TeV Particle Astrophysics 2021(TeVPA 2021)

Monday, October 25, 2021 - Friday, October 29, 2021

Wangjiang Hotel

Book of Abstracts

Contents

Session 1 / 0

Dark SHINE: Dark Photon Search Experiment at SHINE

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The talk will present the physics motivation, the conceptual design and the latest R&D status of the Dark Photon search experiment at SHINE (i.e. Dark SHINE-暗光计划). The project will also have further physics program expansion for exotic muonium state search, LLP search and other BSM signatures to be explored.

Session 2 / 1

Cosmic photons from LHAASO as probes of Lorentz symmetry violations

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The Large High Altitude Air Shower Observatory˜(LHAASO) is one of the most sensitive gamma-ray detector arrays currently operating at TeV and PeV energies. Recently the LHAASO experiment detected ultra-high-energy˜(UHE) photon emissions up to 1.4 PeV from twelve astrophysical gamma-ray sources. We point out that the detection of cosmic photons at such energies can constrain the photon self-decay motivated by superluminal Lorentz symmetry violation˜(LV) to a higher level, thus can put strong constraints to certain LV frameworks. Meanwhile, we suggest that the current observation of the PeV-scale photon with LHAASO may provide hint to permit a subluminal type of Lorentz violation in the proximity of the Planckian regime, and may be compatible with the light speed variation at the scale of 3.6×10^{17} GeV recently suggested from gamma-ray burst˜(GRB) time delays. We further propose detecting PeV photons coming from extragalactic sources with future experiments, based on LV-induced threshold anomalies of e^+e^- pair-production, as a crucial test of subluminal Lorentz violation. We comment that these observations are consistent with a D-brane/string-inspired quantum-gravity framework, the space-time foam model.

session / 2

Multi-wavelength studies on TeV gamma-ray binaries

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TeV gamma-ray binaries, consisting of a compact object in orbit with a massive star, emit broad-band radiations from radio to TeV gamma-rays. The energy spectra of gamma-ray binaries peak above 1 MeV, distinguishing them from the well-known X-ray binaries. So far, less than ten such kinds of binaries have been found, and only 2 of them with the compact objects being identified as rotational pulsars. It is widely believed that non-thermal emissions are produced by synchrotron radiation and inverse-Compton (IC) scattering in the shock where the pulsar wind is terminated by stellar outflows from the massive companion. I will briefly summarize the basic observational properties of detected gamma-ray binaries and discuss our recent theoretical studies on these systems. Recently, LHAASO detected a 1.4 PeV gamma-ray event from LHAASO J2032+4102, which is likely associated with the gamma-ray binary PSR J2032+4127/MT91 213. I will discuss the possible mechanisms that produce such kinds of ultra-high energy photons in gamma-ray binaries.

Please choose the session this abstract belongs to:

Gamma rays

Session 3 / **3**

Contribution of SNRs to Cosmic Rays

Author: Siming Liu[1]

[1] *Purple Mountain Observatory*

In this talk, I will review our recent multiwavelength study of a sample of gamma-ray supernova remnants (SNRs), which can be used to constrain evolution of high energy particles in SNRs. Our results suggest that shocks of SNRs may not be efficient PeVatrons. However, they can readily accelerate particles to about 100 TeV. In particular, shocks of the supernova that gave rise to the Geminga pulsar may be responsible to the cosmic ray spectral bump near 10 TeV.

Session 2 / **4**

Suppression of the TeV pair-beam plasma instability by a weak intergalactic magnetic field

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We constrain the intermediate-scale intergalactic magnetic field (IGMF) through its suppression of the electrostatic instability for blazar-induced pair beams. IGMF of Femto-Gauss strength is sufficient to significantly deflect the TeV pair beams, which reduces the flux of secondary cascade emission below the observational limits. A similar flux reduction may result from the electrostatic beam-plasma instability, which operates the best at zero IGMF. We study the effect of sub-fG level IGMF on the electrostatic instability of the blazar-induced pair beam. Considering IGMF with correlation lengths smaller than a few kpc, we find that such fields increase the transverse momentum of the pair beam particles, which dramatically reduces the linear growth rate of the electrostatic instability and hence the energy-loss rate of the pair beam. Our results show that the IGMF eliminates the beam-plasma instability as an effective energy-loss agent at a field strength three orders of magnitude below that needed to suppress the secondary cascade emission by magnetic deflection. For intermediate-strength IGMF, we do not know a viable process to explain the observed absence of GeV-scale cascade emission.

Please choose the session this abstract belongs to:

Extragalactic sources

Summary:

Context:

- Several gamma-ray observations from distant blazars show a suppressed emission of the inverse Compton scattering cascade of the blazar-induced pair beams at the GeV energy band.
- The first possible explanation is the deflections of the pair beam electrons and positrons by magnetic fields of Femto Gauss strengths in the intergalactic medium.
- The second one is the drain of the pair energy by beam-plasma instabilities resulting in heating up the intergalactic plasma.
- The beam-plasma instabilities of blazar-induced pair beams operate the best at zero intergalactic magnetic fields.

Method:

- We investigate the effect of weak intergalactic magnetic fields with small correlation lengths on the electrostatic beam-plasma instability linear growth rate numerically.
- We find that the weak intergalactic magnetic fields increase the angular distribution of the particles of the pair beam.
- We show that this widening of the pair beam reduces the linear growth rate of the electrostatic instability.
- This reduction of the linear growth rate increases the energy loss time of the beam-plasma instability suppressing the beam-plasma instability.

Results

- The beam-plasma instability suppression occurs at magnetic field strengths three orders of magnitude less than the lower limit of the magnetic fields needed to deflect the secondary cascade emission.
- The intermediate scale intergalactic magnetic fields where he beam-plasma instability nor the intergalactic magnetic field deflection work as an explanation for the observed blazars spectra and so this parameter space region can be excluded if there is no third mechanism that prevents the full electromagnetic cascade emission of the TeV gamma-ray beams from the distance blazars.

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Constraining sub-GeV Dark Matter from Boosted and Migdal Effects

Author: Lei Wu[1]

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Given the current strong constraints on WIMPs, search for sub-GeV Dark Matter (DM) now is an essential task in direct detections. To overcome the limitation of low recoils, enhancing the ionization rate of electrons from the Migdal effect and modifying the velocity distribution of DM from the interaction of DM and cosmic rays are two important ways. In this work, we find that these two ways are complementary to probe sub-GeV DM. The former can cover heavier DM, while the latter can cover lighter DM. Both of them can cover DM with a mass of 20 MeV to 200 MeV. Including momentum, the transfer effect can greatly improve the existing bounds.

Session 3 / 6

Time-dependent treatment of cosmic-ray spectral steepening due to turbulence driving

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Cosmic-ray acceleration at non-relativistic shocks relies on scattering by turbulence that the cosmic rays drive upstream of the shock. We explore the rate of energy transfer from cosmic rays to non-resonant Bell modes and the spectral softening it implies. Accounting for the finite time available for turbulence driving at supernova-remnant shocks yields a smaller spectral impact than found earlier with steady-state considerations. Generally, for diffusion scaling with the Bohm rate by a factor η, the change in spectral index is at most η divided by the Alfv\'enic Mach number of the thermal sub-shock. For M_A less than 50 it is well below this limit. Only for very fast shocks and very efficient cosmic-ray acceleration the change in spectral index may reach 0.1. For standard SNR parameters it is negligible. Independent confirmation is derived by considering the synchrotron energy losses of electrons: if intense nonthermal multi-keV emission is produced, the energy loss, and hence the spectral steepening, is very small for hadronic cosmic rays that produce TeV-band gamma-ray emission.

Session 2 / 7

Cherenkov Telescope Array Sensitivity to the High-Energy Tail of the Galactic Center Excess

Author: Oscar Macias[1]

Co-authors: Deheng Song [2]; Roland Crocker [3]; Shin'ichiro Ando [4]; Shunsaku Horiuchi [2]; van Leijen Harm [4]

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Past studies of the Fermi Galactic Center Excess (GCE) have found evidence for a "high-energy tail" in the GCE spectrum. Such a signature could be the result of inverse-Compton (IC) gamma rays produced by the injection of electrons/positrons into the interstellar medium by the putative population of millisecond pulsar (MSPs) responsible for the GCE. For this TeVPA 2021 contribution, we present the results of an exhaustive study on simulated data, in which we analyze the detection potential of the forthcoming Cherenkov Telescope Array (CTA) to the high-energy tail of the GCE. In particular, we find that CTA will have sufficient sensitivity to detect this signal for physically reasonable electron/positron acceleration efficiencies, provided that the Galactic diffuse emission model (GDE) is well understood. Furthermore, we discuss the necessary conditions for a reliable CTA discovery in the case of a high degree of uncertainties in the GDE model. We also show that in the event that CTA observes an excess of diffuse gamma rays in the Galactic bulge, it will be able to discriminate between the dark matter and MSPs hypotheses, based on their distinct spatial morphologies.

Session 2 / 9

Origin of the very high energy gamma-ray emission from the Crab pulsar wind nebula

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We study electron and positron acceleration at the termination shock of a striped pulsar wind by integrating particle trajectories in a prescribed model of the magnetic field and flow pattern. We find that drift motion on the shock surface maintains either electrons or positrons on Speiser orbits in a ring-shaped region close to the equatorial plane of the pulsar, where they are accelerated to very high energy by the first-order Fermi mechanism. We calculate the resulting inverse Compton emission from these electrons, and demonstrate that the observed > TeV gamma-ray emission from the Crab Nebula can be well reproduced for reasonable parameters of the Crab pulsar wind and turbulence levels in the nebula. We show that the recent observations of the Crab Nebula up to ˜ PeV energies by LHAASO allow for putting novel constraints on parameters of the Crab pulsar wind that are still poorly known.

Please choose the session this abstract belongs to:

Galactic sources

Session 3 / 10

Simulations of the TeV-PeV cosmic-ray anisotropy

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We calculate the shape of the TeV-PeV cosmic-ray anisotropy (CRA) in 3D Kolmogorov turbulence. We present the first numerical calculations of the CRA down to TeV energies, using realistic values for the coherence length of the interstellar turbulence. At these low energies, the large-scale CRA aligns with the direction of local magnetic field lines around the observer. In this type of turbulence, the cosmic-ray intensity is flat in a broad region perpendicular to magnetic field lines. Even though the CRA is rather gyrotropic, we show that the local realization of the turbulence around the observer results in the appearance of weak, non-gyrotropic, small-scale anisotropies, which contain important information about the local turbulence level. Our findings will be useful to interpret observations of the cosmic-ray anisotropy by LHAASO.

Please choose the session this abstract belongs to:

Cosmic rays

Session 1 / 16

LST-1, the Large-Sized Telescope prototype of CTA: status and first observations.

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The contribution will present the status of the project and some highlights of the first observational data.

Summary:

CTA (Cherenkov Telescope Array) is the next generation ground-based observatory for gamma-ray astronomy at very high energies. Once completed, CTA will outperform present-day facilities by an order of magnitude in sensitivity, and significantly enlarge the accessible energy range and survey capabilities. Deployed in the CTA north site, on the island of La Palma (Spain), LST-1 is the prototype for the CTA Large-Sized Telescopes, which will cover the lower end of the energy range of the array, down to 20 GeV. LST-1 started astronomical observations in late 2019, and is currently completing its commissioning phase. We will present the status of the instrument and an overview of the first physics results.

Session 1 / **17**

Horizontal air showers and neutrino search with LHAASO-KM2A

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High-energy transients, e.g., gamma-ray bursts (GRBs), supernovae, and blazars, are potential sources of high-energy cosmic rays. Neutrinos are a good probe of the origin of cosmic rays.
Horizontal air showers (HAS) are expected to be initiated by deeply penetrating high en-ergy particles such as neutrinos. Indeed, at large zenith angles the electromagnetic com-ponent of ordinary air showers should be attenuated by the atmosphere well before reaching the ground level and the muon component is expected to dominate the second-ary particles. Neutrino candidate events, on the contrary, are expected to be like the elec-tromagnetic showers, with a small muon content. Measuring the muon content provides a method to discriminate between showers, then to tag neutrino candidate events.
The LHAASO-KM2A is constituted by a large array of both electromagnetic and under-ground muon detectors, with unprecedented total sensitive area (greater than 40,000 m2).
In this talk I show the first results of HAS with the half array of LHAASO-KM2A, including the zenith angle distribution of extensive air showers and the transition from electromag-netic-dominated showers to muon-dominated ones above a zenith angle of 60 deg.

Session 3 / **18**

Cosmic-ray acceleration in young supernova remnants in dense circumstellar environments

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Co-authors: Iurii Sushch [2]; Jonathan Mackey [1]

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[2] *North-West University Potcheftroom*

Supernova remnants are known to accelerate cosmic rays (CRs) on account of their non-thermal emission of radio waves, X-rays, and gamma rays. However, the ability to accelerate CRs up to PeV-energies has yet to be demonstrated. The presence of cut-offs in the gamma-ray spectra of several young SNRs led to the idea that PeV energies might only be achieved during the very initial stages of a remnant' s evolution.

We use the time-dependent acceleration code RATPaC to study the acceleration of cosmic rays in supernovae expanding into dense environments around massive stars, where the plentiful target material might offer a path to the detection of gamma-rays by current and future experiments. We performed spherically symmetric 1-D simulations in which we simultaneously solve the transport equations for cosmic rays, magnetic turbulence, and the hydrodynamical flow of the thermal plasma in the test-particle limit.

We investigated typical parameters of the circumstellar medium (CSM) in the freely expanding winds around red supergiant (RSG) and luminous blue variable (LBV) stars. The maximum achievable energy might be limited to sub-PeV energies: we find a maximum CR energy of 600-700 TeV, reached within one month after explosion for a strong magnetic field in the progenitor' s wind and 100-200 TeV for a weak ambient field.

Session 1 / 19

Follow-up Study of the Energy-Dependent Morphology of Geminga with HAWC

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The local positron excess above 10 GeV measured by PAMELA, Fermi-LAT, and AMS-02 remains an essential question in the field of astroparticle physics. Dark matter particle decay/annihilation presents a viable mechanism to explain this positron excess. However, pulsars are also emitters of electrons/positrons. The HAWC collaboration studied the contribution from two-mid aged pulsars, Geminga and PSR B0656+14, with 500 days of observations, and found high efficiency with a slow diffusion coefficient suggesting no significant contribution to the above positron excess. This result introduced a new subclass of gamma-ray sources, TeV halos. Using five years of data from the HAWC gamma-ray observatory and a new inverse Compton halo model, we fit the diffusion coefficient and electron spectral index to study the energy-dependence of particle diffusion.

Session 1 / 20

Improving the signal estimation from On/Off observations in gamma-rays

Author: Giacomo D\'Amico[1]

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Signal estimation in the presence of background noise is a common problem in several scientific disciplines. An "on/off" measurement is performed when the background itself is not known, being estimated from a background control sample. In this work, we devise a novel reconstruction method, Bayesian analysis including single-event likelihoods (dubbed BASiL), for estimating the signal rate based on the Bayesian formalism. It uses information on event-by-event individual parameters and their distribution for the signal and background population. Events are thereby weighted according to their likelihood of being a signal or a background event and background suppression can be achieved without performing fixed fiducial cuts. We provides a performance test using real data and simulations of observations with the MAGIC telescopes, as a demonstration of the performance for Cherenkov telescopes. BASiL allows one to estimate the signal more precisely, avoiding loss of exposure due to signal extraction cuts.

Session 4 / 21

Latest results from the CUORE experiment

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Latest results from the CUORE experiment

The Cryogenic Underground Observatory for Rare Events (CUORE) is the first bolometric experiment searching for 0νββ decay that has been able to reach the one-tonne mass scale. The detector, located at the LNGS in Italy, consists of an array of 988 TeO2 crystals arranged in a compact cylindrical structure of 19 towers. CUORE began its first physics data run in 2017 at a base temperature of about 10 mK and in April 2021 released its 3rd result of the search for 0νββ, corresponding to a tonne-year of TeO2 exposure. This is the largest amount of data ever acquired with a solid state detector and the most sensitive measurement of 0νββ decay in 130Te ever conducted, with a median exclusion sensitivity of 2.8×10ˆ25 yr. We find no evidence of 0νββ decay and set a lower bound of 2.2 ×10ˆ25 yr at a 90% credibility interval on the 130Te half-life for this process. In this talk, we present the current status of CUORE search for 0νββ with the updated statistics of one tonne-yr. We finally give an update of the CUORE background model and the measurement of the 130Te 2νββ decay half-life, study performed using an exposure of 300.7 kg·yr.

Please choose the session this abstract belongs to:

Neutrinos

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Cosmic-Ray and Gas Properties in the MBM 53-55 Clouds and the Pegasus Loop as Revealed by HI Line Profiles, Dust, and Gamma-Ray Data

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In studying the interstellar medium (ISM) and Galactic cosmic rays (CRs), uncertainty of the interstellar gas density has always been an issue. To overcome this difficulty, we newly considered HI line profiles in the analysis of gamma-ray data from the Fermi Large Area Telescope (LAT) for the MBM 53, 54, and 55 molecular clouds and the Pegasus loop. We decomposed the ISM gas into intermediate-velocity clouds, cold and optically thick HI, warm and optically thin HI, CO-bright H2, and CO-dark H2 using detailed correlations with the HI line profiles from the HI4PI survey, the Planck dust-emission model, and the Fermi-LAT gamma-ray data. We then fitted the CR spectra measured directly at/near the Earth and the measured gamma-ray emissivity spectrum simultaneously to constrain the local interstellar spectrum. In this contribution, we will present the analysis, and discuss the obtained CR and ISM gas properties.

Please choose the session this abstract belongs to:

Gamma rays

Session 1 / 24

Dark matter freeze-in from semi-production

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We study a novel dark matter production mechanism based on the freeze-in through semi-production, i.e. the inverse semi-annihilation processes. A peculiar feature of this scenario is that the production rate is suppressed by a small initial abundance of dark matter and consequently creating the observed abundance requires much larger coupling values than for the usual freeze-in. We provide a concrete example model exhibiting such production mechanism and study it in detail, extending the standard formalism to include the evolution of dark matter temperature alongside its number density and discuss the importance of this improved treatment. We show that, even if it was never in full thermal equilibrium in the early Universe, dark matter could, nevertheless, have strong enough present-day annihilation cross section to lead to observable signals, such as the Galactic Center gamma-ray excess.

Please choose the session this abstract belongs to:

Dark matter

Session 1 / 25

Searching for dark matter self-interactions in tidally formed ultra-diffuse galaxies and cluster substructures

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[2] *Tsinghua University*

Cold dark matter can be interacting rather frequently at dense regions of galaxies. It has been shown that these interactions could provide explanations for several small-scale anomalies. In recent years, small-scale observations continue to challenge our understanding of the nature of dark matter: two ultra-diffuse galaxies DF2 and DF4, are found to be deficient in dark matter, and the number of small-scale lenses seems to be excess in number in massive clusters. In this talk, we present some of our works related to these observations. We show that self-interacting dark matter can be consistent with these very different observations, and in some cases, provide more natural explanations. Its interesting interplay with other aspects of galaxy evolution is worthy of further exploration.

Please choose the session this abstract belongs to:

Dark matter

Session 1 / 26

Dark Matter Capture in Neutron Stars

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The capture of dark matter (DM) in neutron stars provides a cosmic laboratory in which to study the nature of dark matter particles and their interactions under extreme conditions. We outline an improved treatment of the dark matter capture process that incorporates a number of important, yet previously overlooked, physical effects, including momentum dependent form factors and baryon interactions. We compare projected sensitivities for dark matter capture in neutron stars with limits from direct detection experiments. For both DM-nucleon and DM-lepton scattering, dark matter capture in neutron stars provides a means to probe interactions that would be difficult or impossible to observe on Earth.

Please choose the session this abstract belongs to:

Dark matter

Session 1 / 27

A gamma-ray enhancement event in Tycho's supernova remnant

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We will present a γ-ray enhancement event detected from Tycho ' s supernova remnant (SNR), which lasted for 1.5
years and showed a factor of 3.6 flux increase mainly in the energy range of 4–500 GeV. While several young SNRs (including Tycho ' s SNR) were previously found to show peculiar X-ray structures with flux variations in one- or several-year timescales, such an event at γ-ray energies is for the first time seen. The hard γ-ray emission and year-long timescale of the event necessitate a synchrotron radiation process, although the required conditions are either ultra-high energies for the electrons in the process, upto ~10 PeV (well above the cosmic-ray "knee" energy), or high inhomogeneity of the magnetic field
in the SNR. This event in Tycho ' s SNR is likely analogous to the γ-ray flares observed in the Crab nebula, the comparably short timescales of them both requiring a synchrotron process, and similar magnetohydrodynamic processes such as magnetic reconnection would be at work as well in the SNR to accelerate particles to ultra-relativistic energies. The event and its implications thus reveal the more complicated side of the physical processes that can occur in young SNRs.

Please choose the session this abstract belongs to:

Galactic sources

Session 4 / 28

Belle II experiment: status and prospects

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The Belle II experiment at the SuperKEKB energy-asymmetric e+e− collider is a substantial upgrade of the B factory facility at the Japanese KEK laboratory. The target luminosity of the machine is 6×1035 cm−2s−1 and the Belle II experiment aims to record 50 ab−1 of data, a factor of 50 more than its predecessor. With this data set, Belle II will be able to measure the Cabibbo-Kobayashi-Maskawa (CKM) matrix, the matrix elements and their phases, with unprecedented precision and explore flavor physics with B and charmed mesons, and τ leptons. Belle II has also a unique capability to search for low mass dark matter and low mass mediators. We also expect exciting results in quarkonium physics with Belle II. In this presentation, we will review the status of the Belle II detector, the results of the planned measurements with the full available Belle II data set, and the prospects for physics at Belle II.

Please choose the session this abstract belongs to:

Particle physics

Session 1 / 29

Dark-sector physics at Belle II

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The Belle II experiment is in the unique position of probing a yet uncharted sector of particle physics, which includes hypothetical particles coupling very weekly with the standard model ones that might help explaining the nature of dark matter and other anomalies. Belle II analyzed 0.5 fb-1 of commissioning data to exclude part of the parameter space of models including low mass Z' bosons and axion-like particles. The results of a new search for Dark-Higgstrahlung processes, obtained on the 2019 data set, are presented and longer-term reach on a variety of Dark Sector signatures are also discussed.

Please choose the session this abstract belongs to:

Dark matter

Session 2 / 30

The implications of TeV detected GRB afterglows for acceleration at relativistic shocks

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We revisit the external shock picture of gamma-ray burst afterglow models, in light of recent very-high-energy gamma-ray detection from GRB190829A. The maximum electron energy achievable at an ultra-relativistic weakly-magnetized shock is thought to proceed in the "ballistic" transport regime. This limits synchrotron photons to energies below the often assumed burn-off limit. A single zone synchrotron/SSC model if developed to compare the revised afterglow predictions against multi-wavelength data of GRB190829A. Reproducing the hard spectrum reported by H.E.S.S.collaboration within our simple single zone model is a serious challenge when Klein-Nishina effects are correctly accounted for.

Please choose the session this abstract belongs to:

Extragalactic sources

Session 2 / 31

Relationship between gamma-ray loudness and X-ray spectra of radio galaxies

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Radio galaxy (RG) is one of AGNs. The Fermi has detected about 60 RGs, but it is only 10% of part of the RGs detected in the radio band. In this study, we investigated the difference in their X-rays properties between GeV-loud and GeV-quiet RGs. In addition to 38 RGs detected by Fermi with available X-ray data, we selected 25 RGs shown in Mingo et al. 2014 and Massaro et al. 2015 as GeV-quiet RGs. We performed X-ray spectral analysis of these 63 RGs using data from the XMM-Newton, Chandra, NuSTAR, and Swift. As a result, the distribution of photon indices and luminosities showed no obvious difference between GeV-loud and GeV-quiet RGs. On the other hand, for the distribution of the absorption column density $N_{\rm H}$, about half of the GeV-quiet RGs have $N_{\rm H}$ larger than $10^{22}{\rm cm}^{-2}$ and most of the GeV-loud RGs have $N_{\rm H}$ smaller than $10^{22}{\rm cm}^{-2}$. This can be explained by that jet of GeV-loud RGs are observed from a smaller viewing angle and thus the disk/corona X-ray emission is not blocked by the torus, resulting in a smaller absorption. On the other hand, jet of GeV-quiet RGs are observed from a larger angle and thus the disk/corona X-ray emission is easily blocked by the torus, resulting in a bigger absorption.

Please choose the session this abstract belongs to:

Galactic sources

Session 2 / 33

The formation of gamma-ray halos around supernova remnants through particle escape

Author: Robert Brose[1]

Co-authors: Iurii Sushch [2]; Martin Pohl [3]

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Supernova remnants (SNRs) are known to accelerate particles to relativistic energies, on account of their nonthermal emission. The particularities of the acceleration mechanism are still debated and here we discuss how particle escape modifies the observable spectra as well as morphological features that might be revealed by the observational progress from radio to gamma-ray energies.

We use our time-dependent acceleration code RATPaC to study the formation of extended gamma-ray halos around supernova remnants and the morphological implications that arise when the high-energetic particles start to escape from the remnant.

We find a strong difference in the morphology of the gamma-ray emission from supernova remnants at later stages dependent on the emission process. At early times, both the inverse-Compton and the Pion-decay morphology are shell-like. However, as soon as the maximum-energy of the freshly accelerated particles starts to fall, the inverse-Compton morphology starts to become center-filled, whereas the Pion-decay morphology keeps its shell-like structure. Both emission-spectra show a spectral softening caused by the escape of the highest-energetic particles. Escaping high-energy electrons start to form an emission halo around the remnant at this time. There are good prospects for detecting this spectrally hard emission with the future Cerenkov Telescope Array, as there are for detecting variations in the gamma-ray spectral index across the interior of the remnant. Due to the projection effects there is no significant variation of the spectral index expected with current-generation gamma-ray observatories.

Please choose the session this abstract belongs to:

Cosmic rays

Session 2 / 34

A toy multi-zone model for multi-wavelength emission of blazars

Author: Rui Xue[1]

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In this work, we develop a self-consistent multi-zone model to describe the time-dependent multi-wavelength emission of blazars. Based on Very Long Baseline Array observations of M 87 jet, we speculate and assume that numerous discrete emission zones throughout the jet of a blazar. We model the temporal evolution of the electron spectrum in each emission zone taking into account the injection, cooling and escape of relativistic electrons. By doing so, we are able to calculate the multi-wavelength light curve of each emission zone. The observed emission of a blazar is then the superposition of the emission from all discrete emission zones. This model can reproduce some observational phenomena of blazars, such as the flat radio spectra, Gaia-VLBI downstream offset, and the minute-scale gamma-ray variability, which are difficult to explain under the conventional one-zone models.

Please choose the session this abstract belongs to:

Extragalactic sources

Session 1 / 35

Constraining Dark Matter Annihilation with Cosmic Ray Antiprotons using Neural Networks

Author: Kathrin Nippel[1]

Co-authors: Felix Kahlhoefer [2]; Michael Korsmeier [3]; Michael Krämer [2]; Silvia Manconi [2]

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The interpretation of data from indirect detection experiments searching for dark matter annihilations requires computationally expensive simulations of cosmic-ray propagation. In this work we present a new method based on Recurrent Neural Networks that significantly accelerates simulations of secondary and dark matter Galactic cosmic ray antiprotons while achieving excellent accuracy. This approach allows for an efficient profiling or marginalisation over the nuisance parameters of a cosmic ray propagation model in order to perform parameter scans for a wide range of dark matter models. We identify importance sampling as particularly suitable for ensuring that the network is only evaluated in well-trained parameter regions. We present resulting constraints using the most recent AMS-02 antiproton data on several models of Weakly Interacting Massive Particles. The fully trained networks are released as DarkRayNet together with this work and achieve a speed-up of the runtime by at least two orders of magnitude compared to conventional approaches.

Please choose the session this abstract belongs to:

Dark matter

Session 2 / 36

Particle Acceleration by Magnetic Reconnection Driven by Current-Driven Kink Instability Turbulence in Relativistic Jets

Author: Yosuke Mizuno[1]

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We have investigated the acceleration of particles injected into a three-dimensional relativistic magnetohydrodynamic (RMHD) simulations of propagating relativistic jet subject to current-driven (CD) kink instability. RMHD simulations show that, once turbulence driven by CD kink instability fully develops, the amplitude of excited wiggles along the jet spine attains maximum growth, causing disruption of the magnetic field lines and the formation of fast magnetic reconnections. Low-energy protons injected into the jet at this state experience exponential acceleration, mostly in directions parallel to the local magnetic field, up to maximum energies E˜10ˆ{16} eV for B˜ 0.1G. Our results can explain observed variable emission patterns, specially at very high energies observed in blazars.

Please choose the session this abstract belongs to:

Extragalactic sources

Session 2 / 37

Strongly coupled dark sector and dark pions

Author: Lingfeng Li[1]

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We studied the phenomenology and experimental searches of the dark pions, which are the lightest hadrons in a hidden sector confining gauge theory. Such a scenario arises in many extensions of the Standard Model (SM). We consider that the leading interactions between the light hidden sector quarks and the SM particles come from the mixing of the light hidden quarks with heavy electroweak doublet states through Higgs Yukawa couplings, so that the leading portals are the Z and Higgs bosons. We will also point interesting cosmological aspects of strongly coupled dark sector models.

Please choose the session this abstract belongs to:

Dark matter

Session 2 / 38

Radio Constraints on Multi-Messenger High-Energy Emission from Galaxy Clusters

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Galaxy clusters can work as gigantic reservoirs of cosmic rays, and they are considered to be possible sources of the IceCube neutrinos.
Some clusters are found with extended radio emission called radio halos, which provides crucial information about the non-thermal components in the intra-cluster medium. We study the high-energy emission from the galaxy clusters considering the constraints from the observations of the radio halos.
It has been believed that the radio emission is powered by the turbulent re-acceleration of relativistic electrons because radio halos are preferentially found in merging systems.
Concerning the origin of cosmic-ray electrons, we compare two scenarios, 'secondary' and 'primary' scenarios, where electrons are mainly produced through the pp collision in the secondary scenario.
We model the evolution of the spectrum and cosmic-ray distribution in a specific cluster, the Coma cluster, by solving the Fokker-Planck equation, considering the re-acceleration and spatial diffusion.
On the other hand, the occurrence of radio halos is modeled with the Monte Carlo merger tree and constrained by the observed statistical properties.

Please choose the session this abstract belongs to:

Extragalactic sources

Summary:

Both secondary and primary scenarios seem to be compatible with current multi-wavelength observations, although the required injection profile of cosmic-rays and the lifetime of the radio haloes are considerably different. We roughly estimated the neutrino background intensity and find that galaxy clusters can make a sizable contribution to the IceCube data even in the primary scenario. Future high-sensitivity observation in radio and gamma-ray bands would be crucial to distinguish those two scenarios.

Session 3 / 39

Particle acceleration at quasi-perpendicular non-relativistic high Mach number shocks

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Electron and ion acceleration at a non-relativistic collisionless shocks is studied by employing large scale one-dimensional particle-in-cell (PIC) simulations in the de-Hoffmann and Teller (dHT) frame of reference. We demonstrate that diffusive shock acceleration of both electrons and ions occurs in quasi-perpendicular shock configurations at large Alfvén Mach numbers. We also identify the role of precursor waves on the electron energization in the upstream region. The emergence of a significant non-thermal ion component holds important implications for observations of hadronic emission from collisionless shocks occurring for example in supernova remnants, and colliding stellar winds.

Please choose the session this abstract belongs to:

Cosmic rays

Session 1 / 40

The XENON Dark Matter Search Experiment

Author: Fei Gao[1]

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To date, dark matter (DM) has only been observed through its gravitational interaction. Detection of a DM signal in an ultra-low background terrestrial detector will represent a ground-breaking discovery in physics and cosmology. The XENON collaboration has pioneered the development of liquid xenon time projection chambers and built a series of such detectors to lead the search for DM particles. As the first tonne scale experiment with the lowest electronic recoil background of its kind, the XENON1T detector sets the world-leading upper limit on DM-nucleon cross-section with DM masses above 0.1 GeV. The XENON1T experiment is also leading the search for other rare processes such as signals from solar axion and the coherent elastic scattering of solar Boron-8 neutrinos. The XENONnT experiment is running at the INFN Gran Sasso National Laboratory in Italy, featuring a 6-tonne liquid xenon target and approximately 6 times lower background than its predecessor XENON1T. In this talk, I will review the world-leading results achieved with XENON1T, and discuss the status and discovery potential of XENONnT.

Please choose the session this abstract belongs to:

Dark matter

Session 3 / 41

Implications of turbulence dependent diffusion on cosmic ray spectra

Author: Julien Dörner[1]

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The propagation of cosmic rays can be described as a diffusive motion in most galactic environments. The Milky Way and its cosmic-ray distribution have been studied in detail by the measurement of high-energy gamma-rays with Fermi. A gradient in the cosmic-ray density and spectral energy behavior has been measured indirectly this way and is in need of explanation.

In this talk we use recent analysis of the diffusion tensor, which shows that the energy scaling of the diffusion tensor $\kappa \propto E^{\gamma_i}$ is a function of the turbulence level b/B, to explain this behavior. Therefore, we probe different types of diffusion tensors and compare the results to the measurements.

Please choose the session this abstract belongs to:

Cosmic rays

Session 4 / 42

Search for High-Energy Neutrinos from Blazars with IceCube

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The IceCube Neutrino Observatory is the world largest neutrino telescope, instrumenting one cubic kilometre of Antarctic ice. IceCube started its operation in 2011 and a diffuse flux of neutrino was discovered in 2013. To this day the sources of those neutrinos are still largely unknown. One of the most promising neutrino source candidates are blazars, Active Galactic Nuclei with jets aligned towards Earth.

In 2018 IceCube reported the first observation of an astrophysical high-energy neutrino, IC170922A, in spatial and temporal coincidence with blazar TXS 0506+056. Other examples of coincidences that have been observed with lower significance are, but not limited to, IC190730A with blazar PKS 1506+012 and IC141209A with blazar GB6 J1040+0617. What these have in common is that they involve a blazar and a high-energy neutrino with a high probability of being astrophysical in origin (neutrino alert). These coincidences can be combined to calculate a global p-value by performing a stacking analysis. Here we present the sensitivity and discovery potential obtained with 1916 blazars from the Fourth Catalog of Active Galactic Nuclei detected by Fermi-LAT (4LAC) and 275 neutrinos detected by IceCube between 2011 and 2020 that would have passed the neutrino alert criteria.

Please choose the session this abstract belongs to:

Neutrinos

Session 3 / 43

The low rate of Galactic supernova remnant pevatrons

Author: Pierre Cristofari[1]

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The search for pevatrons (objects capable of accelerating partilces up to 10^{15} eV) has become one of the key targets of the high−energy gamma−ray community.
These objects are of crucial importance in the context of the origin of cosmic rays (CRs), since the sources of Galactic CRs are expected to
be able to accelerate particles up to PeV energies, at least at some stage of their evolution.
Currently, the
most widely accepted candidates for the origin of Galactic CRs are supernova remnants (SNRs),
and more precisely the shocks expanding in the interstellar medium (ISM) after stellar explosions.
But surprisingly, all detected SNRs have been shown not to be pevatrons, making the situation somewhat bewildering. A special attention is currently being devoted to the search of a SNR pevatron, and we discuss the possibility that only very rare SNRs might be pevatrons, and thus, the probability of detecting one is remarkably reduced.

Please choose the session this abstract belongs to:

Cosmic rays

Session 2 / 44

Hybrid origins of the cosmic-ray nuclei spectral hardening at a few hundred GV

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Many experiments have confirmed the spectral hardening at a few hundred GV of cosmic-ray (CR) nuclei spectra, and 3 general different origins have been proposed: the primary source acceleration, the propagation, and the superposition of different kinds of sources. In this talk, I will report some new findings from the AMS-02 nuclei spectra of B and its dominating parents species (C, N, O, Ne, Mg, and Si): the nuclei spectral hardening in a few hundred GV should have hybrid origins. Besides the propagation origin, the superposition of different kinds of sources are also needed for different kinds of the CR primary nuclei species. All these results can be further confirmed by more precise CR nuclei spectra data in high rigidity regions (like that from DAMPE), and could provide us an opportunity to improve the current CR models.

Please choose the session this abstract belongs to:

Cosmic rays

Session 2 / 45

Search for fractionally charged particles in space with DAMPE

Author: Chengming LIU[1]

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The existence of fractionally charged particles (FCP) in present is some extensions to the Standard Model of particle physics, and their detection would be a significant breakthrough. Most of the previous cosmic-rays (CRs) studies are mainly focused on the secondary CRs from the extensive air shower, but there is rarely on-orbit study to search FCP from primary CRs. The DArk Matter Particle Explorer (DAMPE) was launched into space on the 17th December 2015, and it has been working well in space for more than five years with the purpose of measuring CRs and gamma-rays and as today a large amount of scientific data has been acquired. In this work the five years ' on-orbit data of DAMPE have been analyzed for the search of 2/3 fractionally charged particle (FCP). The FCP is assumed to have high penetration capability, and therefore in the selections the particle is required to penetrate the entire detector from top to bottom. Two sub-detectors, the Plastic Scintillator Detector (PSD) and the Silicon Tungsten tracKer (STK), are used for charge discrimination. The Geant4 simulations toolkit is used to investigate the signal region and selection efficiency of 2/3 FCP in the detector. No FCP signal is found with DAMPE. The detailed selection methods and progress of DAMPE will be presented and discussed.

Please choose the session this abstract belongs to:

Cosmic rays

Session 1 / 47

Search for Gamma-ray Line emission from Dark Matter annihilation in the Galactic Centre with the MAGIC telescopes

Author: Tomohiro Inada[1]

Co-authors: Daniel Kerszberg [2]; Daniele Ninci [2]; Javier Rico [2]; Masahiro Teshima [3]; Moritz Huetten [3]

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We present a search for dark matter (DM) spectral lines in the Galactic centre (GC) region with the MAGIC telescopes. MAGIC is a stereoscopic system of Atmospheric Cherenkov telescopes, located on the Canary island of La Palma (Spain) and sensitive to gamma rays in the energy range from 50 GeV to 50 TeV. Observations at high zenith angles significantly increase the telescopes' collection area and sensitivity for gamma rays in the TeV regime. We discuss how we exploit the data from a complex sky region to search for a line-like DM signature and derive constraints on line emission from more than 200 hours of MAGIC high-zenith angle observations of the GC region. Our analysis allows us to derive competitive limits to the DM annihilation cross-section in the TeV range and to exclude a previously unconstrained range of heavy SUSY models.

Please choose the session this abstract belongs to:

Dark matter

Plenary / 48

Heavy dark matter at colliders

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In this talk, I will review the general search ideas of dark matter at colliders, focusing on the usage and complementarity between different search methods and frameworks. I will show a few concrete examples of recent developments in deriving new results from Open Data. Furthermore, the future perspective of probing heavy dark matter at various future colliders will be discussed.

Please choose the session this abstract belongs to:

Plenary talk

Summary:

Invited plenary review talk on "Heavy dark matter at colliders".

Session 4 / 50

The KM3NeT detector –status, perspectives and preliminary results

Author: Annarita Margiotta[1]

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KM3NeT is a deep-sea infrastructure mainly devoted to the detection of neutrinos over a large range of energy. It hosts two Cherenkov neutrino telescopes in different sites of the Mediterranean Sea: ARCA, located at 3500 m sea depth, offshore Sicily, will look for high energy neutrinos coming from astrophysical sources; ORCA, installed 2500 m under the sea level, in front of the Provencal coast, will detect atmospheric neutrinos to investigate neutrino properties, in particular the neutrino mass order, through the study of oscillation patterns.
The two telescopes are organized as 3D lattices of Digital Optical Modules, each hosting 31 small photomultipliers, distributed along vertical, flexible lines. The distance between the optical modules depends on the scientific goal of the detector: longer for ARCA, in order to instrument a much wider volume of water, more than 1 km3, and identify very high energy neutrinos; shorter for ORCA, to detect atmospheric neutrinos.
The modular structure of the detectors allows for analyses and searches to be performed even in a preliminary and not complete configuration.
This talk discusses the main scientific goalsof a km3 Mediterranean neutrino telescope, describes the status of the construction, and shows the first preliminary analyses performed using data collected in the present partial configuration.

Please choose the session this abstract belongs to:

Neutrinos

Session 2 / 52

Fast X-ray variability of radio galaxy M87

Author: Ryo Imazawa[1]

Co-authors: Hiromitsu Takahashi [1]; Yasushi Fukazawa [1]

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M87 is one of the nearest radio galaxy. We can study the core, jet, and some components by radio to X-ray observations.
Regarding TeV gamma ray observations, it is known to show an intra-day variability.
Such fast variability may occur at the particle acceleration region. But due to rough angular resolution, we cannot know which component causes this variability.
We searched for fast X-ray variability of the M87 from long-exposure X-ray archive data.

Please choose the session this abstract belongs to:

Extragalactic sources

Summary:

As a result, we found an intra-day variability during Suzaku/XIS data in 2006.
Suzaku/XIS cannot resolve each component, but HST-1 was the brightest component in the X-ray band in this period; core had 1/4 of HST-1 flux.

Therefore, this variability possibly comes from HST-1, but we cannot rule out the possibility of large core variability.
A soft photon index > 2.0 in the X-ray band indicates that variability component is synchrotron emission from accelerated electrons in HST-1 or core.
In addition, we also find a possible variability of core on the Chandra/HRC observation in 2017.
In this period, NuSTAR X-ray spectra have a power law with a photon index of 1.8, and thus not likely a synchrotron spectrum from the jet. Here the X-ray emission from the core was dominant in this period.
Also, we find that one NuSTAR observation showed a higher flux than other NuSTAR observations by a factor of 2.5.
From these results, both core and HST-1 can be the origin of the X-ray variability.
We will discuss the variability site and emission mechanism.

Session 1 / 53

Energy budget of cosmological first-order phase transition

Author: Xiao Wang[1]

[1] *Sun Yat-sen University*

The energy budget of cosmological first-order phase transition is essential for the gravitational wave spectra. Most of the previous studies are based on the bag model with same sound velocity in the symmetric and broken phase. We study the energy budget and the corresponding gravitational wave spectra beyond the bag model, where the sound velocities could be different in the symmetric and broken phase. Taking the Higgs sextic effective model as a representative model, we calculate the sound velocities in different phase, the gravitational wave spectra, and the signal-to-noise ratio for different combinations of phase transition parameters beyond the bag model. We compare these new results with the ones obtained from the bag model. The proper sound velocities and phase transition parameters at the appropriate temperature are important to obtain more precise predictions.

Please choose the session this abstract belongs to:

Cosmology

Session 1 / 54

Searching for Axion Echos from Supernova Remnants

Authors: Chen Sun[1]; JiJi Fan[2]; Manuel Buen-Abad[3]

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[2] *Brown University*

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In this talk, I will discuss possible constraints on the axion-photon coupling arising from supernova remnants. I will assume axions to be dark matter and focus on the gegenschein signals from their decay stimulated by radios emitted from supernova remnants. I will show that this could put competitive bounds in the axion mass range between 10^{-6} eV and 10^{-4} eV.

Please choose the session this abstract belongs to:

Dark matter

Session 1 / 55

Search for dark matter in the Galactic Centre region with the H.E.S.S. Inner Galaxy Survey

Authors: Alessandro Montanari[1]; Denys, for the H.E.S.S. collaboration Malyshev[2]; Emmanuel Moulin[1]

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The presence of dark matter (DM) in the universe is indicated by copious astrophysical and cosmological measurements, however, its underlying nature is still under debate. Among the most promising candidates to explain dark matter are weakly interacting massive particles (WIMPs), that have mass and coupling strength at the electroweak scale. If thermally produced in the early universe, WIMPs have a present relic density consistent with that observed today. The self-annihilation of WIMPs would produce Standard Model particles, including gamma-rays in the final state. For a long-time, dark matter annihilation signals have been searched indirectly through gamma-rays. The inner part of the Milky Way is predicted as the brightest source of DM annihilation. A region of several degrees around the Galactic Centre has been observed in the last years by the H.E.S.S. collaboration with the Inner Galaxy Survey (IGS), with the aim to achieve the best sensitivity to faint and diffuse emissions. To search for DM annihilation signal, we analyzed observations taken between 2014 and 2020 with the five-telescope array and consisting of about 550 hours. No significant excess was found, therefore we derived strong constraints on the velocity-weighted annihilation cross-section of dark matter particles. Different annihilation channels can be inspected to probe thermal WIMPs in the TeV mass range.

Please choose the session this abstract belongs to:

Dark matter

Session 1 / 56

Precision cosmology and the stiff-amplified gravitational-wave background from inflation: implications for the Hubble tension

Author: Bohua Li[1]

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The recent NANOGrav finding of a common-spectrum process has invited interpretations as possible evidence of a primordial stochastic gravitational-wave background (SGWB)
stronger than predicted by standard inflation + ΛCDM. Such an SGWB would contribute an extra radiation component to the background Universe which may affect its expansion history. As such, it may help alleviate the current Hubble tension, a novel connection between gravitational waves and cosmology. We demonstrate this by considering a cosmological model, the "standard inflation + stiff amplification" scenario, with two components added to the base-ΛCDM model: a stiff component ($w \equiv p/\rho = 1$) and the primordial SGWB.
Previously, we showed that even for *standard* inflation, the SGWB may be detectable at the high

frequencies probed by laser interferometers, if it is amplified by a possible early stiff era after reheating. Models that boost the SGWB enough to cause significant *backreaction*, however, must still preserve the well-measured radiation-matter equality, respecting the demands of precision cosmology. For that, we calculate the fully-coupled evolution of the SGWB and expansion history, sampling parameter space (tensor-to-scalar ratio, reheating temperature and temperature at stiff-to-radiation equality). We then perform a joint analysis of the NANOGrav results and latest upper bounds from *Planck*, big bang nucleosynthesis and Advanced LIGO-Virgo, to constrain the model. The resulting blue-tilted, stiff-amplified SGWB is still too small to explain the NANOGrav results. However, if someday, Advanced LIGO-Virgo detects the SGWB, our model can explain it within standard inflation (*without* requiring an initial spectral tilt). Meanwhile, this model may bring current high-z measurements of the Hubble constant within 3.4σ of the low-z measurements by SH0ES (from 4.4σ) and within 2.6σ of those by H0LiCOW (from 3.1σ), reducing the tension.

Please choose the session this abstract belongs to:

Gravitational waves

Session 3 / 57

Cosmic Ray Small-Scale Anisotropies in Slab Turbulence

Author: Marco Kuhlen[1]

Co-authors: Philipp Mertsch [1]; Vo Hong Minh Phan [1]

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In the standard picture of cosmic ray transport the propagation of charged cosmic rays through turbulent magnetic fields is described as a random walk with cosmic rays scattering on magnetic field turbulence. This is in good agreement with the highly isotropic arrival directions as this diffusion process effectively isotropizes the cosmic ray distribution. However, high-statistics observatories like IceCube and HAWC have observed significant deviations from isotropy down to very small angular scales. This is in strong tension with this standard picture of cosmic ray propagation. By relaxing one of the assumptions of quasi-linear theory and explicitly considering the correlations between the fluxes of cosmic rays from different directions, we show that power on small angular scales is a generic feature of particle propagation through turbulent magnetic fields. We present a first analytical calculation of the angular power spectrum assuming a physically motivated model of the magnetic field turbulence and find good agreement with numerical simulations. We argue that in the future, the measurement of small-scale anisotropies will provide a new window to testing magnetic turbulence in the interstellar medium.

Please choose the session this abstract belongs to:

Cosmic rays

Session 2 / 58

Mapping the viable parameter space for testable leptogenesis

Authors: Juraj Klaric[1]; Marco Drewes[1]; Yannis Georis[2]

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In this talk, we present a new comprehensive study of the allowed parameter space within which type-I seesaw-based leptogenesis with three heavy neutrinos is possible. We include both freeze-in (ARS leptogenesis) and freeze-out (resonant leptogenesis) mechanisms. We show that, in presence of an approximately degenerate heavy neutrino mass spectrum, leptogenesis is feasible accross the whole experimentally accessible mass range all the way up to the TeV-scale and for active-sterile mixing considerably larger than in the minimal scenario where only two heavy neutrinos are present. Such large mixing would open up the possibility to perform consistency checks of the model.

Talk based on the following article: [arXiv:2106.16226].

Please choose the session this abstract belongs to:

Particle physics

Session 2 / 59

Long-term VERITAS observations of LS I +61° 303 and a multi-waveband perspective

Author: Sonal Ramesh Patel[1]

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We present multi-waveband studies of the TeV gamma-ray binary, LS I +61° 303. LS I +61° 303 displays variable emission from radio to TeV, modulated with the orbital period of 26.5 days, and with a spectral energy distribution peaking at MeV-GeV energies. The imaging atmospheric Cherenkov telescope array, VERITAS, has been observing this binary since November 2006 and has collected a rich dataset spanning over a decade. In this work, we use 174 hours of VERITAS data, complemented by observations from instruments working at lower energies, Fermi-LAT and Swift-XRT. Contemporaneous observations with these datasets are used to probe the correlations between the three wavebands. Also, to study the broadband emission from this source, these simultaneous data are used to generate spectral energy distributions during the orbital phase bin of maximum TeV emission (0.6-0.8). The implications of the correlation study and possible broadband emission scenarios will be discussed in this work.

Please choose the session this abstract belongs to:

Galactic sources

Session 3 / 60

Low-Energy Cosmic-Ray Electron and Nuclei from Discrete Stochastic Sources

Author: Vo Hong Minh Phan[1]

Co-authors: Florian Schulze [1]; Philipp Mertsch [1]; Sarah Recchia [2]; Stefano Gabici [3]

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Data from the Voyager probes have provided us with the first measurement of cosmic ray intensities at MeV energies, an energy range that had previously not been explored. Simple extrapolations of models that fit data at GeV energies, e.g., from AMS-02, however, fail to reproduce the Voyager data in that the predicted intensities are too high. Oftentimes, this discrepancy is addressed by adding a break to the source spectrum or the diffusion coefficient in an ad hoc fashion, with a convincing physical explanation yet to be provided. In this talk, we will show that the discrete nature of cosmic-ray sources, which is usually ignored, is instead a more likely explanation. We model the distribution of intensities expected from a statistical model of discrete sources and show that its expectation value is not representative but has a spectral shape different from that for a typical configuration of sources. The Voyager proton and electron data are however compatible with the median of the intensity distribution. We will also discuss some preliminary results concerning the implications of this model for the spectrum of iron and the ionization rate induced by low-energy cosmic rays in molecular clouds.

Please choose the session this abstract belongs to:

Cosmic rays

Session 3 / 61

Constraining the cosmic ray spectrum in the vicinity of the supernova remnant W28: from sub-GeV to multi-TeV energies (Poster during the break)

Author: Vo Hong Minh Phan[1]

Co-authors: Giovanni Morlino [2]; Jacco Vink [3]; Julian Krause [4]; Mélissa Menu [5]; Regis Terrier [4]; Stefano Gabici [4]

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Supernova remnants interacting with molecular clouds are ideal laboratories to study the acceleration of particles at shock waves and their transport and interactions in the surrounding interstellar medium. In this paper, we focus on the supernova remnant W28, which over the years has been observed in all energy domains from radio waves to very-high-energy gamma rays. The bright gamma-ray emission detected from molecular clouds located in its vicinity revealed the presence of accelerated GeV and TeV particles in the region. An enhanced ionization rate has also been measured by means of millimetre observations, but such observations alone cannot tell us whether the enhancement is due to low energy (MeV) cosmic rays (either protons or electrons) or the X-ray photons emitted by the shocked gas. The goal of this study is to determine the origin of the enhanced ionization rate and to infer from multiwavelength observations the spectrum of cosmic rays accelerated at the supernova remnant shock in the unprecedented range spanning from MeV to multi-TeV particle energies. We developed a model to describe the transport of X-ray photons into the molecular cloud, and we fitted the radio, millimeter, and gamma-ray data to derive the spectrum of the radiating particles. The contribution from X-ray photons to the enhanced ionization rate is negligible, and therefore the ionization must be due to cosmic rays. Even though we cannot exclude a contribution to the ionization rate coming from cosmic-ray electrons, we show that a scenario where cosmic-ray protons explain both the gamma-ray flux and the enhanced ionization rate provides the most natural fit to multiwavelength data. This strongly suggests that the intensity of CR protons

is enhanced in the region for particle energies in a very broad range covering almost 6 orders of magnitude: from roughly below 100 MeV up to several tens of TeV.

Please choose the session this abstract belongs to:

Cosmic rays

Plenary / 62

Highlights of TA Experiment

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The Telescope Array (TA) is an ultra-high energy cosmic ray detector, the largest in the Northern Hemisphere, sensitive to cosmic rays with energies from 1 PeV to above 100 EeV. The main detector is a hybrid detector consisting of an array of 507 surface detectors covering 700 km^2 overlooked by three fluorescence telescope detector stations. The energy range has been extended at the low end by the TA Low Energy (TALE) extension consisting of fluorescence detector stations with higher elevation viewing angle and an infill array of surface detectors. At the lowest energies, around 1 PeV, the TALE fluorescence telescopes operate as imaging air Cherenkov telescopes and work in hybrid with the Non-Imaging Cherenkov (NICHE) array for hybrid Cherenkov observation. TA is also being extended at the highest energies by increasing the covered area by a factor of four in the TA$\times$4 project. In this presentation, we will present the latest results from TA including a measurement of the spectrum and anisotropy studies, nuclear composition results from TALE, and the first results from TA$\times$4.

Please choose the session this abstract belongs to:

Plenary talk

Session 3 / 63

Nonlinear Propagation of Low-Energy Cosmic Rays from Supernova Remnants

Author: Hanno Jacobs[1]

Co-authors: Philipp Mertsch [2]; Vo Hong Minh Phan [3]

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The transport of Galactic cosmic rays (CRs) in the near-source environment is investigated. After release from the accelerator, large gradients in the CR density can trigger the resonant streaming instability, producing Alfvén waves. The scattering on the self generated magnetic turbulence leads to efficient self-confinement of CRs. Various damping processes and their dependence on the phases of the interstellar medium have been modelled. For the first time we consider the interplay of the self-confinement with Coulomb and ionisation losses, which become important for CR energies of

a GeV and below as tested by the Voyager probes. While TeV particles are no longer self-confined after a few tens of kyr, the transport of MeV and GeV particles is still inhibited after 1 Myr with significant implications for modelling of Galactic CRs.

Please choose the session this abstract belongs to:

Cosmic rays

session / 64

Evidence for inverse Compton emission from globular clusters

Author: Deheng Song[1]

Co-authors: David Nataf [2]; Oscar Macias [3]; Roland Crocker [4]; Shunsaku Horiuchi [5]

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The Fermi-LAT has detected gamma rays from dozens of globular clusters. The millisecond pulsars hosted by the globular clusters are very likely the primary source of them. However, the relative contributions between the curvature radiation from millisecond pulsar magnetospheres and inverse Compton emission from relativistic e± launched into the globular cluster environment have long been unclear. In this contribution, I will present the result for searching inverse Compton emission in 8-year Fermi-LAT data from the directions of 157 Milky Way globular clusters. We find a mildly statistically significant (3.8σ) correlation between the measured globular cluster gamma-ray luminosities and their photon field energy densities. However, this may also be explained by a hidden correlation between the photon field densities and the stellar encounter rates of globular clusters. We also find two components in the gamma-ray spectra of globular clusters: i) an exponentially cut-off power law and ii) a pure power law. We uncover the latter component at a significance of 8.2σ and inverse Compton emission by the relativistic e± injected by millisecond pulsars naturally explains it. We find the luminosity of this power-law component is comparable to, or slightly smaller than, the luminosity of the curved component, suggesting the fraction of millisecond pulsar spin-down luminosity into relativistic e± is similar to the fraction of the spin-down luminosity into prompt magnetospheric radiation.

Please choose the session this abstract belongs to:

Gamma rays

Session 3 / 65

Explaining cosmic ray antimatter with secondaries from old supernova remnants

Author: Philipp Mertsch[1]

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Despite significant efforts over the past decade, the origin of the cosmic ray positron excess has still not been unambiguously established. A popular class of candidate sources are pulsars or pulsar wind nebulae but these cannot also account for the observed hard spectrum of cosmic ray antiprotons. We revisit the alternative possibility that the observed high-energy positrons are secondaries created by spallation in supernova remnants during the diffusive shock acceleration of the primary cosmic rays, which are further accelerated by the same shocks. The resulting source spectrum of positrons at high energies is then naturally harder than that of the primaries, as is the spectrum of other secondaries such as antiprotons. We present the first comprehensive investigation of the full parameter space of this model — both the source parameters as well as those governing galactic transport. Various parameterisations of the cross sections for the production of positrons and antiprotons are considered, and the uncertainty in the model parameters discussed. We obtain an excellent fit to recent precision measurements by AMS-02 of cosmic ray protons, helium, positrons and antiprotons, as well as of various primary and secondary nuclei. This model thus provides an economical explanation of the spectra of *all* secondary species — from a single well-motivated population of sources.

Please choose the session this abstract belongs to:

Cosmic rays

Session 2 / 66

Accelerating Steep Cosmic Ray Spectra with Revised Diffusive Shock Acceleration

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Galactic cosmic rays (CRs) are accelerated by astrophysical shocks, primarily supernova remnants (SNRs), via diffusive shock acceleration (DSA), an efficient mechanism that predicts power-law energy distributions of CRs. However, observations of both nonthermal SNR emission and Galactic CRs imply CR spectra that are steeper than the standard DSA prediction, $\propto E^{-2}$. Recent kinetic hybrid simulations suggest that such steep spectra may be the result of a "postcursor", or drift of CRs and magnetic structures with respect to the thermal plasma behind the shock. Using a semi-analytic model of non-linear DSA, we generalize this result to a wide range of astrophysical shocks. By accounting for the presence of a postcursor, we produce CR energy distributions that are substantially steeper than E^{-2} and consistent with observations. Our formalism reproduces both modestly steep spectra of Galactic SNRs ($\propto E^{-2.2}$) and the very steep spectra of young radio supernovae ($\propto E^{-3}$).

Please choose the session this abstract belongs to:

Cosmic rays

Plenary / 67

Recent results from the Tibet ASgamma experiment

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The Tibet ASgamma experiment is located at 4,300m above sea level, at Yangbajing, in Tibet, China.The experiment is composed of a 65,700 m2 surface air shower array and 3,400 m2 underground water Cherenkov muon detectors. The surface air shower array is used for reconstructing the primary particle energy and direction, while the underground muon detectors enable us to discriminate gamma-ray induced muon-poor air showers from cosmic-ray (proton, helium,…) induced muon-rich air showers.Recently,the Tibet ASgamma experiment successfully observed gamma rays in the 100 TeV region from some point/extended sources as well as sub-PeV diffuse gamma rays along the Galactic disk.In this talk, The observational results will be presented, followed by some future prospect.

Please choose the session this abstract belongs to:

Plenary talk

Session 1 / 68

Localizing and Classifying Gamma-Ray Sources Using Deep Neural Network

Authors: Chris Van Den Oetelaar[1]; Saptashwa Bhattacharyya[2]

Co-authors: Boris Panes [3]; Gabrijela Zaharijas [2]; Guðlaugur Jóhannesson [4]; Roberto Ruiz Austri [5]; Sascha Caron [1]

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Due to the dominating presence of diffuse emission at GeV energies, detecting and localizing (faint) gamma-ray point sources in the Fermi-LAT data is a challenging task. Going beyond traditional statistical methods, here we show the application of deep learning and computer vision algorithms to localize and classify gamma-ray point sources starting from the raw Fermi-LAT sky images. We prepare the training data based on 10 years of Fermi-LAT exposure and we use the source properties of active galactic nuclei (AGNs) and pulsars (PSRs) from the incremental version of the fourth Fermi-LAT source catalog (4FGL-DR2). Relative to our previous work, here our training data is more robust, contains yearly flux variation, exploits full detector potential with increasing spatial resolution from lowest to highest energies, covering 300 MeV to 1 TeV. The localization methods developed and applied for the gamma-ray sources, are also tested for astrophysical sources seen in optical wavelengths. The localized gamma-ray sources are then fed into a different deep neural network suitable for the classification of various point source classes. The complete data analysis pipeline for automatic point source search and classification methods using deep learning could prove to be a competitive alternative to traditional algorithms for catalog preparation.

Please choose the session this abstract belongs to:

Gamma rays

Session 3 / 69

Testing the consistency of propagation between light and heavy cosmic rays

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Thanks to the precise cosmic ray data measured by recent
space experiments, we are able to investigate the cosmic ray acceleration and propagation models more comprehensively and reliably. In this work, we combine the secondary-to-primary ratio and the primary spectra measured by PAMELA, AMS02, ACE-CRIS and Voyager-1 to constrain the cosmic ray source and transport parameters. The study shows that the Z > 2 data yield a high-energy diffusion slope between 0.37 and 0.44. The Z <=2 species obtain a looser constraint on the diffusion slope between 0.34 and 0.44. The best-fit propagation parameters show that the heavy and light cosmic ray species can give compatible results. But disagreements exist between the heavy and light elements at low energies. The B/C ratio yields a much larger diffusion slope variation around 4 GV or a stronger Alfven velocity than the light nuclei. This indicates that the heavy and light particles
may suffer different low-energy transport behaviors in Galaxy. However, better understanding on the consistency/inconsistency between the heavy and light relies on more accurate calculations on cross-sections, correlations in data systematic errors and Solar modulation.

Please choose the session this abstract belongs to:

Cosmic rays

Session 2 / 70

Detecting and characterising pulsar halos with the Cherenkov Telescope Array

Authors: Christopher Eckner[1]; Francesca Calore[1]; Gabrijela Zaharijas[2]; Pierrick Martin[3]; Veronika Vodeb[2]

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Pulsar halos constitute a recently identified TeV class of sources that will be observed with the upcoming Cherenkov Telescope Array (CTA), especially in the context of the Galactic Plane Survey (GPS), one of the Key Science Projects of CTA. In this study, we examine the prospects offered by CTA for the detection and characterization of such objects. CTA will cover energies from 20 GeV to 300 TeV, in between those already probed by the Fermi-LAT and the High Altitude Water Cherenkov (HAWC) Observatory, and will also have a better angular resolution than both, allowing us to explore the radial profile of the halos. From simple models for individual pulsar halos and their population in the Milky Way, we examine under which conditions such sources can be identified in the GPS observations, possibly supplemented by additional dedicated exposure. In the framework of a full spatial-spectral likelihood analysis, we derive the sensitivity of CTA by considering both, the general extended emission, and the specific physical pulsar halo model.

Please choose the session this abstract belongs to:

Galactic sources

Session 2 / 71

MAGIC observations of gamma-ray bursts

Author: Yusuke Suda[1]

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TeV gamma-ray telescopes are the established energy frontier in gamma-ray burst study. Starting from a bright long GRB 190114C detected by the MAGIC telescopes, there are three published long GRB detections together with the H.E.S.S. In order to understand this newly revealed nature of GRBs, further detections are longing and investigation with a large sample of non-detected GRBs is important. In this contribution, we present recent progress of our GRB programs including preliminary results of two interesting GRBs; a strong hint of detection from a relatively low luminosity long GRB 201015A and a clear detection from a long GRB 201216C at redshift of 1.1.

Please choose the session this abstract belongs to:

Extragalactic sources

Session 1 / 72

Dark Matter decay to neutrinos

Author: Carlos Argüelles-Delgado[1]

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Dark matter (DM) particles are predicted to decay into Standard Model particles which would produce signals of neutrinos, gamma-rays, and other secondary particles. Neutrinos provide an avenue to probe astrophysical sources of DM particles. We review the decay of dark matter into neutrinos over a range of dark matter masses from MeV/c2 to ZeV/c2. We examine the expected contributions to the neutrino flux at current and upcoming neutrino and gamma-ray experiments, such as Hyper-Kamiokande, DUNE, CTA, TAMBO, and IceCube Gen-2. We consider galactic and extragalactic signals of decay processes into neutrino pairs, yielding constraints on the dark matter decay lifetime that ranges from tau ~ 1.2×10ˆ21 s at 10 MeV/c2 to 1.5x10ˆ29 s at 1 PeV/c2.

Please choose the session this abstract belongs to:

Dark matter

Session 2 / 73

On the Hard Gamma-Ray Spectrum of SNR G106.3+2.7

Author: Yiwei Bao[1]

Co-author: Yang Chen [2]

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Multi-wavelength observations indicate that there must be a hadronic component in the γ-ray spectrum of SNR G106.3+2.7. However, fitting the hard γ-ray spectrum requires a hard proton spectrum, while usual observations and recent numerical simulations prefer a soft proton spectrum. Here we explore an alternative scenario to explain the γ-ray spectrum of G106.3+2.7 within the current understanding of acceleration and escape processes.

Please choose the session this abstract belongs to:

Galactic sources

Session 2 / 74

Searches for long-lived particles at CMS

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New particles with long lifetimes are introduced by many extensions to the standard model and would produce striking and non-conventional signatures in collider experiments such as long-lived charged particles, highly displaced jets, and particles that come to a rest within the detector and later decay. We present the results of several recent searches for long-lived particles with the CMS experiment in Run II of the LHC.

Please choose the session this abstract belongs to:

Particle physics

Session 4 / 75

Searches for BSM Higgs bosons at CMS

Author: Mingshui CHEN[1]

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Several theories beyond the Standard Model predict the existence of additional neutral or charged Higgs particles other than the 125 GeV Higgs boson. In this presentation, the latest CMS results on searches for these particles will be discussed.

Please choose the session this abstract belongs to:

Particle physics

Session 4 / 76

Rare, Exotic, and Invisible Higgs Decays at CMS

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We present the latest results in the search for rare, exotic, and invisible Higgs boson decays in proton-proton collision events collected with the CMS detector at the LHC. The rich experimental program we describe, which includes searches for lepton flavor violation and decays to dark matter and light scalars, provides a wide ranging probe for physics beyond the standard model.

Please choose the session this abstract belongs to:

Particle physics

Session 1 / 77

Dark Matter searches at CMS

Author: Mingshui CHEN[1]

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Dark matter can be sought in complementary experiments: direct detection, indirect detection and colliders all contribute to a comprehensive set of searches for weakly interacting massive particles (WIMPs). This talk presents the latest results from the searches for Dark Matter by the CMS experiment.

Please choose the session this abstract belongs to:

Dark matter

Session 4 / 78

Searches for Axion-Like Particles at CMS

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This talk will present latest results of the searches for Axion-like particles at CMS experiment.

Please choose the session this abstract belongs to:

Particle physics

Session 4 / 79

Search for heavy resonances at CMS

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Many extensions to the Standard Model predict new phenomena occurring at high mass. These include new scalar or vector resonances, as well as new heavy fermions. This talk will summarize recent searches for such heavy particles based on 13 TeV pp collision data collected by the CMS experiment at the LHC.

Please choose the session this abstract belongs to:

Particle physics

Session 1 / 80

Researches on axion-like particles with gamma-ray observations

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Axion-like particles (ALPs) are hypothetical particles predicted by many extensions of the Standard Model and can also be candidates for dark matter. Many astrophysical phenomena are expected if ALPs exist. At GeV to TeV energies, they could lead to spectral oscillations of distant sources that travel across the external magnetic field. ALPs may also reduce the TeV opacity of the universe, which is caused by the extragalactic-background-light (EBL) absorption of the TeV photons. According to these predicted ALP effects, we search for the existence of ALPs with gamma-ray observations and study their properties. Specifically, we use the Fermi-LAT observation of NGC 1275 to constrain the ALP-photon coupling by considering a regular magnetic field component of the host cluster of NGC 1275. We obtain more stringent constraints than previous works. In our anonther work, we study how the extragalactic gamma-ray background spectrum will be modulated if ALPs exist and find that in some optimistic cases ALPs can cause great deviation of the EGB spectrum from the prediction of a pure EBL absorption scenario.

Please choose the session this abstract belongs to:

Dark matter

Session 1 / 81

Combined Dark Matter Searches Towards Dwarf Spheroidal Galaxies with Fermi-LAT, HAWC, H.E.S.S., MAGIC, and VERITAS

Authors: Benjamin Zitzer[1]; Celine Armand[2]; Chiara Guiri[3]; Daniel Kerszberg[4]; Daniel Salazar-Gallegos[5]; Elisa Pueschel[3]; Emmanuel Moulin[6]; Eric Charles[7]; J. Patrick Harding[8]; Javier Rico[9]; Kirsten Tollefson[5]; Lucia Rinchiuso[6]; Mattia di Mauro[7]; Meiner Tjark[10]; Vincent Poireau[11]

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The search for new physics beyond the Standard Model (SM) is closely tied to understanding the nature of Dark Matter (DM). Dwarf spheroidal galaxies (dSphs) are prime targets for indirect DM searches because their ratios of DM mass to baryonic mass is high. We present a novel combination analysis with multiple gamma-ray observatories. We established a collaboration of three Imaging Air Cherenkov Telescopes (IACTs): H.E.S.S., MAGIC, and VERITAS; the Fermi-LAT satellite, and the water Cherenkov detector, HAWC. Our collaboration maximizes the sensitivity of DM searches towards 20 dSphs by combining dSph data for the first time across these observatories. We focus our search on Weakly Interacting Massive Particles (WIMPs) DM annihilation to SM particles. This analysis uses a joint maximum likelihood to constrain DM self-annihilation cross sections to SM particles versus DM particle mass. Our constraints are over a DM mass range [5 GeV, 100 TeV] which is the widest range ever considered for indirect DM searches. Our limits will be the strictest for indirect detection to date with a factor 2-3 improvement over individual experiments' limits.

Please choose the session this abstract belongs to:

Dark matter

Session 3 / 82

Explaining low diffusivity and CR bubbles around SNRs

Author: Benedikt Schroer[1]

Co-authors: Colby Haggerty [2]; Damiano Caprioli [3]; Oreste Pezzi [4]; Pasquale Blasi [4]

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In the typical picture of cosmic ray transport in the region around their sources cosmic rays escape along the local magnetic field lines. We investigate this phenomenon using 2D and 3D hybrid particle-in-cell simulations.

The escaping cosmic rays excite resonant and non-resonant streaming instabilities resulting in enhanced particle scattering. This leads to a large pressure gradient that causes the formation of an expanding bubble of gas, cosmic rays and self-generated magnetic fields. We find that the gas density and diffusion coefficient inside the bubble are reduced with respect to the ambient interstellar medium providing a possible explanation for the low diffusion coefficient inferred by γ-ray observations of interactions of accelerated particles leaving a supernova remnant with nearby molecular clouds.

Please choose the session this abstract belongs to:

Cosmic rays

Plenary / **83**

Multi-TeV Gamma-ray Sky Observed using HAWC –Highlights & Recent Results

Author: Chang Dong Rho[1]

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The High Altitude Water Cherenkov (HAWC) Gamma-ray Observatory, located in between the volcanoes Sierra Negra and Pico de Orizaba in Mexico, has continuously been observing its entire overhead sky since 2015. The 2 sr field-of-view, >95% duty cycle, and sensitivity reaching over 100 TeV make HAWC a valuable experiment in the field of high energy astrophysics. In this presentation, we will show some of the exciting highlights of the HAWC analyses such as the detection of extended gamma-ray "halos" from the Geminga and Monogem pulsars, the discovery of TeV gamma rays from the jet lobes of microquasar SS 433, and the study of the daily variability of the blazars Mrk 421 and Mrk 501. This talk will also present some of our recent results as well as our updated sky catalog.

Please choose the session this abstract belongs to:

Plenary talk

Session 3 / **84**

Measurements of the cosmic ray proton and helium spectra with the DAMPE experiment

Author: Chuan YUE[1]

Co-authors: Antonio Surdo [2]; Francesca Alemanno [3]; Margherita Di Santo [4]; Pengxiong Ma [5]; Qiang Yuan [1]

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The DArk Matter Particle Explorer (DAMPE) is a space-based mission designed as a high energy particle detector for measuring cosmic-rays and gamma-rays in space. It was successfully launched on December 17, 2015, and since then has been in stable data taking for more than five and a half years. The large geometric factor and thick calorimeter enables DAMPE to have very good potential to identify different cosmic-ray components and measure their spectra individually up to about 100TeV. In this contribution, we focus on the measurements of cosmic-ray proton and helium spectra obtained by analysing the on-orbit data collected by DAMPE. The measurements of DAMPE cover a wider range of energies than any other single experiment, and reveal new spectral features above 10 TeV for both of proton and helium. These results provide new implications in understanding the acceleration and propagation processes of Galactic cosmic rays.

Please choose the session this abstract belongs to:

Cosmic rays

Plenary / 85

Future gamma ray experiments

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Gamma ray detectors are key for understanding the non-thermal processes in our universe, usually associated with highly energetic processes in black hole jets, neutron stars or stellar explosions. They are also a unique tool in Fundamental Physics and Cosmology, and, together with cosmic ray, neutrino and gravitational wave detectors, have inaugurated the field of multimessenger astronomy. At energies below ~10 GeV, gamma ray detectors usually operate from space, while detectors at higher energies, up to PeV, rely on the detection of the particle shower generated by gamma rays as they enter our atmosphere. We will briefly go over the detection techniques and detectors in operation today, and then review some of the gamma ray detectors that are being built or planned.

Please choose the session this abstract belongs to:

Plenary talk

Session 1 / 86

Shedding light on low-mass subhalo survival with numerical simulations

Author: Alejandra Aguirre-Santaella[1]

Co-authors: Go Ogiya [2]; Jens Stücker [3]; Miguel Sanchez-Conde [1]; Raúl Angulo [3]

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In this work, we carry out a suite of specially-designed numerical simulations to shed further light on dark matter (DM) subhalo survival at mass scales relevant for gamma-ray DM searches, a topic subject to intense debate nowadays. Specifically, we have employed an improved version of DASH, a GPU N-body code, to study the evolution of low-mass subhalos inside a Milky Way-like halo with unprecedented accuracy. We have simulated subhalos with varying mass, concentration, and orbital properties, and considered the effect of the gravitational potential of the Milky-Way galaxy itself. In addition to shedding light on the survival of low-mass galactic subhalos, our results will provide detailed predictions that will aid current and future quests for the nature of DM.

Please choose the session this abstract belongs to:

Dark matter

Session 1 / 87

Cherenkov Telescope Array sensitivity to branon dark matter models

Author: Alejandra Aguirre-Santaella[1]

Co-authors: Daniel Nieto Castaño [2]; Miguel Sanchez-Conde [1]; Viviana Gammaldi [1]

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TeV DM candidates are gradually earning more and more attention within the community. Among others, extra-dimensional brane-world models may produce thermal DM candidates with masses up to 100 TeV, which could be detected with the next generation of very-high-energy gamma-ray observatories such as the Cherenkov Telescope Array (CTA). In this work, we study the sensitivity of CTA to branon DM via the observation of dwarf spheroidal galaxies. We computed annihilation cross section values needed to reach a 5σ detection as a function of the branon mass. Additionally, in the absence of a predicted DM signal, we obtained 2σ upper limits on the annihilation cross section. These limits lie 1.5–2 orders of magnitude above the thermal relic cross section value. Yet, CTA will allow to exclude a significant portion of the brane tension-mass parameter space in the 0.1–60 TeV branon mass range, and up to tensions of ~10 TeV. More importantly, CTA will significantly enlarge the region already excluded by AMS and CMS, and will provide valuable complementary information to future SKA radio observations.

[Based on JCAP 10 (2020) 041, arXiv:2006.16706]

Please choose the session this abstract belongs to:

Dark matter

Session 3 / 88

On the spectral softening in core-collapse supernova remnant expanding inside the wind bubble

Author: Samata Das[1]

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Context. Supernova Remnants (SNRs) are considered as the primary sources of galactic cosmic rays (CRs), accelerated by diffusive shock acceleration (DSA) mechanism at SNR shocks. The core-collapse SNRs expand in the complex ambient environment, inside wind-blown bubbles created by the mass-loss of massive stars during their different evolutionary stages. Therefore, the evolution of core-collapse SNRs, as well as cosmic ray acceleration is expected to be considerably different from SNR evolution in a uniform environment.

Aim. The impact of SNR shock interactions with different discontinuities and circumstellar magnetic field present in the wind bubbles on particle spectra, and emission morphology from the remnant are the areas of our focus.

Methods. Supernova explosion has been injected inside the wind-blown bubble at the pre-supernova stage formed by a massive star. Then, the transport equation for cosmic rays, hydrodynamic equations, and magnetic field induction equation have been solved simultaneously in 1-D spherical symmetry.

Result. We have acquired softer particle spectra with spectral index close to 2.5 during the propagation of supernova shock inside the shocked wind. Additionally, the magnetic field structure significantly influences the emission morphology from the remnant.

Please choose the session this abstract belongs to:

Cosmic rays

Summary:

We present our contribution about the determination of the **spectral softening** arising from the supernova remnant shock propagating through the **very hot shocked wind material** in the **core-collapse scenario**.

- **sub-shock compression ratio for forward shock** diverges from **4 and reaches about 1.5** as **the sonic Mach number of forward shock decreases** during its evolution through **the hot material**.
- When the forward shock interacts with the hot wind bubble, we have obtained **persistent softer particle spectra with spectral index close to 2.5** beyond free wind region between **the energy range $0.3\mathrm{GeV} - 10\mathrm{TeV}$**.
- **The CSM magnetic field has a significant impact on the emission morphology**.

Session 1 / 89

Modelling the X-ray emission of the Boomerang Nebula

Author: Xuan-Han Liang[1]

Co-authors: Jiashu Pan [1]; Qizuo Wu [1]; Ruo-Yu Liu [1]

[1] *Nanjing University*

The Boomerang Nebula, a pulsar wind nebula associated with the supernova remnant G106.3+2.7, is a possible counterpart of the ultrahigh-energy gamma-ray source LHAASO J2226+6057. The SNR-PWN complex is considered as a PeVatron candidate, acting as a factory accelerating particles to PeV energies. In this work, we model the extended nonthermal X-ray emission around the pulsar PSR J2229+6114, which is believed to power the Boomerang Nebula. We find that the X-ray intensity profile and the spectral index profile can be explained by the transport of relativistic electrons from the inner region of the nebula to the outer region, taking into account the transition from the quasi-ballistic regime to the diffusive regime. The required magnetic field in the nebula is found to be about 200 microGauss in the model. This result may imply that the inverse Compton radiation of electrons inside the nebula is suppressed, and support the hadronic origin of the gamma-ray emission.

Please choose the session this abstract belongs to:

Galactic sources

Session 1 / 90

Non-Standard Interactions Searches in IceCube

Author: Grant Parker[1]

[1] *é*

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Non-standard interactions (NSI) is a general term for neutrino-matter interactions not described by the Standard Model, prompting investigation through their potential to relieve experimental tensions. These interactions may also add parameter degeneracies, which are important to constrain when interpreting experiment data. Using Earth's large range of matter baselines, IceCube has been able to constrain neutral-current NSI by searching for model-specific deviations in neutrino fluxes. Here, we comment on previous and ongoing IceCube NSI analyses, and present world-leading results from the latest analysis constraining the mu-tau flavor-changing parameter, which uses an 8-year sample of high-energy (500 GeV - 10 TeV) upgoing muon tracks.

Please choose the session this abstract belongs to:

Neutrinos

session / 91

Recent Gamma-ray Results from DAMPE

Author: Kai-Kai Duan[1]

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DArk Matter Particle Explorer (DAMPE), a space-borne high energy cosmic ray and gamma-ray detector, has surveyed the whole sky for five years and collected more than 220,000 photons above 2 GeV since the launching on Dec. 17, 2015. Based on the 5-yr DAMPE observation, we have detected more than 200 gamma-ray sources and the Fermi Bubbles. With the excellent energy resolution, DAMPE has an advantage in searching for gamma-ray line structures. We have set constraints on the annihilation cross-section or decay lifetime for dark matter.

Please choose the session this abstract belongs to:

Gamma rays

Session 3 / 92

Implications of Li to O data of AMS-02 on our understanding cosmic-ray propagation

Author: Michael Korsmeier[1]

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Space-borne experiments like AMS-02 determine cosmic-ray spectra with unprecedented precision. This allows for more elaborate and better examinations of cosmic-ray propagation in our Galaxy. However, the analysis of this increasingly precise cosmic-ray data requires also a more careful assessment of systematic uncertainties. I will present the results from the analysis of comic-ray measurements of Lithium, Beryllium, Boron, Carbon, Nitrogen and Oxygen by AMS-02. The focus of the analysis lies on systematic uncertainties related to propagation and nuclear cross-sections. The cosmic-ray data is well described by various propagation scenarios which differ for example by including or discarding reaccelartion and/or a break in the diffusion coefficient. In all cases the slope of the diffusion coefficient is robustly constrained in the range between 0.45-0.5 at intermediate rigidities and we find that the use of the AMS-02 Beryllium data provides a lower limit on the vertical size of the Galactic propagation halo at about 3 kpc. However, the consideration of cross section uncertainties is of vital importance. One main conclusion of our work is that cross sections have become a fundamental systematic preventing a deeper understanding of CR propagation.

Please choose the session this abstract belongs to:

Cosmic rays

Session 2 / 93

The study of the longitude development of muons in air shower

Author: Liping wang[1]

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The longitude development of the muonic component in the extensive air shower can help to determine mass composition of cosmic rays. By using the timing information of muons, the production positions of muons can be reconstructed . X_maxˆμwhich is the position with muon production reaching maximum is sensitive to the mass composition of cosmic rays. In this paper, the reconstruction of muon’ s geometrical production heights along the shower axis by using their timing information are studied for cosmic rays with energies from 1PeV to 10 PeV by CORSIKA data

Please choose the session this abstract belongs to:

Cosmic rays

Summary:

According to our analysis, the resolution of X_maxˆμ is 453.6 g/ 〖cm〗 ˆ2 with a resolution about 11.46g/ 〖cm〗 ˆ2 for showers initiated by protons with energy 10 PeV ,and zenith angle θ= 〖45〗 ˆ°

Session 1 / 94

Searching for Dark Matter with the Southern Wide-field Gamma-ray Observatory (SWGO)

Author: Aion Viana[1]

Co-authors: Andrea Albert [2]; Harm Schoorlemmer [3]; J. Patrick Harding [2]; Jim Hinton [3]; Vitor de Souza [1]

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Despite mounting evidence that dark matter (DM) exists in the Universe, its fundamental nature remains unknown. We present sensitivity estimates to detect DM particles with a future very-high-energy (⪆ TeV) wide field-of-view gamma-ray observatory in the Southern Hemisphere, currently in its research and development phase under the name Southern Wide field-of-view Gamma-ray Observatory (SWGO). This observatory would search for gamma rays from the annihilation or decay of DM particles in many key targets in the Southern sky, such as the Galactic halo, several dwarf galaxies, including the promising Reticulum II, and the Large Magellanic Cloud. With a wide field of view and long exposures, such an observatory will have unprecedented sensitivity to DM in the mass range of ~100 GeV to a few PeV from observations of a large fraction of the Galactic halo around the Galactic Center and from Galactic subhalos targets. These results, combined with those from other present and future gamma-ray observatories, will likely probe the thermal relic annihilation cross section of Weakly Interacting Massive Particles for all masses from ~80 TeV down to the GeV range in most annihilation channels.

Please choose the session this abstract belongs to:

Dark matter

Session 2 / 95

Long-term multi-wavelength variability of Markarian 421 and Markarian 501

Author: Vitalii Sliusar[1]

Co-authors: Matteo Balbo [1]; Roland Walter [1]

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Markarian 421 (Mrk 421) and Markarian 501 (Mrk 501) are two close bright and well-studied high-synchrotron-peaked blazars, which feature bright and persistent GeV and TeV emission. We use the longest and densest dataset of unbiased observations of these two sources, obtained at TeV and GeV energies during 5 years with the FACT telescope and Fermi LAT. To characterize the variability and derive constraints on the emission mechanism model parameters we augment the dataset with contemporaneous multi-wavelength observations from radio to X-rays. We study and correlate the light curves from radio to gamma-rays, identify individual flares and look for inter-band connections, which are expected from the shock propagations within the conical jet. For Mrk 421 we find that the X-rays and TeV are well correlated with close to zero lag, supporting the SSC emission scenario. The timing between the TeV, X-ray flares in Mrk 421 is consistent with periods expected in the case of Lense–Thirring precession of the accretion disc. Mrk 501 variability on long-term periods is also consistent with SSC, with a sub-day lag between X-rays and TeVs. We investigate two periods of source activity before and after MJD 57600, later the source is in the quiescent state. Fractional variability for both blazars shows two bump structure with the highest variability in X-ray and TeV bands.

Please choose the session this abstract belongs to:

Extragalactic sources

Summary:

Markarian 421 (Mrk 421) and Markarian 501 (Mrk 501) are two close bright and well-studied high-synchrotron-peaked blazars, which feature bright and persistent GeV and TeV emission. We use the longest and densest dataset of unbiased observations of these two sources, obtained at TeV and GeV energies during 5 years with the FACT telescope and Fermi LAT. To characterize the variability and derive constraints on the emission mechanism model parameters we augment the dataset with contemporaneous multi-wavelength observations from radio to X-rays. We study and correlate the light curves from radio to gamma-rays, identify individual flares and look for inter-band connections, which are expected from the shock propagations within the conical jet. For Mrk 421 we find that the X-rays and TeV are well correlated with close to zero lag, supporting the SSC emission scenario. The timing between the TeV, X-ray flares in Mrk 421 is consistent with periods expected in the case of Lense–Thirring precession of the accretion disc. Mrk 501 variability on long-term periods is also consistent with SSC, with a sub-day lag between X-rays and TeVs. We investigate two periods of source activity before and after MJD 57600, later the source is in the quiescent state. Fractional variability for both blazars shows two bump structure with the highest variability in X-ray and TeV bands.

Session 1 / 96

Prospect of Detecting X-Ray Halos Around Middle-Aged Pulsars with eROSITA

Author: Ben Li[1]

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The detection of extended TeV γ-ray emission (dubbed "TeV halos") from Geminga and Monogem pulsars by HAWC collaboration implies that the halo-like morphologies around middle-aged pulsarsmay be common. The γ-rays above 10 TeV are thought to arise from inverse Compton (IC) scattering of relativistic electrons/positrons in the pulsar halos off cosmic microwave background photons. In themeanwhile, these electrons and positrons can produce X-ray synchrotron emission in the interstellar magnetic field, resulting in a diffuse emission in the X-ray band (namely X-ray halos). Here, we study the prospect of detecting X-ray halos with eROSITA from 10 middle-aged pulsars with characteristic age τ_c larger than tens of thousands of years in the ATNF pulsar catalog. Assuming a benchmark value (i.e., B=3μG) for the magnetic field, most of the X-ray halos are found to be bright enough to be detectable by eROSITA in the energy range of 0.5−2 keV during its four-year all-sky survey. Among these pulsar halos, three are supposed to produce X-ray fluxes above the eROSITA sensitivity of the first all-sky survey. Given the good angular resolution and the large field of view, eROSITA is expected to be able to measure the spatial distribution of the X-ray halos from sub-pc scale up to tens of pc scale. The intensity profile of the X-ray halos are very useful to constrain the magnetic field and the energy-dependence of the diffusion coefficient in the pulsar halos.

Please choose the session this abstract belongs to:

Galactic sources

Plenary / 97

Highlights from the CALET observations on the ISS

Author: Shoji Torii[1]

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The CALorimetric Electron Telescope (CALET), developed and operated by Japan in collaboration with Italy and the United States, is a high-energy astroparticle physics experiment installed on the International Space Station (ISS). Its mission goals include investigating the possible presence of nearby sources of high-energy electrons, performing direct measurements of observables sensitive to the details of the acceleration and propagation of galactic particles, and detecting potential dark matter signatures. CALET measures cosmic-ray electron+positron flux up to 20 TeV, gamma rays up to 10 TeV, and nuclei up to 1,000 TeV. Charge measurements cover from Z=1 to 40 allowing to study the more abundant elements and to extend the range of long-term observations above iron. CALET is collecting science data on the International Space Station since October 2015 with excellent and continuous performance with no major interruptions. Approximately 20 million triggered events per month are recorded with energies > 10 GeV. Here, we present the highlights of CALET observations carried out during the first 5.5 years of operation, including the electron+positron energy spectrum, the spectra of protons and other nuclei, gamma-ray observations, as well as the characterization of on-orbit performance. Some results on the electromagnetic counterpart search for LIGO/Virgo gravitational wave events and the observations of solar modulation and gamma-ray bursts are also included.

Please choose the session this abstract belongs to:

Cosmic rays

Session 3 / 98

Studies of Medium and Heavy mass cosmic ray nuclei with the DAMPE space mission

Author: Dimitrios Kyratzis[1]

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The Dark Matter Particle Explorer (DAMPE), is a space–borne detector designed for precise galactic Cosmic Ray (CR) studies in a wide energy range (up to hundreds of TeV), along with detailed measurements of high–energy gamma–rays and indirect searches of Dark Matter (DM) annihilation/decay to detectable particles. The satellite was successfully launched into a sun–synchronous orbit at 500 km, on December 17th 2015 and has been successfully acquiring data ever since. The instrument consists of four sub-detectors, namely: a Plastic Scintillator Detector (PSD), a Silicon TracKer-converter (STK), a deep BGO calorimeter (˜32 X_0, ˜1.6 λ_I) and a Neutron Detector (NUD).

DAMPE provided valuable insight on the spectra of cosmic-ray electrons+positrons, protons, along with recent measurements of helium, leading to impressive findings that necessitate a careful reconsideration of prevailing CR models. In this work, ongoing advancements regarding the analyses of medium (ranging from lithium up to oxygen) and heavier (iron group) mass nuclei will be illustrated. Additionally, preliminary results on secondary-over-primary ratios (i.e., B/C) crucial in deciphering the nature of CR propagation in the Galaxy, will be discussed.

Please choose the session this abstract belongs to:

Cosmic rays

Plenary / **99**

Latest Results from the Pierre Auger Observatory

Author: Bruce Dawson[1]

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Our understanding of the characteristics of the highest energy cosmic rays has improved enormously with the operation of the Pierre Auger Observatory, situated in western Argentina. Its extremely large collecting area (3000 square kilometres), coupled with the layers of cross-checks provided by two fundamentally different detection techniques (surface and fluorescence detectors) has led to large numbers of events at high energies with well-understood measurement uncertainties. In this talk I will describe the state of our understanding of the highest energy cosmic rays with a variety of results from the Auger Observatory. This time marks the end of "Phase 1" of the life of the experiment, as we move to the completion of a major upgrade known as AugerPrime.

Please choose the session this abstract belongs to:

Plenary talk

Session 2 / **100**

Unveiling the complex correlation patterns and emission mechanisms in Mrk 421

Author: Axel Arbet-Engels[1]

Co-authors: David Paneque [2]; Lea Heckmann [2]

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Thanks to its brightness and proximity, the BL Lac type object Mrk 421 is an ideal target to probe blazar jet physics. We present a detailed characterisation and theoretical interpretation of the broadband emission of Mrk 421, focusing on the multi-band flux correlations. The analysis makes use of an extensive multi-wavelength campaign organised in 2017, during which the correlation patterns show some disparity and complex behaviours. Four multi-hour NuSTAR observations were organised simultaneously to those from MAGIC, which allow us to obtain a precise measurement of the high energy turnover of the two spectral bumps. A detailed investigation of the very-high-energy (VHE; >100 GeV) versus X-ray flux correlation is performed, by binning the data into several subenergy bands. A positively correlated variability is observed at a significance level above 5 sigma, but the correlation changes substantially across the various bands probed. Furthermore, during the simultaneous MAGIC and NuSTAR observations, a variation of the inverse Compton component up to a factor 3 is detected, without a corresponding variability in the synchrotron regime, what is usually referred to as an "orphan gamma-ray activity". During the campaign, we also detected an intriguing bright flare at VHE without a substantial flux increase in the X-rays. Within a leptonic scenario, this behaviour is best explained by the appearance of a second population of highly-energetic electrons spanning a narrow range of energies. Finally, our intra-band correlation study reveals an anti-correlation between the UV/optical and X-ray bands at a significance level above 3 sigma. This behaviour suggests changes in the acceleration and cooling efficiencies of the electrons.

Please choose the session this abstract belongs to:

Extragalactic sources

Summary:

Based on arXiv:2106.05516

Plenary / **102**

MAGIC telescopes: the Gathering

Author: Marina Manganaro[1]

[1] *University of Rijeka*

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MAGIC (Major Atmospheric Gamma-ray Imaging Cherenkov telescopes) is a system of two Cherenkov telescopes located on the Canary island of La Palma (Spain), at the Roque de Los Muchachos Observatory. MAGIC telescopes are operating in stereo mode since 2009. Their design and configuration, together with a dedicated trigger system developed ad-hoc, allows us to reach an energy threshold of 15GeV. This made it possible to observe high redshift sources at the limit of detection for Imaging Atmospheric Cherenkov telescopes and to deeply study the Geminga pulsar tail emission. A careful strategy of alert follow-ups from other facilities and the fast reposition of the telescopes made possible the detection of the first (and only so far) neutrino blazar and of gamma-ray bursts in the VHE gamma-ray band, respectively. Moreover, the GRB detection of 190114C allowed a test of general relativity through the study of the Lorentz Invariant Violation. I will gather here the recent highlights from MAGIC, in the study of galactic and extragalactic sources, spanning from multimessenger astronomy to astroparticle and fundamental physics.

Please choose the session this abstract belongs to:

Plenary talk

Summary:

Highlights from the MAGIC (Major Atmospheric Gamma-ray Imaging Cherenkov telescopes) Collaboration

session / 103

Magnetic field amplification by turbulent dynamo in relativistic collisionless shocks

Author: sara tomita[1]

Co-author: Yutaka Ohira [2]

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Cosmic rays are thought to be efficiently produced in collisionless shocks in high-energy astrophysical sources, where cosmic rays are diffusively scattered by magnetic fluctuations. The magnetic field near the shock decides the maximum energy of cosmic rays accelerated in the sources and emission mechanisms by the accelerated particles. However, magnetic field strength and structure around the shock are not understood yet.
Recent magnetohydrodynamics (MHD) simulations of shocks propagating into inhomogeneous media show that the ambient magnetic field is amplified by turbulent dynamo in the downstream region. According to these simulations, the turbulent dynamo always works as long as the magnetic energy is smaller than the kinetic energy of the downstream turbulence. However, the shocks formed in astrophysical phenomena are often driven by collisionless plasma, where non-thermal particles are generated, so that it is unknown whether the MHD approximation is applied to the downstream flow. For shocks in gamma-ray bursts, the size of density fluctuations has to be about ten times the gyroradius of the thermal protons to amplify the magnetic field by the downstream turbulence. We perform particle-in-cell simulations of relativistic collisionless shocks propagating into a pair plasma with a density clump whose size is ten times the gyroradius of downstream thermal plasmas. We found that the magnetic field amplification does not work if the amplitude of the upstream density fluctuation is below a critical value.

Please choose the session this abstract belongs to:

Gamma rays

Summary:

In order to investigate whether the MHD approximation is satisfied in the downstream region of collisionless shocks, we perform particle-in-cell simulations of relativistic collisionless shocks propagating into an inhomogeneous magnetized plasma. As a result, the magnetic field amplification by turbulent dynamo does not work if the amplitude of the upstream density fluctuation is below a critical value.

Plenary / 104

The Very Energetic Radiation Imaging Telescope Array System (VERITAS)

Author: Stephan O'Brien[1]

[1] *McGill University*

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The Very Energetic Radiation Imaging Telescope Array System (VERITAS) is an array of four 12m imaging atmospheric Cherenkov telescopes located in Southern Arizona, USA. Sensitive to gamma rays in the ~80 GeV to >30 TeV energy range, VERITAS is amongst the most sensitive instruments currently operating within this energy regime. VERITAS operates a diverse science program including studies of Galactic and extragalactic particle accelerators, local measurements of cosmic-ray abundances, indirect searches for dark matter, probing fundamental physics and constraining cosmological fields. VERITAS also dedicates a significant portion of observing time to Target-of-Opportunity observations, allowing for follow up of multi-messenger alerts and other astrophysical transients. In this talk I will discuss the operating status of VERITAS and present key highlights from the VERITAS science program.

Please choose the session this abstract belongs to:

Plenary talk

Plenary / 105

Cosmic surveys as a probe of dark matter

Author: Ting Li[1]

[1] *University of Toronto*

Astrophysical and cosmological observations currently provide the only robust, empirical measurements of dark matter. Astronomical observations with large-scale surveys can provide necessary guidance for the experimental dark matter program. In this talk, I will summarize astrophysical observations that can constrain the fundamental physics of dark matter in the era of modern surveys. I will highlight the progress that has been made so far with past and ongoing astronomical observations, and discuss how the next generation cosmic survey programs will complement other experiments to strengthen our understanding of the fundamental characteristics of dark matter.

Please choose the session this abstract belongs to:

Plenary talk

Session 2 / 106

Forbush Decrease of cosmic ray electrons and positrons with DAMPE

Author: Jingjing Zang[1]

[1] *Linyi University*

The Forbush Decrease (FD) represents the rapid decrease of the intensities of charged particles accompanied with the coronal mass ejections (CMEs) or high-speed streams from coronal holes. We study the FD event occurred in September, 2017, with the electron and positron data recorded by the Dark Matter Particle Explorer. The evolution of the FDs from 2 GeV to 20 GeV with a time resolution of 6 hours are given. We observe two solar energetic particle events in the time profile of the intensity of cosmic rays, the earlier and weak one has not been shown in the neutron monitor data. Furthermore, both the amplitude and recovery time of fluxes of electrons and positrons show clear energy-dependence, which is important in probing the disturbances
of the interplanetary environment by the coronal mass ejections.

Please choose the session this abstract belongs to:

Cosmic rays

Plenary / 107

Constraints on dark photon dark matter using gravitational wave detector data

Author: Cristiano Palomba[1]

[1] *INFN Rome Division*

Dark photons with masses in the range of 1e-14 —1e-11 eV could interact with the optical components of the gravitational-wave detectors, producing a potentially detectable stochastic and narrow-band signal. In this talk, I will present methodologies and results for a recent dark photon search carried out using the data collected in the third observing run of Advanced LIGO and Virgo. Although no signal has been detected, interesting constraints on the coupling of dark photons to baryons have been obtained, surpassing limits obtained in direct dark matter detection experiments over a significant range of dark photon masses. Prospects for future searches using gravitational-wave detectors will also be discussed.

Please choose the session this abstract belongs to:

Plenary talk

Session 2 / 108

Constraining the baryon loading factor of AGN jets: implication from the gamma-ray emission of the Coma cluster

Author: Xin-Yue Shi[1]

Co-authors: Ruo-Yu Liu [1]; Xiang-Yu Wang [2]; Yi Zhang [1]

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High-energy cosmic rays (CRs) can be accelerated in the relativistic jets of Active Galactic Nuclei (AGNs) powered by supermassive black holes.
The baryon loading efficiency onto relativistic CR baryons from the accreting black holes is poorly constrained by observations so far. In this presentation, we suggest that the γ-ray emission of galaxy clusters can be used to study the baryon loading factor of AGN jets, since CRs injected by AGN jets are completely confined in the galaxy clusters and sufficiently interact with intra-cluster medium via hadronic process, producing diffuse γ-rays.
We study the propagation of CRs in the galaxy clusters and calculate the radial distribution of the gamma-rays in the galaxy cluster with different injection rates from AGNs.
By comparison with the γ-ray flux and upper limits of the Coma cluster measured by $Fermi$-LAT and VERITAS, we find the upper limit of the average baryon loading factor (defined as the efficiency with which the gravitational energy is converted into relativistic particles) to be $\eta_p < 0.1$.
The upper limit is much lower than that required to account for diffuse neutrino flux in the conventional blazar models.

Please choose the session this abstract belongs to:

Cosmic rays

Summary:

Galaxy clusters can effectively confine the CRs in cosmological times, so CRs can sufficiently interact with ICM to produce γ-ray and neutrino radiation.

In our study, taking into account effects of the injection history of AGN jets, we have studied the propagation and distribution of CRs in the Coma cluster and obtained constraints on the average baryon loading factor using the γ-ray observations.
The upper limits of the average baryon loading factor are $\eta_p \sim 0.01$ and $\eta_p \sim 0.1$, respectively, from the $Fermi$-LAT and VERITAS observations for various cosmic-ray power-law indexes.
We also use the integral radiation energy to obtain the upper limits on the conventional baryon loading factor $\eta_{p,\mathrm{rad}}$, which are $\eta_{p,\mathrm{rad}} \sim 1$ ($Fermi$-LAT) and $\eta_{p,\mathrm{rad}} \sim 10$ (VERITAS), respectively. If such a constraint can be generalized to all the AGN in the universe, one may conclude that blazars cannot be the major sources of the diffuse neutrino background measured by IceCube, when comparing this upper limit to the theoretically required one.

Session 1 / 109

J-factor estimation of dwarf spheroidal galaxies with the member/foreground mixture model

Author: Shunichi Horigome[1]

Co-authors: Kohei Hayashi [2]; Masahiro Ibe [3]; Miho Ishigaki [4]; Shigeki Matsumoto [1]

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Dwarf spheroidal galaxies (dSphs) are known as promising candidates of the indirect detection of the WIMP dark matter. However, the sensitivity of the detection depends on an astrophysical factor, so-called J-factor, which has various statistical uncertainties. These uncertainties affect the sensitivity of the detection by a factor of O(10), thus we should consider these uncertainties to achieve proper constraints on theories of the dark matter. In this talk, we will focus on one of the uncertainty sources, the foreground contamination problem, and present our new method. In contrast with that the conventional method cannot estimate the amount of the uncertainty caused by the contamination effect, our method can properly estimate the amount of uncertainty as a statistical error thanks to mixture model approach.

Please choose the session this abstract belongs to:

Dark matter

Session 2 / 112

General relativistic, multi-wavelength and multi-messenger study on black hole accretion flows and outflows

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The Event Horizon Telescope (EHT) detected the black hole shadow in the elliptical galaxy M87*. This provided powerful evidence of the presence of supermassive black holes and the mass of the

black hole was estimated to be ˜6.5 billion solar mass.
For revealthe magnitude of the black hole spin and the dynamics of relativistic jets and accretion flows near the event horizon by future EHT with multi-wavelength observations from radio to gamma-ray band, we developed a multi-wavelength general relativistic radiative transfer code RAIKOU. We calculated the images and multi-wavelength spectra of accretion flows and relativistic jets of supermassive black holes to reveal the black hole spacetime and the dynamics of accretion flows and relativistic jets. We also briefly report our recent numerical work on the high-energy neutrino emission induced by p-p collision process of accelerated proton in accretion flows around spinning black holes.

Please choose the session this abstract belongs to:

Extragalactic sources

Session 2 / 113

The discovery in very-high-energy gamma rays of Blazar TXS1515-273 by MAGIC and extreme MAGIC results

Author: Serena Loporchio[1]

[1] *I*

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BL Lac objects which possess a synchrotron peak at unusually high X-ray frequencies (peak_S ≥10ˆ17 Hz) were categorized as extreme high-frequency BL Lacs (EHBLs) by Costamante et al. (2001). As a consequence of the location of the synchrotron peak, the inverse Compton hump of EHBLs is expected to peak in the gamma-ray band, making them interesting targets for very-high-energy gamma rays studies. Such objects are expected to be very faint according to the blazar sequence. Nevertheless, in recent studies, when detected at very-high-energy gamma rays, some of them have revealed very interesting intermittent temporal behaviour. Here we present the recent results on the candidate extreme blazar TXS 1515–273 (z = 0.1285) discovered in the very-high-energy range by MAGIC, together with a multiwavelength dataset. The interpretation of the broadband emission has been performed with different leptonic models. Observations and models are put in context with the recent studies and results on extreme blazars carried on by the MAGIC telescopes.

Please choose the session this abstract belongs to:

Extragalactic sources

Session 2 / 114

Temporal resolution of transient sources with LST-1: application to HESS J0632+057(poster)

Author: Arnau Aguasca-Cabot[1]

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The Cherenkov Telescope Array (CTA) prototype Large-Sized Telescope (LST-1) was inaugurated in 2018 and, after its commissioning, it is progressively entering the scientific data taking phase. In this contribution, we present a dedicated study on the capability of LST-1 to probe the very high energy (VHE) emission from galactic transient sources. Making use of numerical simulations of the VHE flux profiles for selected cases, we constrain the minimum time required to obtain a significant detection of the source, requiring a test statistics TS ≥ 4 for every flux point in the simulated source light curve. We apply our algorithm to the gamma-ray binary system HESS J0632+057. Our results suggest that the minimum time-bin in HESS J0632+057 obtained with the LST-1 would be a few minutes at the maximum flux phase (0.3-0.4 and 0.6-0.8), whereas at the minimum flux phase (0.4), it would be of a few hours. We briefly discuss the timing capabilities of LST-1 for galactic transient events.

Please choose the session this abstract belongs to:

Galactic sources

Session 2 / 115

H.E.S.S. observations of galactic molecular clouds

Author: Atreyee SINHA[1]

Co-authors: Giada PERON [2]; Sabrina CASANOVA [2]; Vardan BAGHMANYAN [3]; Yves GALLANT [1]

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Cosmic Ray (CR) interactions with the dense gas inside Giant Molecular Clouds (GMCs) produce neutral pions, which in turn, decay into gamma rays. Because of the high target density for CRs in GMCs the study of gamma-ray emission from GMCs can yield a model-independent insight into the spatial and spectral properties of CRs without any significant contamination by other sources. While multiple such studies have been performed at GeV energies using the Fermi-LAT, measurements at TeV energies have been complicated due to difficulties separating such faint extended emission from the large scale galactic diffuse emission and the dominant residual hadronic background.
Using field-of-view models for the residual hadronic background and a 3D likelihood method, eg, as implemented in gammapy, we model the emission from the direction of the clouds with a gas tracer template while masking the known sources in the field. This allows us to probe the CR density at specific points in the galaxy, and in turn, distribution of CR sources and the propagation of CRs. In this contribution, we will present the analysis strategy and report on observations of molecular clouds as seen by H.E.S.S.

Please choose the session this abstract belongs to:

Galactic sources

Session 1 / 116

Searching for WIMPs in the Large Magellanic Cloud

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We present a radio search for WIMP dark matter in the Large Magellanic Cloud (LMC). We make use of a recent deep image of the LMC obtained from observations of the Australian Square Kilometre Array Pathfinder (ASKAP), and processed as part of the Evolutionary Map of the Universe (EMU) survey. LMC is an extremely promising target for WIMP searches at radio frequencies because of the large J-factor and the presence of a substantial magnetic field. We detect no evidence for emission arising from WIMP annihilations and derive stringent bounds. This work excludes the thermal cross section for masses below 480 GeV and annihilation into quarks.

Please choose the session this abstract belongs to:

Dark matter

Session 1 / 117

The Core Science Program of the ASTRI Mini-Array

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Celestial sources emitting at high-energy (HE, E>100 MeV) and at very high-energy (VHE, E>100 GeV) are of the order of a few thousands and a few hundreds, respectively. The number of sources emitting at ultra high-energy (UHE, E> several tens of TeV) are just a few dozen, and are currently being investigated by means of both ground-based imaging atmospheric Cherenkov telescopes (IACTs) and particle shower arrays. These rare VHE and UHE sources represent a new frontier in the astro-particle field. In a few years, an array composed of nine ASTRI dual-mirror, Schwarzschild-Couder telescopes will be deployed and start scientific observations at the Observatorio del Teide (Tenerife, Spain). The ASTRI Mini-Array will devote the first three to four observing years to specific science topics, with the aim of providing robust answers to a few selected open questions in the VHE and UHE domains. We identified the following Core Science topics to be investigated: the origin of cosmic rays, the extra-galactic background light and the study of fundamental physics, the novel field in the VHE domain of gamma-ray bursts and other multi-messenger transients, and finally the usage of the ASTRI Mini-Array to investigate ultra high-energy cosmic rays and to address stellar intensity interferometry studies. These topics have strong connections with astro-particle physics, dealing with particle acceleration and propagation and fundamental physics studies. We review the scientific prospects assessed through dedicated simulations, proving the potential of the ASTRI Mini-Array in pursuing breakthrough discoveries and discuss the synergies with current and future VHE facilities in the Northern hemisphere, such as MAGIC, LHAASO, HAWC and CTAO-N.

Please choose the session this abstract belongs to:

Gamma rays

Session 1 / 118

Search for long term variability of HESS J1745-290 at the centre of the Galaxy

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The galactic center (GC) is a prime spot for VHE gamma ray observations, with both point sources and diffuse emission, one of which is the H.E.S.S. source known as HESS J1745-290, whose position is notably compatible with the supermassive black hole SgrA*.

We provide here a study of the variability of HESS J1745 in the GC using all H.E.S.S. data available since 2004.
We perform the first spectro-morphological maximum likelihood analysis of this source and the diffuse VHE emission (DE) around the GC, which allows us to separate them and provides a natural way to re-calibrate the GC source emission to limit systematic effects. Then, using the results of this analysis, we derive light curve of the central source and the diffuse emission over the last 16 years, in order to provide a light curve of the central source re-calibrated by the DE.

No long term, yearly, variability is found over this period. A detailed analysis of the sensitivity of H.E.S.S. to variations of this specific source over 16 years shows that flux variations larger than 25% can be excluded.

Please choose the session this abstract belongs to:

Gamma rays

Plenary / 119

Dark Matter Direct Detection Experiments

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The dark matter exists from many cosmological indirect evidences. In order to search dark matter directly, energy deposition due to interactions between dark matters and normal matters can be measured with multiple advanced techniques. This talk will summarize the current and planned dark matter direct detection experiments with dark matter mass range from $\mathrm{MeV/c^2}$ to $\mathrm{TeV/c^2}$, including experimental approaches, detector setups, results and potentials. Also, some novel ideas will be introduced here.

Please choose the session this abstract belongs to:

Plenary talk

Session 1 / 120

Light gravitino dark matter: LHC searches and the Hubble tension

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The recent measurements of the cosmological parameter H0 from the direct local observations and the inferred value from the cosmic microwave background show approximately 4σ discrepancy. This may indicate new physics beyond the standard ΛCDM. We investigate the keV gravitino dark matter that has a small fraction of nonthermal components (e.g., from the late decay of next-to-lightest-supersymmetric-particle bino) under various cosmological constraints. We find such a scenario is highly predictive and can be tested by searching for the dilepton plus missing energy events at the LHC. Besides, we also discuss its implication for Hubble tension, which can be reduced to 3σ level marginally.

Please choose the session this abstract belongs to:

Dark matter

Session 1 / 121

Status of the SABRE South Experiment at the Stawell Underground Physics Laboratory

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The SABRE (Sodium iodide with Active Background REjection) experiments aim to detect an annual rate modulation from dark matter interactions in ultra-high purity NaI(Tl) crystals. The SABRE South experiment is located at the Stawell Underground Physics Laboratory (SUPL), Australia, and is the first deep underground laboratory in the Southern Hemisphere, due to be completed in late 2021.

SABRE South is designed to disentangle seasonal or site-related effects from the dark matter-like modulated signal first observed by DAMA/LIBRA and is a partner to the SABRE North effort at the Laboratori Nazionali del Gran Sasso (LNGS).

SABRE South is instrumented with ultra-high purity NaI(Tl) crystals immersed in a liquid scintillator veto further surrounded by passive steel and polyethylene shielding and a plastic scintillator muon veto. This experiment is currently under construction and will be commissioned from late 2021 to early 2022. We will present the status of SABRE South, its expected background, and its sensitivity to a DAMA/LIBRA like modulation. We will also present recent NaI(Tl) crystal quenching factor measurements performed at the Heavy Ion Accelerator Facility, and a report on the status of SUPL.

Please choose the session this abstract belongs to:

Dark matter

session / 122

Neutrino Target of Opportunity program for the Cherenkov Telescope Array

Author: Olga Sergijenko[1]

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Astrophysical objects capable of hadronic acceleration to relativistic energies have long been believed to be sources of astrophysical neutrinos. Nevertheless, the long exposure neutrino sky map shows no significant indication of point sources so far. This may point to a large population of faint, steady sources or flaring objects as origins of this flux. The spatially and temporally 3σ correlated observations of the flaring gamma-ray blazar TXS 0506+056 and a high-energy neutrino detected by IceCube in September 2017, is a result of a Neutrino Target of Opportunity (NToO) program in which all currently operating imaging atmospheric Cherenkov telescopes (IACTs) take part and represents the most compelling evidence for a high-energy neutrino point source so far. The case for TXS 0506+056 being a neutrino source was made stronger by evidence of a 5-month long neutrino flare in 2014-2015. The Cherenkov Telescope Array (CTA) will be the next-generation ground-based gamma-ray observatory. In this work, we investigate the detection probability for the very-high-energy gamma-ray counterparts to neutrino sources from the populations simulated by the FIRESONG software to resemble the diffuse astrophysical neutrino flux measured by IceCube. We scan over parameters that can be used to describe the populations such as luminosity and density (density rate) for steady (flaring) objects. Several CTA array layouts and instrument response functions are tested in order to derive optimal follow-up strategies and the potential science reach of the NToO program for CTA. We find that CTA has a very high per-alert probability of detecting a steady source counterpart in certain parameter space regions. For the blazar flares resembling the neutrino flare of TXS 0506+056 in 2014-2015, CTA will detect more than 30% of the sources in 30 minutes of observation. We also investigate the effect of higher night sky background and the reduced CTA Alpha layout on the detection probability.

Please choose the session this abstract belongs to:

Gamma rays

Session 1 / 123

High-energy neutrinos and gamma-rays from the AGN-driven wind and torus in NGC 1068

Author: Susumu Inoue[1]

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Powerful, broadly collimated winds, likely driven by accretion disks around supermassive black holes (BHs), are observed in the majority of active galactic nuclei (AGN) and can play a crucial role in the evolution of AGN and their host galaxies. If some of the wind power is dissipated by shocks near the BH, protons can be thereby accelerated and undergo $p\gamma$ interactions with the AGN radiation, leading to emission of high-energy neutrinos, as well as broadband electromagnetic cascade emission triggered by $\gamma\gamma$ interactions. The TeV-range neutrinos tentatively detected by IceCube from the nearby, obscured Seyfert galaxy NGC 1068 can be interpreted consistently if the velocity of the shock is $\sim$1000 km/s, similar to that measured for its wind through IR to UV emission lines. While the $p\gamma$ cascade emission is heavily attenuated in the GeV-TeV bands, the observed GeV-range gamma rays from NGC 1068 may arise mainly as pp gamma rays from an external shock where the wind interacts with the obscuring torus, in addition to an underlying starburst component. Further multi-messenger observations of NGC 1068 and other AGN to test this scenario are discussed.

Please choose the session this abstract belongs to:

Extragalactic sources

Session 2 / 124

Measurement of the attenuation length of muon in the air shower with muon detectors of LHAASO

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The muons number observed at the ground from air showers is sensitive to the mass composition of cosmic rays and hadronic interaction model, the attenuation length of these muons will affect the measurement of the muon number. The muon detectors of LHAASO KM2A can directly measure the muons number in the air shower. Using the data recorded by the first-quarter array of KM2A in August 2020, the muons number is measured for the air shower events with zenith angle less than 45 degree. Based on the constant intensity cut method, the muon attenuation length is derived by fitting the muon number with same flux in different zenith angle. The relation between attenuation length and muon number in the shower is studied also. The simulation also does for QGSII-Gheisha, EPOS-Fluka models. The muon decay attenuation length from simulationn data is compared with the experimental data.

Please choose the session this abstract belongs to:

Cosmic rays

Session 2 / 125

Understanding the Spectrum of Gamma-Ray Burst 190114C

Author: Marc Klinger[1]

Co-authors: Andrew Taylor [1]; Walter Winter [1]

[1] *DESY*

The recent very-high-energy (VHE) gamma-ray observations of gamma-ray bursts (GRBs) in their afterglow phase motivate a review of the established fireball model in which a relativistic blast wave accelerates electrons in the forward shock, which then radiate via the synchrotron process and inverse Compton scattering on these synchrotron photons (synchrotron self-Compton). We use the

rich observations of GRB 190114C ranging from X-ray (keV) to VHE gamma-rays (TeV) to investigate the properties of the radiating electron distribution assuming a single emitting zone. We present preliminary modeling considering the landscape of solutions finding consistency with the multi-wavelength observations, and consider the implications of these different solution groups.

Please choose the session this abstract belongs to:

Extragalactic sources

Session 3 / 126

The role of cross sections in the evaluation of GCR propagation

Author: Pedro De la Torre Luque[1]

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he propagation of Galactic cosmic rays (CRs) is commonly studied as a diffusive movement which can be evaluated from the spectra of secondary CRs. While the accuracy of current CR data allows us to precisely test our propagation models, the precision of cross sections data for the production of secondary CRs is very poor (>20%), considerably limiting these tests.

In this talk we explore the consequences of the spallation cross sections uncertainties in the evaluation of the spectra of secondary CRs B, Be, Li and F, discussing possible hints of primary production of Li and F. Then, we also examine the so-called "antiproton excess" from different models of propagation obtained from combined analyses of the secondary CRs B, Be, Li and antiprotons. We show that different modifications of the cross sections involved in the production of these nuclei lead to different predictions of the propagation parameters and how this affects our limits of dark matter detection from antinuclei.

Please choose the session this abstract belongs to:

Cosmic rays

Session 3 / 127

CR scattering against pre-existing MHD turbulent modes

Author: Ottavio Fornieri[1]

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We present the phenomenological implications of the micro-physics of CR diffusion as resulting from particle scattering onto the three modes in which \textit{Magneto-Hydro-Dynamics} (MHD) cascades are decomposed. We calculate the diffusion coefficients from first principles based on reasonable choices of the physical quantities characterizing the different environments of our Galaxy, namely the \textit{Halo} and the \textit{Warm Ionized Medium}, and implement for the first time these coefficients in the {\tt DRAGON2} numerical code. Remarkably, we obtain the correct propagated slope and normalization for all the charged species taken into account, without any \textit{ad-hoc} tuning of the transport coefficients. We show that fast magnetosonic modes dominate CR confinement up to $\sim$ 100 TeV; Alfv\'enic modes are strongly subdominant due to the anistropy of the cascade (in agreement with previous findings) up to rigidities in the sub-PeV domain, where their contribution may show up as a spectral feature, potentially observable in the upcoming years. We also find that

such framework cannot be responsible for CR confinement below $\sim 200\ \mathrm{GeV}$, possibly leaving room for an additional confinement mechanism, and that the Kolmogorov-like scaling of the B/C ratio cannot be reproduced. Therefore this scaling might not be the imprint of the pre-exisiting turbulence spectrum

Please choose the session this abstract belongs to:

Cosmic rays

Session 1 / 129

Diagnosing the particle transport mechanism in the Geminga's pulsar halo via X-ray observation

Author: Qizuo WU[1]

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Extended TeV gamma-ray emission, which is also referred to as the TeV halo, has been discovered around the Geminga pulsar and a few other middle-aged pulsars. It is believed that the gamma-ray pulsar halo arises from the inverse Compton radiation of relativistic electrons escaping from the pulsar wind nebula. Therefore, the transport mechanism of these escaping electrons is crucial to understand the origin of the pulsar halo. So far, three kinds of models have been suggested to explain the measured feature of the TeV halo: (1) isotropic diffusion with low diffusion coefficient; (2) isotropic diffusion with the standard diffusion coefficient considering the transition from the quasi-ballistic to the diffusive transport regime; (3) anisotropic diffusion with the standard diffusion coefficient in the interstellar medium and a mean magnetic field direction approximately aligned with observer's line of sight. On the other hand, the synchrotron radiation of the same population electrons are mostly in the X-ray band. We show the expected X-ray intensity profiles of the pulsar halo under these three models. Since X-ray instruments generally have better angular resolution, their measurement on the inner region of the Geminga's pulsar halo can be used to distinguish among different models.

Please choose the session this abstract belongs to:

Galactic sources

Session 1 / 130

Constraints on Sterile Neutrino Mixing from IceCube

Author: Alfonso Garcia[1]

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Several short-baseline neutrino oscillation experiments have yielded unexpected results, which could hint at the existence of sterile neutrinos. IceCube has performed a unique search for sterile neutrinos by exploiting matter-enhanced resonant oscillations, which can be probed using atmospheric and astrophysical neutrinos in the TeV energy regime. The analysis uses the world's largest sample of Earth-crossing muon neutrino events from eight years of IceCube data with a purity above 99.9%.

We present results of this analysis that place stringent limits on an eV-scale fourth neutrino and future prospects for improvements in the event selection and reconstruction.

Please choose the session this abstract belongs to:

Neutrinos

Session 1 / 131

Molecular-line and gamma-ray studies toward SNR G35.6-0.4

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SNR G35.6-0.4 shows complex components in the radio bands and partially overlaps in space with an unidentified TeV source HESS J1858+020. In this study, we reanalyze CO, HI, and Fermi data toward SNR G35.6-0.4 region. The results obtained from the CO and HI data suggest that SNR G35.6-0.4 and HII region G35.6-0.5 locate at different distances. Based on the Fermi data, a GeV source (SrcB) is found to be spatially coincident with both HESS J1858+020 and HII region G35.6-0.5. The spectra of SrcB and HESS J1858+020 can be smoothly connected by a Power-law function with a hard index of ~2.2. Our results may imply that HII regions (or star-forming regions) are the potential PeVatrons.

Please choose the session this abstract belongs to:

Galactic sources

Session 1 / 132

Advanced searches for Lorentz invariance violation with Cherenkov telescopes

Author: Tomislav Terzić[1]

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Lorentz invariance violation (LIV) is an exciting possible consequence of Quantum Gravity (QG). Detecting and measuring LIV would pose an invaluable input for understanding the nature of QG, and suggest a direction for further development of theoretical models describing it. If Lorentz symmetry is indeed violated, the effects thereof are minuscule, but cumulative. Therefore, very high energy (VHE, E > 100 GeV) gamma rays crossing cosmological distances are excellent probes of LIV. So far, no effects of LIV have been detected, however, it has been strongly constrained. Researchers from three major imaging Cherenkov telescopes (IACTs) experiments (H.E.S.S., MAGIC, and VERITAS) join efforts to perform the most sensitive and robust search for the energy-dependent photon group velocity up to date. It is the first attempt at merging data from different instruments to this

purpose, thus creating exceptionally large statistics. Moreover, combining observations from different gamma-ray sources will decrease the influence of source intrinsic effects.
In our contribution, we will describe the likelihood-based analysis method developed for this purpose, and present results on simulated data. We will compare impacts of different observations on the overall result, and discuss characteristics of the most influential data samples. In particular, we will focus on the case of GRB 190114C, the only IACT observation of a gamma-ray burst so far whose data was scrutinized for LIV.

Please choose the session this abstract belongs to:

Gamma rays

Session 2 / **133**

Multiwavelength monitoring of gravitationally lensed blazar QSOB0218+357 between 2016 and 2020

Author: Francesco de Palma[1]

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QSO B0218+357 (z = 0.944±0.002) is currently the only gravitationally lensed source from which very-high-energy (VHE, >˜100GeV) gamma-ray emission has been detected. We report the Fermi-LAT monitoring of the source between 2016 and 2020 in conjunction with multiwavelength monitoring observations in radio interferometry and in the optical, X-ray, and VHE ranges. During the monitoring, individual flares in optical, X-ray and GeV bands were observed. An observable effect of the gravitational lensing , during bright flares, is a time delay between the lensed images. Fermi-LAT detected previous flares in 2012 and 2014, allowing for a measure of the delay (˜11 days) compatible with measures done in other wavelengths. Simultaneous data taken by the MAGIC telescopes allow us to search for the associated VHE emission, constraining the VHE gamma-ray duty cycle of the source, even in the absence of a significant detection. We use the X-ray data obtained with XMM to evaluate the column density of the dust in the lensing galaxy (z = 0.68466±0.00004). We use radio interferometry measurements to model the source-lens-observer geometry and determine the magnifications and time delays for different components of the image. We model the quiescent emission in which the high-energy bump is explained as a combination of synchrotron-self-Compton and external Compton processes. The bulk of the low energy emission can be explained as originated from a region located along the jet at tens of parsecs from the central engine.

Please choose the session this abstract belongs to:

Extragalactic sources

Session 2 / **134**

MAGIC in the multi-messenger Universe: latest news from the neutrino blazar TXS 0506+056

Authors: Andrea Gokus[1]; Anthony C. S. Readhead[2]; Chiara Righi[3]; Elina Lindfors[4]; Elisa Bernardini[5]; Elisa Prandini[5]; Filippo D'Ammando[6]; Florian Eppel[1]; Florian Rösch[1]; Georgios Filippos Paraschos[7]; Ilaria Viale[5]; Jamie Stevens[8]; Jonas Heßdörfer[1]; Jonas Sinapius[9]; Konstancja Satalecka[9]; Matteo Cerruti[10]; Matthias Kadler[1]; Philip G. Edwards[8]; Roopesh Ojha[11]; Sahakyan Narek[12]; Sebastian Kiehlmann[13]; Talvikki Hovatta[4]; Tommaso Aniello[14]; Wrijupan Bhattacharyya[9]

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The evidence for multi-messenger photon and neutrino emission from the blazar TXS 0506+056 has been a major success for the astrophysical community, reached thanks to a powerful strategy of real-time follow-up of neutrino events. The effort of MAGIC and other experiments in coordinating observations to obtain contemporaneous multiwavelength (MWL) flux and spectral measurements was key for measuring the chance coincidence with the high-energy neutrino from the neutrino event IceCube-170922A and constrain theoretical models. While the strategy of follow-ups of neutrino alerts is active and enforced by many facilities, TXS 0506+056 remains the astrophysical source with the highest significance associated with a high-energy neutrino. The monitoring of TXS 0506+056 is providing new information on the time evolution of the MWL radiation from this source and a deeper understanding of the processes leading to the neutrino emission. Here we present the light curves and simultaneous spectral energy distributions from the neutrino blazar TXS 0506+056 during a 3-year monitoring with MAGIC and MWL partners. The theoretical interpretation of the results will be presented and put in context with the multi-messenger efforts of MAGIC in the past years.

Please choose the session this abstract belongs to:

Extragalactic sources

Session 4 / **135**

The astrophysics program of the NOvA experiment

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The NOvA experiment is aimed to solve the fundamental neutrino problems: precise determination of neutrino oscillation parameters, determination of neutrino mass hierarchy, search for the CP-violation in the leptonic sector. NOvA consists of the near detector on the Fermi National Laboratory site, where the muon neutrinos are produced in the NuMI accelerator complex, and the far detector located 810 km away at Ash River, detecting both survived muon and new appeared electron neutrinos. Both detectors have similar structure based on the liquid scintillator filling large volumes with detailed segmentation. The mass of the detectors target part is 14 ktons for the far detector and 220 tons for the near detector, providing to study wide astrophysical program beyond neutrino oscillation and neutrino cross-section measurements, search and detection for different signals from Space and the Earth's environment: supernova, magnetic monopole, atmospheric muons, dark matter and potential signals in coincidence with the LIGO/Virgo gravitational wave events.

Please choose the session this abstract belongs to:

Particle physics

Session 2 / 136

A unified model for orphan and multi-wavelength blazar flares

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Blazars are a class of active galactic nuclei which host relativistic jets oriented close to the observer's line of sight. Blazars have very complex variability properties. Flares, namely flux variations around the mean value with a well-defined shape and duration, are one of the identifying properties of the blazar phenomenon. Blazars are known to exhibit multi-wavelength flares, but also "orphan" flares, namely flux changes that appear only in a specific energy range. Various models, sometimes at odds with each other, have been proposed to explain specific flares even for a single source, and cannot be synthesized into a coherent picture. In this paper, we propose a unified model for explaining orphan and multi-wavelength flares from blazars in a common framework. We assume that the blazar emission during a flare consists of two components: (i) a quasi-stable component that arises from the superposition of numerous but comparatively weak dissipation zones along the jet, forming the background (low-state) emission of the blazar, and (ii) a transient component, which is responsible for the sudden enhancement of the blazar flux, forming at a random distance along the jet by a strong energy dissipation event. Whether a multi-wavelength or orphan flare is emitted depends on the distance from the base of the jet where the dissipation occurs. Generally speaking, if the dissipation occurs at a small/large distance from the supermassive black hole, the inverse Compton/synchrotron radiation dominates and an orphan gamma-ray/optical flare tends to appear. On the other hand, we may expect a multi-wavelength flare if the dissipation occurs at a intermediate distance. We show that the model can successfully describe the spectral energy distribution of different flares from the flat spectrum radio quasar 3C 279 and the BL Lac object PKS 2155-304.

Please choose the session this abstract belongs to:

Extragalactic sources

Session 1 / 137

The ASTRI Mini-Array and its key performance features

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The ASTRI Mini-Array is a next-generation Imaging Atmospheric Cherenkov Telescopes (IACTs) facility for gamma-ray astronomy in the energy band from a few TeV up to 100 TeV and beyond, under construction at the Teide Observatory (in the Canary Island of Tenerife, Spain). The project is led by the Italian *Istituto Nazionale di Astrofisica* (INAF) in collaboration with the *Fundación Galileo Galilei* (FGG), the Spanish *Instituto de Astrofísica de Canarias* (IAC), and other institutes and universities from Italy, Brazil and South Africa. The system will be composed of nine small-sized (~4 meter in diameter) and large field-of-view (~10 degrees) double-mirror IACTs equipped with silicon photo-multiplier cameras managed by fast front-end electronics. The telescope technology is an evolution of that of ASTRI-Horn, a small-sized Cherenkov telescope (SST) prototype developed by INAF within the Cherenkov Telescope Array (CTA) Project, currently operating on Mt. Etna (Italy). The ASTRI Mini-Array is being developed in all its aspects, from the design and implementation of all hardware and software components, including a dedicated off-site Data Center, to the generation and dissemination of the final scientific products. The full array will be operational within the next few years. Thanks to its significantly improved performance above a few TeV, compared to current arrays of Cherenkov telescopes, and an almost flat response over a wide field of view of several squared degrees, the ASTRI Mini-Array will represent soon a prominent facility for deep observations of galactic and extragalactic targets at the TeV and multi-TeV energy scale, in synergy with other ground-based gamma-ray facilities in the Northern Hemisphere, such as LHAASO, HAWC, MAGIC, VERITAS and CTAO-N. In this contribution, we provide an overview of the ASTRI Mini-Array project and review the key performance features of the system.

Please choose the session this abstract belongs to:

Gamma rays

Session 4 / **138**

Search for new physics in dilepton final states with CMS run2 data

Author: Xuyang Gao[1]

[1] *Fudan University*

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Search for high mass BSM are performed in dilepton final states using the proton-proton collision dataset at a center-of-mass energy of 13 TeV collected by CMS in 2016, 2017, and 2018, corresponding to integrated luminosities up to ~140/fb. The observations are consistent with the expectations of the standard model in all searched channels. Upper limits on the cross sections are calculated and lower mass limits are set for various BSM models including Z', QBH, and RPV.

Please choose the session this abstract belongs to:

Particle physics

Plenary / **139**

LHC results on the dark sector

Author: Tulika Bose[1]

[1] *University of Wisconsin-Madison*

This talk will present an overview of LHC results on the dark sector.

Please choose the session this abstract belongs to:

Plenary talk

Session 2 / 140

Galactic Science with the Southern Wide-field Gamma-ray Observatory

Author: Ruben Lopez-Coto[1]

Co-authors: Alison Mitchell [2]; Ekrem Oguzhan Anguner [3]; Gwenael Giacinti [4]

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The Southern Wide-field Gamma-ray Observatory (SWGO) is a proposed ground-based gamma-ray detector that will be located in the Southern Hemisphere and is currently in its design phase. In this contribution, we will outline the prospects for Galactic science with this Observatory. Particular focus will be given to the detectability of extended sources, such as gamma-ray halos around pulsars; optimisation of the angular resolution to mitigate source confusion between known TeV sources; and studies of the energy resolution and sensitivity required to study the spectral features of PeVatrons at the highest energies. Such a facility will ideally complement contemporaneous observatories in studies of high energy astrophysical processes in our Galaxy.

Please choose the session this abstract belongs to:

Galactic sources

Session 1 / 141

Prospects for Primordial Black Hole evaporation studies with the Southern Wide-field Gamma-ray Observatory

Author: Ruben Lopez-Coto[1]

Co-authors: Alessandro De Angelis [2]; Michele Doro [2]; Mosè Mariotti [2]; Pat Hardin [3]

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The search for Primordial Black Hole (PBH) signatures is very broad in techniques, the origin of these signatures and in theories of PBH formation. Searches for imprints of evaporation involve several observables such as the Extragalactic Gamma-Ray background or direct measurement of different species of cosmic rays. Using these observables, one can put very tight constraints on the PBH density in a mass range around 10ˆ14 g. To perform direct observations of the evaporation of these PBHs, one needs to be sensitive to photons in the Very High Energy gamma-ray regime, either using Imaging Atmospheric Cherenkov telescopes or wide field of view shower front detectors. The Southern Wide-field Gamma-ray Observatory is a projected ground-based gamma-ray detector that will be located in the Southern Hemisphere and it is now in its design phase. In this contribution, I will show the limits on PBH evaporation that can be achieved with a straw man detector that is being considered at the moment for SWGO.

Please choose the session this abstract belongs to:

Dark matter

Plenary / **142**

The Status and New Results of DAMPE Experiment

Author: Yunlong Zhang[1]

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

The Dark Matter Particle Explorer (DAMPE), primarily designed to directly measure high energy cosmic rays and gammas in space, was launched into 500 km orbit successfully on December 17th, 2017, and, since then, it is in continuous data taking. DAMPE consists four sub-detectors: top layers of plastic scintillators as a charged measurement detector, a 12 layers silicon strip tracker, an imaging BGO calorimeter with 32 radiation lengths, and a bottom boron-doped scintillator to detect secondary neutrons. The goal is to find dark matter signals indirectly by measuring electron and gamma spectra with up to about 10 TeV. In addition, DAMPE can also carry out cosmic ray fluxes measurement in the range from about 20 GeV to hundreds TeV. The recent measurements of the flux of electrons and positrons, protons and nuclei will be presented.

Please choose the session this abstract belongs to:

Plenary talk

Session 4 / **143**

Measurements on Higgs boson width and anomalous couplings with on-shell and off-shell production in ZZ decay channel at CMS experiment

Author: Hanwen Wang[1]

[1] *Beihang University*

Corresponding Author: allenwang@buaa.edu.cn

The width and the structure of its couplings to the known SM particles is very important to determine whether 125GeV Higgs is the SM Higgs boson. The off-shell technique provides unique way to

measure the Higgs boson width and probe the small anomalous couplings which are allowed in SM. In this talk, a recent measurement on the Higgs width and anomalous couplings with the ZZ decay channel is presented.

Please choose the session this abstract belongs to:

Particle physics

Plenary / 144

The origin of UHECR: current status and future of a decades-long puzzle

Author: Rodrigo Guedes Lang[1]

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Ultra-high-energy cosmic rays (UHECR) are the most energetic known particles of the Universe, being accelerated to energies up to 7 orders of magnitude higher than those achieved in human-made accelerators. Their origins, however, remain an intriguing puzzle even decades after their discovery. In this review, the current status of this puzzle will be presented, discussing the latest measurements from the Pierre Auger Observatory and the Telescope Array experiments as well as the status of different phenomelogical approaches to decipher this question.

Please choose the session this abstract belongs to:

Plenary talk

Plenary / 145

The progress in the construction and operation of the Baikal-GVD

Author: Olga Suvorova[1]

[1] *Institute for Nuclear Research. of the Russian Academy of Sciences*

The progress in the construction and operation of the Baikal-GVD is reported. The detector is designed for search for high energy neutrinos whose sources are not yet reliably identified. It currently includes 2304 optical modules arranged on 64 strings, providing an effective volume of 0.4 km3 for cascades with energy above 100 TeV. We review the scientific
case for Baikal-GVD, the construction plan, and first results from the partially built experiment, which is currently the largest neutrino telescope in the Northern Hemisphere and still growing up.

Please choose the session this abstract belongs to:

Plenary talk

Session 1 / 146

Constraining EeV-Scale Dark Matter with Neutrino Observatories Using Tau Regeneration

Author: Jeffrey Lazar[1]

[1] *Harvard University*

Corresponding Author: jeffreylazar@fas.harvard.edu

In 2016 and 2018, the ANITA collaboration reported the observation of two anomalous events, with polarizations consistent with up-going neutrinos, but coming from too far below the horizon to actually make it through the Earth given their energies. While all Standard Model (SM) explanations of these events have been ruled out, explanations from beyond Standard Model scenarios have been put forth in the literature, including scenarios in which these events arise from heavy dark matter decay to SM particles. In this contribution, we use tau neutrino regeneration to constrain one such explanation. Using ANTARES and IceCube public data, we look for an excess of neutrinos coming from this dark matter decaying in the Galactic Center and the Sun. Furthermore, we show the first accurate simulation of tau neutrino regeneration in the Sun.

Please choose the session this abstract belongs to:

Dark matter

Session 4 / 147

IceCube Upgrade and the performance of the optical module D-Egg

Author: Colton Hill[1]

[1] *Chiba University*

The IceCube Upgrade involves development of several new optical modules:dual-PMT (D-Eggs), multi-PMT (mDOMs), and upgraded traditional modules (pDOMs). In particular, the D-Eggs offer a high-efficiency and cost-effective solution compared to original IceCube modules. Results extracted from the IceCube Upgrade will compliment low energy analyses, as well as be a key component of the upcoming IceCube Gen2, which will include extensive expansion of sensitivity in the TeV+ energy range. Inclusion of new calibration devices and increased module performance
play an important role in this increase. Currently over 280 D-Eggs have been produced and are undergoing detailed testing before permanent deployment into the Antarctic ice. This document highlights results of the mass-production line D-Egg modules for the IceCube Upgrade.

Please choose the session this abstract belongs to:

Neutrinos

Session 1 / 148

Science with the Southern Wide-Field Gamma-ray Observatory

Authors: Francesco Longo[1]; Gwenael Giacinti[1]; Ulisses Barres de Almeida[2]

[1] *SWGO Collaboration*

[2] *SWGO collaboration*

The Southern Wide-field Gamma-ray Observatory (SWGO) is the project to build a new extensive air shower particle detector for the observation of very-high-energy gamma-rays in South America. SWGO is currently planned for installation in the Southern Hemisphere, which grants it a unique science potential among ground-based gamma-ray
detectors. It will complement the capabilities of CTA, working as a wide-field instrument for the monitoring of transient and variable phenomena, and will expand the sky coverage of Northern Hemisphere facilities like HAWC and LHAASO, thus granting access to the entire Galactic Plane and the Galactic Center. SWGO aims to achieve excellent sensitivity over a very large target energy range from about 100 GeV to the PeV, and improve on the performance of current sampling array instruments in all observational parameters, including energy and angular resolution, background rejection, and single-muon detection capabilities. The directives for the final observatory design will be given by a number of key science goals which are being defined over the course of the Project's R&D phase. In this contribution we will present
the core science topics and target performance goals that serve as benchmarks to guide SWGO's design configuration.

Please choose the session this abstract belongs to:

Gamma rays

Session 1 / 149

Decaying Dark Matter at IceCube and its Signature in High-Energy Gamma-Ray Experiments

Author: Barbara Skrzypek[1]

[1] *Harvard University*

Observations of high-energy astrophysical neutrinos in IceCube have opened the door to multi-messenger astronomy, by way of which questions in particle physics could be explored through a combination of IceCube data and optical experiments such as Fermi-LAT. However, the origin of these astrophysical neutrinos is still largely unknown. Among the tensions that still need to be addressed, for example, is the excess of neutrinos observed in the energy range of 40-200 TeV, a contribution that could come from heavy dark matter decay. The dark matter decay hypothesis can be tested through comparisons with gamma-ray data, because a coincident gamma-ray flux is expected to accompany the neutrino flux that IceCube observes. However, gamma-rays become heavily suppressed for sources dominating in particular energy ranges. In the case of the Galactic center, the γ-sky is partially opaque in the (0.1-10) PeV range. This is due to properties of the traversed medium, which can generally consist of extragalactic background light (EBL), the cosmic microwave background (CMB), and the intergalactic magnetic field. These significantly alter the initial spectrum through intermediate processes such as absorption and Inverse-Compton scattering, giving rise to anisotropy and energy features in the final spectrum that reaches telescopes on Earth. The existence of competing photon background models, moreover, complicates estimates of dark matter constraints. In this presentation, we address these questions by studying the impact that these different models have on indirect measurements of heavy dark matter decay. I present my predictions for galactic, inverse-Compton, and extragalactic gamma-ray spectra undergoing attenuation by different backgrounds.

Please choose the session this abstract belongs to:

Dark matter

Plenary / **150**

High-Energy Neutrino Observation Highlights from IceCube

Author: Qinrui Liu[1]

[1] *University of Wisconsin*

The IceCube Neutrino Observatory consists of one cubic kilometer of deep transparent Antarctic ice that has been transformed into a neutrino telescope at the South Pole. It has been operating in its full configuration for the past 10 years. TeV-PeV neutrinos of cosmic origin have been discovered with an energy flux comparable to that of gamma rays and cosmic rays. High-energy neutrinos are unique astronomical messengers. They provide an unobstructed view of the cosmic accelerators that power the highest energy radiation observed while also providing a means to study neutrinos themselves, allowing IceCube to explore a panoply of topics in astronomy and fundamental physics. In this talk, I will introduce the IceCube experiment and summarize its most recent results, emphasizing the physics potential of a natural astrophysical neutrino beam. I will highlight open questions and address how a next-generation detector will tackle them.

Please choose the session this abstract belongs to:

Plenary talk

Session 1 / **151**

A Monte Carlo for Ultra-High Energy Neutrino Propagation

Author: Ibrahim Safa[1]

[1] *University of Wisconsin*

Ultra-high energy neutrinos (>10ˆ16 GeV) are expected to be produced through cosmic-ray interactions with the Cosmic Microwave Background (CMB). This so-called cosmogenic flux of UHE neutrinos is a target of the next generation neutrino observatories: IceCube-Gen2, TAMBO, RNOG, GRAND, POEMMA, and CHANT. Many of these detectors rely on measuring the neutrino interaction either directly at the vertex, or through its charged particle counterpart's electromagnetic or decay shower. A new technique has also been put forward which relies on the observation of Earth-throughgoing tau neutrinos at PeV energies. By measuring the tau neutrino flux at this energy, one can indirectly observe the flux at the EeV scale since these two are related by the cascading down of tau neutrinos through the process of tau regeneration. These ideas demand an accurate simulation of UHE neutrino transport. In this contribution we present TauRunner, a Python Monte Carlo (MC) package specialized in UHE neutrino transport. We present new functionalities, including the incorporations of all neutrino flavors in the propagation and significant performance imrovements enabling an efficient and accurate simulation of neutrino propagation through any media.

Please choose the session this abstract belongs to:

Neutrinos

Plenary / **152**

Recent progress in sub-GeV dark matter detection

Author: Daniel Egana-Ugrinovic[1]

[1] *Perimeter Institute*

In recent years, the search for dark matter with sub-GeV masses has been targeted by a variety of novel experiments with unprecedented sensitivity to low energy depositions.
In this talk, we review the theoretical motivations behind these experiments and the challenges that need to be overcome in order to make a leap forward in detection reach.
In particular, we discuss new explanations for the excess background events that are being observed at several experiments, promising strategies to mitigate them, and novel ideas to significantly lower the energy thresholds required for detection. We argue that the combination of these novel developments could dramatically enhance the potential to discover dark matter with masses as low as fractions of an eV.

Please choose the session this abstract belongs to:

Plenary talk

Session 2 / 153

Contributions from the fixed target program of the LHCb experiment to the understanding of antimatter in cosmic rays: status and prospects

Author: Chiara Lucarelli[1]

[1] *CERN*

Antimatter in cosmic rays is a powerful probe for the indirect
detection of Dark Matter. To constrain the background from secondary antiparticles, produced during cosmic ray propagation through the interstellar medium, the related cross sections need to be determined more precisely at accelerator facilities. The LHCb experiment currently offers the unique fixed-target facility exploiting the beam energy provided by the LHC and can reproduce cosmic collisions between protons at the TeV scale and gas targets of helium and, soon,hydrogen and deuterium. The status and prospects for this campaign ofantimatter production measurements will be discussed.

Please choose the session this abstract belongs to:

Particle physics

Session 4 / 154

Search for invisible decays at BESIII

Author: Yunxuan Song[1]

[1] *Peking University , University of Chinese Academy of Sciences*

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BESIII has collected data sets of 448.2 M $\psi(3686)$ events and 10 B J/ψ events. The huge clean data samples provide an excellent opportunity to search for new physics. We report the search for decay $J/\psi \to \gamma + \mathrm{invisible}$, which is predicted by next-to-minimal supersymmetric model. Without significant signal found, we gave around 6.2 times better UL than previous CLEO-c' s results. In addition, we report the preliminary result of the first search for the invisible decay of Λ.

This invisible decay is predicted by mirror matter model which could explain the 4σ discrepancy in neutron lifetime measurement results between the beam method and the bottle method.

Please choose the session this abstract belongs to:

Particle physics

Session 1 / 155

Searches for dark matter with the ATLAS detector (joint abstract from Exotics, Higgs, and SUSY)

Author: speaker to be assgined ATLAS[1]

[1] *ATLAS*

Corresponding Author: changqiao.li@cern.ch

The presence of a non-baryonic Dark Matter (DM) component in the Universe is inferred from the observation of its gravitational interaction. If Dark Matter interacts weakly with the Standard Model (SM) it could be produced at the LHC. The ATLAS experiment has developed a broad search program for DM candidates, including resonance searches for the mediator which would couple DM to the SM, searches with large missing transverse momentum produced in association with other particles (light and heavy quarks, photons, Z and H bosons) called mono-X searches and searches where the Higgs boson provides a portal to Dark Matter, leading to invisible Higgs decays. The results of recent searches on 13 TeV pp data, their interplay and interpretation will be presented. Prospects for HL-LHC will also be discussed.

Please choose the session this abstract belongs to:

Dark matter

Session 4 / 157

Searches for Higgs boson pair production with the full LHC Run 2 dataset in ATLAS

Author: speaker to be assigned ATLAS[1]

[1] *ATLAS*

Corresponding Author: yanlin@cern.ch

The latest results on the production of Higgs boson pairs (HH) in the ATLAS experiment are reported, with emphasis on searches based on the full LHC Run 2 dataset at 13 TeV. In the case of non-resonant HH searches, results are interpreted both in terms of sensitivity to the Standard Model and as limits on the Higgs boson self-coupling. Search results on new resonances decaying into pairs of Higgs bosons are also reported. Prospects of testing the Higgs boson self-coupling at the High Luminosity LHC (HL-LHC) will also be presented.

Please choose the session this abstract belongs to:

Particle physics

Session 2 / 158

Measurement of top-quark cross sections and properties with the ATLAS detector at the LHC

Author: speakers to be assigned ATLAS[1]

[1] *ATLAS*

Corresponding Author: peter.berta@cern.ch

The remarkably large integrated luminosity collected by the ATLAS detector at the highest proton-proton collision energy provided by LHC allows to use the large sample of top quark events to test theoretical predictions with unprecedented precision. Using data taken with the ATLAS detector at the LHC, recent measurements of total and differential top-quark cross sections as well properties of top-quark production are shown, including new measurements of the spin polarisation in single-top-quark production, of differential cross sections for top-quark pair production with high-momentum top quarks and of the energy asymmetry in top-quark pair events. Several measurements are interpreted within the Standard Model Effective Field Theory, yielding stringent bounds on Wilson coefficients.

Please choose the session this abstract belongs to:

Particle physics

Session 4 / 159

Measurements of the Higgs boson properties with the ATLAS experiment and their interpretations with the ATLAS experiment

Author: Giada MANCINI[1]

[1] *Frascati*

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With the full Run 2 pp collision dataset collected at 13 TeV, very detailed measurements of Higgs boson properties and its interactions can be performed using its decays into bosons and fermions. These measurements are combined allowing to reach the highest possible measurement precision. This talk presents the latest measurements of the Higgs boson properties by the ATLAS experiment in various decay channels, including production mode cross sections, simplified template cross sections, differential and fiducial cross sections, as well as their combination and interpretations. Specific scenarios of physics beyond the Standard Model are tested, as well as a generic extension in the framework of the Standard Model Effective Field Theory.

Please choose the session this abstract belongs to:

Particle physics

Session 4 / 160

Search for rare and lepton flavor violating decays of the Higgs boson with the ATLAS detector

Author: speaker to be assigned ATLAS[1]

[1] *ATLAS*

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The Standard Model predicts several rare Higgs boson decay channels, among which are decays to a Z boson and a photon, H to Zgamma, to a low-mass lepton pair and a photon H to llgamma, and to a meson and photon. The observation of some of these decays could open the possibility of studying the CP and coupling properties of the Higgs boson in a complementary way to other analyses. In addition, lepton-flavor-violating decays of the observed Higgs boson are searched for, where on observation would be a clear sign of physics effects beyond the Standard Model. Several results for decays based on pp collision data collected at 13 TeV will be presented.

Please choose the session this abstract belongs to:

Particle physics

Session 2 / 161

Measurements of associated top quark production and searches for new top-quark phenomena with the ATLAS detector

Author: speaker to be assigned ATLAS[1]

[1] *ATLAS*

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The high center-of-mass energy of proton-proton collisions and the high integrated luminosities at the CERN Large Hadron Collider make it possible to study rare processes of the Standard Model (SM) with unprecedented precision and search for new physics that might enhance extremely rare processes in the SM. Measurements of rare SM processes provide new tests of the SM predictions with the potential to unveil discrepancies with the SM predictions or provide important input for the improvement of theoretical calculations. A significant example of new phenomena are Flavour Changing Neutral Currents (FCNC): forbidden at tree level and highly suppressed at higher orders in the Standard Model (SM), FCNC processes can receive enhanced contributions in many extensions of the SM, so any measurable sign of such interactions is an indication of new physics. In this talk, total and differential measurements of top-quark production in association with additional bosons are shown using data taken with the ATLAS experiment at a center-of-mass-energy of 13 TeV, as well as a recent result on the evidence for the very rare process of four-top-quark production, combining several channels.
In addition, searches for FCNCs with the ATLAS experiment are shown, including a new result on the FCNC coupling of the top quark to the Z boson using the full data taken during Run-2 of the LHC, as well as other searches for beyond-the-Standard-Model phenomena in top-quark final states.

Please choose the session this abstract belongs to:

Particle physics

Session 4 / 162

Searches for resonances decaying to pairs of heavy bosons in ATLAS

Author: speaker to be assigned ATLAS[1]

[1] *ATLAS*

Corresponding Author: shuli@sjtu.edu.cn

Many new physics models predict the existence of Higgs-like particles decaying into two bosons (W, Z, photon, or Higgs bosons) making these important signatures in the search for new physics. Searches for Vγ, VV, and VH resonances have been performed in various final states. In some of these searches, jet substructure techniques are used to disentangle the hadronic decay products in highly boosted configurations. This talk summarises recent ATLAS searches with Run 2 data collected at the LHC and explains the experimental methods used, including vector- and Higgs-boson-tagging techniques.

Please choose the session this abstract belongs to:

Particle physics

Session 2 / 163

ATLAS measurements of CP violation and rare decays processes with beauty mesons

Author: speaker to be assigned ATLAS[1]

[1] *ATLAS*

Corresponding Author: marcella.bona@cern.ch

The ATLAS experiment has performed measurements of B-meson rare decays proceeding via suppressed electroweak flavour changing neutral currents, and of mixing and CP violation in the neutral Bs meson system. This talk will focus on the latest results from the ATLAS collaboration, such as rare processes B0s → mu mu and B0 → mu mu, and CP violation in the B0s —> J/psi phi decays. In the latter, the Standard Model predicts the CP violating mixing phase, phi_s, to be very small and its SM value is very well constrained, while in many new physics models large phi_s values are expected. The latest measurements of phi_s and several other parameters describing the B0s —> J/psi phi decays will be reported.

Please choose the session this abstract belongs to:

Particle physics

Session 4 / 164

Searches for leptoquarks with the ATLAS detector (joint abstract from Exotics and SUSY)

Author: speaker to be assigned ATLAS[1]

[1] *ATLAS*

Corresponding Author: bauer@physik.uni-bonn.de

Leptoquarks (LQ) are predicted by many new physics theories to describe the similarities between the lepton and quark sectors of the Standard Model and offer an attractive potential explanation for the lepton flavour anomalies observed at LHCb and flavour factories. The ATLAS experiment has a broad program of direct searches for leptoquarks, coupling to the first-, second- or third-generation particles. This talk will present the most recent 13 TeV results on the searches for leptoquarks and contact interactions with the ATLAS detector, covering flavour-diagonal and cross-generational final states.

Please choose the session this abstract belongs to:

Particle physics

Session 2 / 165

Searches for BSM physics using challenging and long-lived signatures with the ATLAS detector

Author: speaker to be assigned ATLAS[1]

[1] *ATLAS*

Various theories beyond the Standard Model predict new, long-lived particles with unique signatures which are difficult to reconstruct and for which estimating the background rates is also a challenge. Signatures from displaced and/or delayed decays anywhere from the inner detector to the muon spectrometer, as well as those of new particles with fractional or multiple values of the charge of the electron or high mass stable charged particles are all examples of experimentally demanding signatures. The talk will focus on the most recent results using 13 TeV pp collision data collected by the ATLAS detector. Prospects for HL-LHC will also be shown.

Please choose the session this abstract belongs to:

Particle physics

Session 2 / 166

Search for exotic decays of the Higgs boson and additional scalar particles in ATLAS

Author: ATLAS[1]

[1] *ATLAS*

Corresponding Author: elliot.reynolds@cern.ch

The discovery of the Higgs boson with the mass of about 125 GeV completed the particle content predicted by the Standard Model. Even though this model is well established and consistent with many measurements, it is not capable to solely explain some observations. Many extensions of the Standard Model addressing such shortcomings introduce additional Higgs-like bosons which can be either neutral or charged. Exotic decays of the Higgs boson also provide a unique window for the discovery of new physics, as the Higgs boson may couple to hidden-sector states that do not interact under Standard Model gauge transformations. Also, models predicting exotic Higgs boson decays to pseudo-scalars can explain the g-2 and flavour-sector anomalies, and the galactic centre gamma-ray excess if the additional pseudo-scalar acts as the dark matter mediator. This talk presents recent searches for additional low- and high-mass Higgs bosons, as well as decays of the 125 GeV Higgs boson to new particles, using LHC collision data at 13 TeV collected by the ATLAS experiment in Run 2.

Please choose the session this abstract belongs to:

Particle physics

Session 4 / **167**

Searches for new physics with leptons using the ATLAS detector

Author: speaker to be assigned ATLAS[1]

[1] *ATLAS*

Corresponding Author: antonio.sidoti@cern.ch

Many theories beyond the Standard Model predict new phenomena, such as Z', W' bosons, or heavy leptons, in final states with isolated, high-pt leptons (e/mu/tau). Searches for new physics with such signatures, produced either resonantly or non-resonantly, are performed using the ATLAS experiment at the LHC. This includes a novel search that exploits the lepton-charge asymmetry in events with an electron and muon pair. Lepton flavor violation (LVF) is a striking signature of potential beyond the Standard Model physics. The search for LFV with the ATLAS detector focuses on the decay of the Z boson into different flavour leptons (e/mu/tau). The recent 13 TeV pp results will be reported.

Please choose the session this abstract belongs to:

Particle physics

Session 2 / **168**

Searches for new phenomena in final states with 3rd generation quarks using the ATLAS detector

Author: speaker to be assigned ATLAS[1]

[1] *ATLAS*

Corresponding Author: angela.maria.burger@cern.ch

Many theories beyond the Standard Model predict new phenomena, such as heavy vectors or scalar, and vector-like quarks, in final states containing bottom or top quarks. Such final states offer great potential to reduce the Standard Model background, although with significant challenges in reconstructing and identifying the decay products and modelling the remaining background. The recent 13 TeV pp results, along with the associated improvements in identification techniques, will be reported.

Please choose the session this abstract belongs to:

Particle physics

Plenary / **169**

Searches for gravitational waves from nearby supernovae

Author: Ornella Juliana.Piccinni[1]

[1] *National Institute for Nuclear Physics Rome Division*

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Formed after the collapse of a massive star and the following supernova explosion, supernova remnants hosting potential young neutron stars are ideal targets for searches for continuous gravitational waves.
Astronomical catalogues like the Green supernova catalogue and the online high-energy galactic supernova remnant catalogue (SNRcat), provide accurate information about the sky position of the central compact objects in supernova remnants, making it possible to perform directed searches for these targets, at a reduced computational cost. In this talk, I will review the results from supernova remnant searches using the latest data from LIGO and Virgo. Future search perspectives using new interferometric detector data and the possibility to include new targets will be discussed.

Please choose the session this abstract belongs to:

Plenary talk

Session 4 / 170

Probing new physics at future tau neutrino telescopes

Author: Guo-yuan Huang[1]

Co-authors: Jana Sudip [1]; Manfred Lindner [1]; Werner Rodejohann [2]

[1] *MPIK, Heidelberg, Germany*

[2] *MPIK, Heidelberg*

We explore the new physics scenarios case by case that can modify the interactions between neutrinos and matter at future tau neutrino telescopes. Recent progress of multimessenger astronomy, especially the ultra-high-energy neutrino observations at IceCube, has sparked a campaign towards neutrino detection at extreme energies around the Greisen-Zatsepin-Kuzmin cutoff around 10ˆ9 GeV. A promising class of such observatories is the tau neutrino telescope. The neutrino as an elusive particle, on the one hand, can point directly towards the cosmic accelerators, and on the other hand, provides a promising portal to new physics. While the tau sector is difficult to probe in the laboratory, the tau neutrino telescopes are congenitally sensitive to the new physics lying in the third family. Among many models, we identify two new physics cases at the tree level that can give large contributions to neutrino cross sections while staying within laboratory constraints: the charged Higgs and the leptoquark models. We follow the realistic experimental configurations of the telescopes as close as possible and perform the χ^2 analysis on the energy and angular distributions of the tau events. By numerically solving the propagation equations of neutrino and tau fluxes in matter, we have obtained the sensitivities of future tau neutrino telescopes, GRAND, POMMEA and Trinity, to the charged Higgs and leptoquark models.

Please choose the session this abstract belongs to:

Neutrinos

Plenary / 171

Novel constraints on light dark matter via solar reflection and acceleration by cosmic rays

Author: Maxim Pospelov[1]

[1] *University of Minnesota*

Light (e.g. sub-GeV) WIMPs might be a viable model if the Standard Model is extended by new dark sector degrees of freedom. Many of these dark matter candidates would fall below the thresholds of direct detection experiments. I present new results on (almost) model-independent constraints on properties of dark matter that utilize A. Acceleration of light dark matter via collision with energetic particles such as solar electrons and cosmic rays, B. the most sensitive data on direct detection that comes from the Xe-based line-up of dark matter direct detection experiments.

Please choose the session this abstract belongs to:

Plenary talk

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what we talk about when we talk about gamma-ray binaries

Author: Jian LI[1]

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Gamma-ray binaries are binary systems producing most of their electromagnetic output in gamma rays above 1 MeV. Their multi-wavelength emission are orbitally modulated from radio to TeV and there are only a handful of known gamma-ray binaries. In this talk I will try to review previous results on gamma-ray binaries and also the recent progresses.

Please choose the session this abstract belongs to:

Plenary talk

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Highlights of the LHAASO Experiment

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Review on PeVatrons

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Review on PeV acceleration

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Review on PWNs

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Highlights of the HESS Experiment

Corresponding Author: d.khangulyan@rikkyo.ac.jp

Plenary / **182**

Review on GRBs and FRBs

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Review on neutrino theory

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Review on flavor dark sector

Plenary / **191**

LIGO-Virgo-KAGRA overview and results

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The Advanced LIGO, Virgo, and KAGRA gravitational-wave detectors have now completed three observing runs, and reported dozens of detections from compact binary mergers. This talk will give an overview the current gravitational-wave detections, including events of particular scientific interest such as two possible neutron star-black hole binaries and the most massive black hole binary system to date. We will also discuss searches for gravitational-wave sources beyond compact binary coalescences.

Please choose the session this abstract belongs to:

Plenary talk

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Searches for GeV to PeV neutrinos from gravitational wave sources with IceCube

Author: Aswathi Balagopal V.[1]

[1] *IceCube Neutrino Observatory*

The IceCube Neutrino Observatory observes neutrinos of both astrophysical and atmospheric origin with energies above 100s of GeV. DeepCore, the dense infill array of IceCube, also allows us to probe neutrinos with lower energies, down to a few GeV. Using high energy (>1 TeV) and low energy (< 1 TeV) datasets curated for the search of astrophysical sources, we can conduct follow-up searches of gravitational wave transients detected by the LIGO-Virgo instruments. We present complementary analyses using these datasets to search for neutrino counterparts from the O1, O2 and O3a runs of LIGO-Virgo. The sensitivities of these analyses, along with the unblinded results of the follow-up using high-energy neutrinos will be presented.

Please choose the session this abstract belongs to:

Neutrinos

Session 1 / 193

Astrophysical Tau Neutrinos with IceCube

Author: Cowen Doug[1]

[1] *The Pennsylvania State University*

Kilometer-scale neutrino detectors, like the IceCube Neutrino Observatory deployed in the ice cap at the South Pole, are uniquely capable of detecting astrophysical tau neutrinos. IceCube has sensitivity to tau neutrinos with energies at and well above the threshold for tau lepton production, and has sufficiently large volume to contain tau leptons that travel hundreds of meters. The experiment has world-leading acceptance for astrophysical tau neutrinos at energies above roughly 100 TeV. Astrophysical tau neutrinos are likely produced by neutrino oscillations over cosmic baselines, and can be detected exclusively, through the distinctive signatures created by the tau neutrino interaction vertex and the subsequent tau lepton decay vertex. We present results of IceCube's astrophysical tau neutrino measurements, and provide projections for future improvements and possible new channels for tau neutrino detection.

Please choose the session this abstract belongs to:

Neutrinos

Session 4 / 194

PLEnuM: A global and distributed monitoring system of high-energy astrophysical neutrinos

Author: Lisa Schumacher[1]

[1] *Technical University Munich*

High-energy astrophysical neutrinos, discovered by IceCube, are now regularly observed. The observation rate remains small due to their low flux, such that open questions about high-energy neutrino astrophysics and particle physics remain limited by statistics at best, or unanswered at worst. Fortunately, this situation will improve in the next years: new neutrino telescopes will come online, which are currently planned or under construction. In order to answer open questions, we propose the Planetary Neutrino Monitoring System (PLEnuM), a concept for a global repository of high-energy neutrino observations. PLEnuM can reach more than four times the exposure available today by combining the exposures of current and future neutrino telescopes distributed around the world – IceCube, IceCube-Gen2, Baikal-GVD, KM3NeT, and P-ONE. Depending on the declination, spectral index, and flavor, PLEnuM will improve the sensitivity to astrophysical neutrinos by up to two orders of magnitude. We present first estimates on the capability of PLEnuM to discover the Galactic and extragalactic sources of astrophysical neutrinos and to characterize the diffuse flux of high-energy neutrinos in unprecedented detail.

Please choose the session this abstract belongs to:

Neutrinos

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P-ONE: pathfinder and pilot phase

Author: Christian Spannfellner[1]

[1] *Technical University Munich*

The Pacific Ocean Neutrino Experiment (P-ONE) initiative strives to push the boundaries of high-energy astronomy by creating a next-generation, large-scale neutrino telescope. In this process, P-ONE benefits highly from an already existing deep-sea infrastructure, the NEPTUNE observatory, established and in operation by Ocean Networks Canada (ONC). NEPTUNE provides power and data connections to various nodes, accessible by distinct experiments. One of these nodes, located at the Cascadia Basin in a depth of 2660 meters, is selected to host P-ONE. At this site, two pathfinder experiments, the STRAW projects, have been successfully deployed and connected in 2018 and 2020, respectively. These pathfinder mooring lines shared the goal to measure the optical and background characteristics of the Cascadia Basin. The P-ONE prototype line is the successor of these mooring lines and the next step towards the vision of P-ONE. Its main objective lies in constructing and

deploying a first P-ONE detector mooring line as proof of concept of the individual components and new technologies. We present preliminary results of the pathfinder missions and the present design of the P-ONE prototype line.

Please choose the session this abstract belongs to:

Neutrinos

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Can Galaxy Clusters Explain the Diffuse Neutrino Flux Observed by IceCube? Speaker: Mehr Un Nisa

Author: Mehr Un Nisa[1]

[1] *IceCube Neutrino Observatory*

The originating sites of astrophysical neutrinos, diffuse extragalactic gamma rays, and ultra-high energy cosmic rays remain a largely unresolved puzzle. One class of astrophysical objects that could potentially provide a unified solution to the aforementioned mystery is galaxy clusters. Clusters of galaxies have been hypothesized as reservoirs of accelerated cosmic rays, which can interact with the intra-cluster medium (ICM) to produce a steady flux of neutrinos. Using 10 years of IceCube data, we perform a search for TeV—PeV neutrinos from by stacking 1094 clusters with masses between 10^{13} \(\textup{M}*odot\) and* $\sim 10^{15}$ *\(\textup{M}*\odot\) at redshifts between 0.01 and 2, detected by the Planck mission via the Sunyaev-Zeldovich (SZ) effect. We present the results of our study that places very strong constraints on the contribution of galaxy clusters to the diffuse neutrino flux, and discuss the implications for various models of neutrino production in the aforementioned population of objects.

Please choose the session this abstract belongs to:

Neutrinos

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TAMBO: Hunting Astrophysical tau neutrinos in the Andes

Author: Pavel Zhelnin[1]

[1] *Harvard University*

IceCube' s discovery of astrophysical neutrinos, and subsequent characterization of their energy spectrum up to a few PeV, has provided a new window to the high-energy Universe. A series of next-generation experiments aim to discover neutrinos with ultra-high energies, optimizing their sensitivity in the EeV range. However, many opportunities for discovery still remain in the study of the observed astrophysical flux. In particular, only a handful of astrophysical neutrinos have been detected above 1PeV in energy, and flavor measurements remain challenging due to the difficulty of differentiating tau events from other flavors. TAMBO (Tau Air-Shower Mountain-Based Observatory) is a proposed water-Cherenkov detector set on a cliff-edge in the high Peruvian Andes. Utilizing the unique geometry of the Colca valley, TAMBO is situated to produce a high-purity sample of 1–100 PeV astrophysical tau neutrino events, providing a novel aperture into the under-explored component of the existing high-energy neutrino spectrum.

Please choose the session this abstract belongs to:

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Welcome speech

Corresponding Author: caozh@ihep.ac.cn

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Closing speech

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Announcement of TeVPA2022