRB 221009A, suggesting a low ratio between synchrotron self-Compton (SSC) and synchrotron emission outputs. This requires the magnetic field energy density to be much larger than the synchrotron photon energy density so that the SSC flux is greatly suppressed. This indicates that the jet composition of GRB 221009A is likely Poynting-flux-dominated.

79

Diffuse Gamma-Ray aorund G25 Region based on LHAASO KM2A and WCDA data

Authors: Qihang WuN[one]; xiaona sun[1]

[1] *Guangxi Univisity*

Corresponding Author: wuqh@ihep.ac.cn

G25 region is a complex region with various objects which can accelerate CRs. G24.7+0.6 is a filled-center SNR with an age of ˜9500 yr. G25.18+0.26 is an OB association with massive stars. TeV source MAGIC J1835-069 is located between the two objects. RSGC1, one of the most massive star clusters, contains more than 200 massive stars located in the G25 region.There also exist two X-ray PWN candidates, AX J1837.3-0652 and AX J1838.0-0655 which are both adjacent to HESS J1837-069. MAGIC

J1837-073 lies in the southern part. The residual GeV gamma-rays are resolved into three extended regions (Sun et al. 2020) of which one has a hard SED without cutoff in the GeV band. Analysing LHAASO data in the TeV can give a crucial constraint on the SED and the physical mechanism.
We analysed LHAASO data through scitific tool provided by Xi Shaoqiang and got preliminary results. At first, we processed the LHAASO data for the full range. The source in G25 region has been in the 1LHAASO catalog, 1LHAASO J1837-0654u. We test single point source, multi point sources, and gaussian disk. The gaussian disk (ra=279.3894, dec=-6.8883, radius=0.3777) is the best-fit model. Then we repeat the process in the energy interval of WCDA (1-25TeV), KM2A (>25TeV), and >100TeV in which a gaussian disk model for this region is the best. These models fitted in different energy are spatially coincident with each other. The SED covering the full energy range as well as partial energy bands is fitted well by the LogParabola spectrum. The spectral index of full-energy SED are alpha=3.15, beta=0.29. The TeV excess is most likely related to the PWN candidate AX J1838.0-0655 or/and RSGC1, which is roughly coincident with previous work.

Poster / 80

Measurements of the anisotropy of light nuclei using WCDA data

Authors: Dan li[1]; Hongbo Hu[1]; Wei Liu[1]; dongxu Sun[2]

[1] *IHEP*

[2] *Purple Mountain Observatory*

Corresponding Author: lidan@ihep.ac.cn

In recent years, the hardening of Cosmic Rays spectra above a few hundred GV and softening around 10TV received much attention. These features of observation may provide insights into the potential origins of nearby sources. Measurements of the anisotropy of light nuclei will provide compelling evidence supporting the existence of nearby sources. In this work, PINCness is used to identify light nuclei and heavy nuclei. We have obtained preliminary results of the anisotropy of light nuclei by using two years data of WCDA from around 1 TeV up to hundreds of TeV.

81

Asymmetric diffusion of Geminga pulsar halo

Author: UNKNOWN 魏永健 N[one]

Corresponding Author: weiyongjian@ihep.ac.cn

The gamma-ray halo of the middle-aged pulsar Geminga has been already found by several experiments. A great extension of Geminga pulsar halo has also been detected by LHAASO-WCDA and it exhibits an asymmetric morphology in TeV which may indicate a different scenario in the electron propogation.

82

Searching for dark matter annihilation signal in dwarf irregular galaxies with LHAASO data

Author: 明萱鲁 [1]

[1] *GuangXi University*

Corresponding Author: aigtt.777@hotmail.com

We analyze the LHAASO KM2A data towards dwarf irregular galaxies, aiming to search for possible dark matter annihilation signal in these systems or constrain the dark matter cross section of annihilation if no signal is detected. We focus on the sources that are within the LHAASO's field of view and have largest J-factors.

83

LHAASO observation on SS 433, a hadronic PeVatron powered by microqusar?

Authors: Jian 李剑 [1]; Ruizhi YangN[one]; Ruoyu Liu[2]; Yanhong YuN[one]

[1] *Institute of High Energy Physics, CAS*

[2] *Nanjing University*

Corresponding Author: jianli@ihep.ac.cn

microquasars have been proposed to be able to accelerate hadrons and contribute to Galactic cosmic rays. SS 433 is a canonical microquasar containing the most energetic jet in our Galaxy. It locates at a distance of about 4.6 kpc from the earth and contains a compact objects, most likely a black hole of $10 - 20M_{\odot}$ which is accreting from a massive A3-7 star at a rate of about $10^{-4}M_{\odot}$ per year, several orders of magnitude of the Eddington limit. The high energy gamma emissions have been detected in SS 433 in GeV and TeV. Its broadband spectral energy distribution (SED) can be explained by a pure leptonic scenario. LHAASO observations on SS 433 extend its SED above 100 TeV, demonstrating its potential as a hadronic PeVatron powered by the central blackhole.

84

Discovery of the Very-High-Energy gamma-ray source LHAASO J1959+115 spatially associated with low mass X-ray binary 4U 1957+115

Authors: Haoning HeN[one]; UNKNOWN 朱本阳 N[one]; JIAN LI[1]; Rui Zhang[2]; Shaoqiang xi[3]

[1] *University of science and technology of China*

[2] *PMO*

[3] *IHEP*

Corresponding Author: zhuby@ihep.ac.cn

LHAASO J1959+1128 is a newly discovered gamma-ray source by LHAASO, which is spatially associated with a low mass binary 4U 1957+11, we carried out a detailed study of LHAASO J1959+1128 by analyzing LHAASO KM2A,

85

Analysis of Gamma-ray Binaries LSI+61303 and LS5039 Utilizing LHAASO Detector

Authors: Huihai He[1]; UNKNOWN LI Cong[2]; UNKNOWN LV HongkuiN[one]; Xuqiang Dong[1]

[1] *IHEP*

[2] 高能所

Corresponding Author: dongxuqiang@ihep.ac.cn

Gamma-ray binaries, characterized by a massive star and a compact object in close orbit, emit gamma rays across a wide energy spectrum. LSI+61303 and LS5039 are captivating gamma-ray binaries, known for their intricate behavior. This study utilizes the advanced capabilities of the Large High Altitude Air Shower Observatory (LHAASO) detector to analyze the gamma-ray emission from LSI+61303 and LS5039. The analysis extends the spectral study to energies up to a hundred TeV, providing insights into the high-energy emission regime. Additionally, consistent phase modulation patterns, in line with observations from the Fermi satellite, are observed. These findings enhance our understanding of gamma-ray binaries and shed light on the emission mechanisms and physical processes at play in LSI+61303 and LS5039.

86

Observation for the large-scale anisotropy of cosmic rays by LHAASO-KM2A

Author: Wei GAO[1]

[1] 高能所

Corresponding Author: gaowei@ihep.ac.cn

The large-scale anisotropy of cosmic rays plays an important role in studying the origin and propagation of cosmic rays. The magnitude and morphology of large-scale anisotropy have a complex evolution with the increase of energy. The observations at high energy such as above hundreds TeV have much more significant uncertainties due to the low flux of cosmic rays and the limits for experiments, even though the experiments had long-term data accumulation. As LHAASO has been in operation since July 2021, we select two years' data from the full array of KM2A to observe the LSA of cosmic rays. This work contains the results for the sidereal anisotropy and solar anisotropy of the cosmic-ray all particles. The energy is extended to PeV range, evolution of LSA with energy will be presented in this work.

87

The light-component anisotropy of cosmic rays with LHAASO-KM2A

Author: Weiyan Zhang[1]

[1] *Hebei Noraml University*

Corresponding Author: zhangwy@ihep.ac.cn

Cosmic rays are high-energy particles originating from outer space. Many experimental studies have found that cosmic rays exist in the energy range from hundreds of GeV to PeV, and there is anisotropy in the intensity of cosmic rays in various directions at the level of one-thousandth. There are numerous theoretical hypotheses regarding the origin of cosmic rays. Studying the anisotropy of cosmic ray components is of great significance for exploring the anisotropy origins and understand the propagation mechanisms of cosmic rays. In this work, we present a preliminary result for the anisotropy of cosmic ray's light component base on the LHAASO-KM2A's data. The light-component anisotropy evolved with the energy and the dip of the amplitude and the shift of the phase appear at more lower energy than the all particles.

Plenary talks / 88

Probing extreme particle acceleration in the SNR G106.3+2.7 region with LHAASO

Author: Sha WU[1]

[1] *IHEP*

Corresponding Author: wusha@ihep.ac.cn

Identification of cosmic-ray (CR) accelerators, especially those that can accelerate protons up to PeV regime (namely, PeVatrons), is one of major goals of high-energy astrophysics and plays a crucial role in understanding the origin of Galactic CRs. In this contribution, we report the LHAASO obsesrvation on an intriguing SNR-PWN complex consisting of the famous PeVatron candidate SNR G106.3+2.7 and the Boomerang Nebula powered by a very energetic pulsar with a spindown luminsoity of 2.2e37erg/s. As multiple ultrahigh-energy gamma-ray sources being resolved around the SNR-PWN complex, it is definitely one of the most dynamic regions processing extreme particle acceleration in our Galaxy. The origin of the detected TeV-PeV gamma-ray emission is discussed.

90

Investigating the thunderstorm events by LHAASO-WCDA data

Authors: Cheng LIU[1]; Xing Ruoyu 邢若愚 N[one]

[1] *IHEP*

Corresponding Author: liuc@ihep.ac.cn

Since the completion and operation of the LHASSO-WCDA array, there has been a phenomenon of short-term abnormal decrease in counting rate followed by recovery. After analyzing monitoring data such as temperature, air pressure, and atmospheric electric field, it was finally determined to be related to the drastic changes in the atmospheric electric field during thunderstorms. By analyzing the raw single-channel data during the decline, we found the correlation between the array counting rate, single-channel counting rate, and the atmospheric electric field. The specific analysis process and data are presented in the poster.

conference contributions / 91

Time structure of the extensive air shower Electron and Muon Components measured by LHAASO-KM2A

Authors: Xiaopeng ZHANG 张笑鹏 [1]; jia LIU 刘佳 [2]

[1] 高能所

[2] *Key Laboratry of Partical Astrophysics, IHEP*

Corresponding Author: jialiu@ihep.ac.cn

The temporal and spatial structure of an EAS front detected at ground level reflects the nature of the primary particle and its interactions with atmosphere nuclei. We give the experiment results of the temporal structure of the shower front of the electronic and muonic EAS components, observed to larger distances from the shower axis up to core distances of R = 500m at the maximum depth

of cosmic ray air showers in the knee region. For the description of the shower disc profile and thickness, a new equations are proposed.

92

Gamma-ray glows detected by LHAASO-KM2A related to thunderstorms

Authors: Xiaopeng ZHANG 张笑鹏 [1]; Yue Fu[2]; xiangdong Sheng 盛祥东 [1]

[1] 高能所

[2] *IHEP*

Corresponding Author: zhangxp@ihep.ac.cn

ith its large effective area and good time resolution, LHAASO provides a valuable opportunity to study thunderstorm-related high-energy atmospheric phenomena. By analyzing LHAASO-KM2A data and atmospheric electric fields, we observe an increase in particle numbers during thunderstorms caused by thunderstorm ground enhancements (TGEs). Nearly at the same time when some of the TGEs are terminated by lightning strikes, a large number of detectors are fired in a very short time duration, which could be either induced by an electromagnetic pulse or a possible downward terrestrial gamma-ray flash (TGF).

93

Observations to Microquasar SS 433 with LHAASO

Authors: Hasan Mariam[1]; Zhiguo Yao[2]

[1] *IHEP*

[2] *IHEP, Beijing, China*

Corresponding Author: mariamhasan@ihep.ac.cn

Micro quasars that are compact binary star systems composed of a stellar-mass black hole or neutron star accreting matter from a companion star exhibit powerful and highly collimated jets of particles and radiation. These micro quasar jets are unique that provide valuable insights into particle acceleration and transport processes under extreme conditions. In this poster, I will present the observations to microquasar jet named SS433 with LHAASO.

SS433 is an unusual and fascinating astronomical object known as a microquasar. SS433 is classified as a binary star system consisting of a massive star and a compact object, most likely a black hole or neutron star. The compact object is accreting matter from the massive star, creating a disk of material around it. One of the most remarkable features of SS433 is the emission of two powerful jets of matter from its central region. These jets are being expelled at relativistic speeds, approaching a significant fraction of the speed of light. The jets are oriented almost perpendicular to the disk of the binary system.

I will explain the observational techniques, including high-energy gamma-ray observations, that have enabled us to review the particle acceleration processes in these jets. Through a combination of WCDA and KM2A results, we explore the east and west lobes of this source.

The results obtained from these investigations contribute to our broader understanding of particle acceleration and transport in high-energy astrophysical environments. Moreover, microquasars serve as analogs for other cosmic phenomena, such as active galactic nuclei and gamma-ray bursts,

thereby shedding light on the physical processes that shape the universe's most energetic and dynamic events. This research not only advances our knowledge of microquasar jets but also has implications for fundamental astrophysical processes, cosmic-ray acceleration, and the interplay between matter, radiation, and magnetic fields in extreme environments.

Ultimately, unraveling the mysteries of particle acceleration and transport in microquasar jets deepens our comprehension of the universe's most enigmatic and powerful phenomena and contributes to the broader field of high-energy astrophysics.

Speech and ceremony / **94**

Leaders' Speech

Speech and ceremony / **95**

Unveiling ceremony

Status reports of LHAASO Working Groups & Committees / **96**

Introduction of Participants

Plenary talks / **97**

Physics Coordinator Commettee work report

Corresponding Author: chensz@ihep.ac.cn

Plenary talks / **98**

Speakers Bureau work report

Corresponding Author: yangrz@ustc.edu.cn

conference contributions / **99**

Data Production

Corresponding Authors: yinlq@ihep.ac.cn, yaozg@ihep.ac.cn

Plenary talks / **100**

SNR summary

Corresponding Author: liusm@swjtu.edu.cn

conference contributions / **101**

Cosmic ray summary

Corresponding Author: llma@ihep.ac.cn

conference contributions / **102**

A common origin of multi-messenger anomaly of galactic cosmic rays

Corresponding Author: guoyq@ihep.ac.cn

conference contributions / **103**

Young Cluster summary

Corresponding Author: yangrz@ustc.edu.cn

104

the anisotropy of light nucle

Status reports of LHAASO Working Groups & Committees / **105**

Leaders' Speech

Status reports of LHAASO Working Groups & Committees / **106**

Unveiling ceremony

Status reports of LHAASO Working Groups & Committees / **107**

open address

Corresponding Author: caozh@ihep.ac.cn

Plenary talks / **108**

Introduction of Participants

Plenary talks / **109**

Leaders' Speech

Plenary talks / **110**

Unveiling ceremony

Plenary talks / **111**

Open address

Corresponding Author: caozh@ihep.ac.cn