Cosmic Ray Anisotropy Workshop CRA2019

Report of Contributions

Contribution ID: **14** Type: **not specified**

Constraining astrophysical models by using the energy spectrum and mass composition data measured at the Pierre Auger Observatory

Monday, 7 October 2019 15:00 (30 minutes)

The Pierre Auger Observatory, thanks to its hybrid detection technique, provides information about the energy, the mass composition and the arrival direction of ultra-high energy cosmic rays (UHECRs). Starting from a simple astrophysical scenario for origin and propagation of cosmic rays, it is possible to perform a combined fit to both the energy spectrum and the mass composition data.
We considered only events with energies above the region where the transition between Galactic and extragalactic cosmic rays is supposed to occur (E > few 10^{18} eV), hence data can be interpreted assuming a pure extragalactic origin. The adopted astrophysical model consists of identical sources uniformly distributed in a comoving volume, which accelerate nuclei through a rigidity-dependent mechanism. The fit results suggest that nuclei are injected with a hard spectrum up to a relatively low maximum energy. A quite heavy chemical composition at the acceleration sites is favoured.
The measured fluxes can be sensitive to poorly-known physical quantities relevant to the UHECRs propagation, e.g. the extra-galactic background light spectrum and the photo-disintegration cross sections of nuclei, and to the hadronic interaction models used to take into account the shower development in atmosphere. A discussion of the effects of such choices on the combined fit results will be presented.

Primary author: GUIDO, Eleonora (INFN Sezione Torino)

Presenter: GUIDO, Eleonora (INFN Sezione Torino)

Contribution ID: **15** Type: **not specified**

Anisotropy Searches with DAMPE

Monday, 7 October 2019 16:00 (30 minutes)

The DArk Matter Particle Explorer (DAMPE) is a satellite-borne experiment successfully launched in December 2015. The main scientific goal of the mission is to perform high precision measurements of the High Energy Cosmic Ray (HECR) sky looking also for Dark Matter signals. After more than three years of data taking, DAMPE has collected over 5.6 billion events.
In recent years the anisotropy of CRs results have been presented by several collaborations with the use of ground-based and space-based experiments from energies above tens of GeV up to EeV. In this work we present the sensitivity of DAMPE experiment to the anisotropy signal. We discuss the method used for anisotropy searches and present the preliminary results using the DAMPE 2016 data for all particle types at energy deposit in the calorimeter from 100 to 500 GeV. This includes studies on the different angular scales.

Primary author: STOLPOVSKIY, Mikhail (University of Geneva)

Presenter: STOLPOVSKIY, Mikhail (University of Geneva)

Contribution ID: **16** Type: **not specified**

Telescope Array search for EeV photons

Wednesday, 9 October 2019 17:10 (30 minutes)

We present the results of a search for diffuse photons with energies higher than 1 EeV based on Telescope Array surface detector data and a novel neural network event analysis technique. The results of a search for point sources of photons for all directions in the Northern hemisphere and a search for several target source classes are also presented.

Primary author: KUZNETSOV, Mikhail (ULB & INR RAS)

Co-authors: Prof. RUBTSOV, Grigory (INR RAS); Prof. KALASHEV, Oleg (INR RAS)

Presenter: KUZNETSOV, Mikhail (ULB & INR RAS)

Contribution ID: **17** Type: **not specified**

Solar Wind Interaction with the Local Interstellar Medium: Consequences for Cosmic Ray Propagation

Wednesday, 9 October 2019 11:00 (40 minutes)

We present the results of our investigation of the solar wind (SW) interaction with the local interstellar medium (LISM). The model is based on MHD treatment of ions and takes into account their charge exchange with neutral atoms. We focus on the structures that affect the Galactic cosmic ray (GCR) transport: magnetic barriers in the heliosheath, instability of the heliopause, heliospheric boundary layer of strongly depressed plasma density on the LISM side of the heliopause, the effect of the neutral solar wind on the bow wave in the LISM flow, and new discontinuities identified in the LISM at distances exceeding 2,000 au into the heliotail. Simulation results are validated by multiple observational data sets. In particular, we show strong correlation of GCR fluxes with Voyager 1 observations before it ultimately crossed the heliospheric boundary and entered the LISM. Our SW-LISM interaction pattern is also in agreement with the anisotropy of 1-10 TeV CRs observed in air shower experiments. We also discuss the properties of the SW and LISM turbulence observed in situ by the Voyager spacecraft.

Primary authors: Prof. POGORELOV, Nikolai (Department of Space Science, University of Alabama in Huntsville); Prof. ZHANG, Ming (Florida Institute of Technology); Dr CARRINGTON, Laura (University of California, San Diego); Dr FRATERNALE, Federico (Politechnico di Torino); Prof. HEERIKHUISEN, Jacob (University of Waikato, New Zealand); Dr KIM, Tae (University of Alabama in Hunstville); Dr KRYUKOV, Igor (Institute for Problems in Mechanics, Russian Academy of Sciences)

Presenter: Prof. POGORELOV, Nikolai (Department of Space Science, University of Alabama in Huntsville)

Contribution ID: **19** Type: **not specified**

Cosmic ray anisotropy study by means of muon bundles

Tuesday, 8 October 2019 16:30 (30 minutes)

In this work, muon bundles detected at the ground level are used as a tool for high energy cosmic ray anisotropy search. Due to their penetrating ability, muons with a good accuracy retain the direction of a primary particle. Long-term muon bundle registration from 2012 to 2019 was performed with the coordinate-tracking detector DECOR, which is a part of the Unique Scientific Facility "Experimental complex NEVOD" (Moscow, Russia). About 10 million events with primary energies more than 1 PeV were recorded. We describe a method which compensates the influence of the meteorological conditions on the intensity of muon bundles at the Earth surface. Results of the search of the dipole anisotropy of cosmic rays with energy more than 1 PeV are presented, and their comparison with those of other facilities is also given.

Primary author: Dr AMELCHAKOV, Mikhail (National Research Nuclear University MEPhI (Moscow Engineering Physics Institute))

Co-authors: Mrs IZHBULYAKOVA, Zarina (National Research Nuclear University MEPhI); Dr KHOKHLOV, Semen (National Research Nuclear University MEPhI); Dr KOKOULIN, Rostislav (National Research Nuclear University MEPhI)

Presenter: Dr AMELCHAKOV, Mikhail (National Research Nuclear University MEPhI (Moscow Engineering Physics Institute))

Contribution ID: **20** Type: **not specified**

Expected arrival-direction correlations between ultra-high-energy cosmic rays and high-energy neutrinos

Thursday, 10 October 2019 16:40 (30 minutes)

The discovery of a diffuse flux of astrophysical neutrinos by IceCube has opened up new possibilities for the search of cosmic-ray sources. The sources that accelerate cosmic rays to extreme energies are most-likely also high-energy neutrino emitters. To find such sources one can look for correlations in arrival directions between astrophysical neutrinos and ultra-high-energy cosmic rays (UHECRs). However, UHECRs are deflected by magnetic fields on their way from their sources to Earth, and are subject to energy-loss processes (resulting in a maximum distance from which they can arrive). We investigate how these effects influence the expected probability to find correlations between high-energy neutrinos and UHECRs, depending on the evolution with redshift of the sources. The possibility to observe correlations between UHECRs and neutrinos is already strongly constrained by the absence of neutrino multiplets in the IceCube measurements. However, if connections between neutrinos and cosmic rays are measured, it would give a precise indication for the local density of the emitters.

Primary authors: VAN VLIET, Arjen (DESY Zeuthen); Dr PALLADINO, Andrea (DESY Zeuthen); Dr WINTER, Walter (DESY Zeuthen); Dr FRANCKOWIAK, Anna (DESY Zeuthen)

Presenter: VAN VLIET, Arjen (DESY Zeuthen)

Contribution ID: **22** Type: **not specified**

Detection of a gamma-ray halo around Geminga with the Fermi-LAT and implications for the positron flux

Thursday, 10 October 2019 15:00 (30 minutes)

An excess in the flux of cosmic positrons at Earth above 10 GeV has been measured by Pamela, Fermi-LAT and with unprecedented precision by AMS-02. The observed flux cannot be explained by the production of positrons in the spallation reaction of hadronic cosmic rays with the interstellar medium. Various interpretations have been invoked to explain this excess, such as the production in Galactic supernova remnants and pulsar wind nebulae (PWNe) or, intriguinly, in the dark matter halo of the Milky Way. Recently, Milagro and HAWC experiments reported the detection of an extended gamma-ray emission from Geminga and Monogem PWNe at TeV energies. These nearby and powerful PWNe have been widely considered as the main candidates to contribute to the cosmic positrons at Earth. Severe constraints for a significant PWNe contribution to the positron excess can be derived from this gamma-ray emission, which has been interpreted as coming from the electrons and positrons accelerated in the PWNe and undergoing inverse Compton scattering in the interstellar medium. Moreover, the size of extension of these halos suggests that the diffusion around PWNe is about two orders of magnitude less intense than the value assumed to fit the cosmic-rays measured by AMS-02. In this contribution we report the first detection of a significant emission from the Geminga halo at GeV energies in Fermi-LAT data, derived by including the proper motion of its pulsar. We present a detailed study of the gamma-ray halo around Geminga and Monogem, and show the constraints found for the contribution of these PWNe to the positron excess, combining Milagro and HAWC data with measurements from the Fermi-LAT for the first time. The size of extension and the consequences for the diffusion coefficient in these halos at GeV energies are also explored. We demonstrate that using gamma-ray data from the LAT is of central importance to provide a precise estimate for the PWN contribution to the cosmic positron flux.

Primary author: MANCONI, Silvia

Co-authors: DONATO, Fiorenza (University of Turin); DI MAURO, Mattia (NASA)

Presenter: MANCONI, Silvia

Contribution ID: **23** Type: **not specified**

Unveil the origin of cosmic-ray leptons within a coherent multi-channel propagation scenario

Thursday, 10 October 2019 14:30 (30 minutes)

The interpretation of cosmic-ray (CR) data still represents a major challenge that experiments have to face: a coherent interpretation of the measured CR spectra is hampered by our incomplete knowledge about both the acceleration mechanisms and the transport properties across the Galaxy. The main challenge in this context is to identify a unified picture that includes all the available observables. To this aim, we first perform a multi-channel fit of the available CR data based on the DRAGON numerical code, to set the relevant propagation parameters. On top of that, we discuss several physically-motivated possibilities (i.e. recent burst, constant injection, time-dependent emission) for the injection of e^+e^- pairs accelerated at nearby antimatter factories, such as pulsar wind nebulae, and compute their propagation. Finally, we address the all-lepton spectrum and assess the contributions of both young, nearby supernova remnants, and possibly an additional hidden source, to the observed CR lepton flux above ~ 1 TeV recently measured by H.E.S.S., VERITAS, CALET and DAMPE.

Primary authors: Dr GAGGERO, Daniele (IFT Madrid); Mr FORNIERI, Ottavio (University of Siena/IFT Madrid); Dr GRASSO, Dario (INFN Pisa)

Presenter: Mr FORNIERI, Ottavio (University of Siena/IFT Madrid)

Contribution ID: **25** Type: **not specified**

Particle escape in middle-aged SNRs

Tuesday, 8 October 2019 12:00 (30 minutes)

The escape process of particles accelerated at supernova remnant (SNR) shocks is one of the poorly understood aspects of the shock acceleration theory. In this talk I will describe a phenomenological approach to study the particle escape and its impact on the gamma-ray spectrum resulting from hadronic collisions both inside and outside of a middle-aged SNR. Under the assumption that in the spatial region immediately outside of the remnant diffusion is suppressed with respect to the average Galactic one, I will show that a significant fraction of particles are still located inside the SNR long time after their nominal release from the acceleration region. This fact results into a gamma-ray spectrum that resembles a broken power law, similar to those observed in several middle-aged SNRs. Above the break, the spectral steepening is determined by the diffusion coefficient outside of the SNR and by the time dependency of the maximum energy. Consequently, the comparison between the model prediction and actual data will contribute to determining these two quantities, the former being particularly relevant within the predictions concerning the gamma-ray emission from the halo of escaping particles around SNRs which could be detected with future Cherenkov telescope facilities.

Primary author: CELLI, Silvia

Presenter: CELLI, Silvia

Contribution ID: **26** Type: **not specified**

Recent progress in solar modulation modelling in light of new cosmic-ray data from AMS-02

Wednesday, 9 October 2019 16:40 (30 minutes)

After entering the Galactic cosmic rays (CRs) into the heliosphere, their intensities decrease during their propagation toward the Earth. This effect is subjected to a variety of physical processes through their propagation which referred to as CR solar modulation. The key ingredients in the study of this phenomenon are the knowledge of the local interstellar spectrum (LIS) of Galactic cosmic rays and the understanding of how the solar modulation affects the LIS inside the heliosphere. For this purpose, here we present an improved data-driven description of the solar modulation phenomenon, that is, the temporal evolution of the CR flux inside the heliosphere caused by the 11-year variability cycle of the Sun's magnetic activity. The model was applied to the Galactic proton flux measured by Voyager 1, AMS-02 and PAMELA missions which provide valuable information, allowing us to shed light on the shape of the LIS and the details of the solar modulation for the time period from mid-2006 to mid-2017. The new results for the temporal dependence of the key model parameters, their relationship with solar activity proxies, the implications for the CR transport in magnetic turbulence, and the new insights on our understanding of the solar modulation effect are presented.

Primary authors: Dr KHIALI, Behrouz (INFN, Sez. di Tor Vergata, SSDC-ASI); Prof. BERTUCCI, Bruna (Perugia University , INFN Sez. Di Perugia); Prof. FIANDRINI, Emanuele (Perugia University , INFN Sez. Di Perugia); Dr TOMASSETTI, Nicola (Perugia University , INFN Sez. Di Perugia)

Presenter: Dr KHIALI, Behrouz (INFN, Sez. di Tor Vergata, SSDC-ASI)

Contribution ID: **27** Type: **not specified**

Recent results from the Tibet ASgamma experiment and related topics

Tuesday, 8 October 2019 14:30 (30 minutes)

The Tibet air shower array is located at 4,300 m above sea level, Tibet, China.
In 2014, an array of underground muon detectors is added under the surface
air shower array. We would like to present recent results from the Tibet
ASgamma experiment on cosmic ray anisotropy, Sun shadow, and gamma-ray observation, together with some related topics.

Primary authors: Dr TAKITA, Masato (ICRR, the University of Tokyo); THE TIBET ASGAMMA COLLABORATION

Presenter: Dr TAKITA, Masato (ICRR, the University of Tokyo)

Contribution ID: **61** Type: **not specified**

The true anisotropy of TeV cosmic rays in the local interstellar medium

Wednesday, 9 October 2019 12:20 (40 minutes)

The Earth resides deep in the heliosphere. The trajectories of CRs measured in air shower experiments are affected by the electromagnetic fields of the heliosphere and disturbed LISM surrounding it. This may severely distort anisotropy maps. To study the properties of interstellar CRs, we should first remove the heliospheric influence. Recent advances in the heliospheric modeling based on observations from Voyager and IBEX have made it possible. In this paper, we reconstruct the anisotropy of TeV CRs in the pristine LISM. The results show a potential source of CR anisotropy and shed light onto the mechanisms of CR transport in the ISM.

Primary author: Prof. ZHANG, Ming (Florida Institute of Technology)

Co-authors: HU, Hongbo; POGORELOV, Nikolai (Department of Space Science, University of Alabama in Huntsville); SCHLICKEISER, Reinhard; ZHANG, Yi

Presenter: Prof. ZHANG, Ming (Florida Institute of Technology)

Contribution ID: **62** Type: **not specified**

Search For PeV Gamma Ray Emission with IceCube Observatory

PeV gamma rays experience strong attenuation due to interaction with the cosmic microwave background, thus allowing access only up to Galactic distances. However, their hadronic origin implies that a measurement of the diffuse PeV emission from the Galactic plane can inform on the cosmic-ray propagation mechanisms as well as cosmic-ray spectrum elsewhere within the Galaxy. Moreover, a successful source detection would point to a Galactic accelerator capable of accelerating cosmic rays up to at least a few PeV. The IceCube observatory and its surface air shower array, IceTop, can detect the extensive air showers produced by PeV gamma rays entering Earth's atmosphere. Air shower footprint from IceTop and TeV muon signal from the deep ice detector are used to distinguish muon-poor gamma ray showers from the highly abundant cosmic rays. In this talk, I will present results from the search for diffuse PeV emission from the Galactic plane and the search for point-like sources in IceCube's field of view.

Primary author: PANDYA, Hershal (Vrije Universitiet Brussel)

Presenter: PANDYA, Hershal (Vrije Universitiet Brussel)

Contribution ID: **63** Type: **not specified**

Using Machine Learning to Interpret Arrival Directions of Ultra-high-energy Cosmic Rays

Tuesday, 8 October 2019 16:00 (30 minutes)

We propose a machine-learning-based method to test various
hypotheses about possible sources of ultra-high-energy cosmic rays (UHECR)
using their arrival directions. We test the discriminating power of
the method on the recently proposed realistic UHECR origin scenario [1], assuming several particular nearby active galaxies as source candidates.

[1] Phys.Rev. D96 (2017) no.8, 083006

Primary authors: KALASHEV, Oleg (Institute for Nuclear Research RAS, Moscow, Russia); PSHIRKOV, Maxim (Moscow, INR & Sternberg Astron. Inst.); ZOTOV, Mikhail (SINP, Moscow)

Presenter: KALASHEV, Oleg (Institute for Nuclear Research RAS, Moscow, Russia)

Contribution ID: **64** Type: **not specified**

Diffusive shock reacceleration at Supernova remnant shocks

Tuesday, 8 October 2019 15:00 (30 minutes)

Diffusive shock acceleration has been successful in describing many aspects of particle acceleration at strong shocks. In the standard description, thermal particles are energized as they cross a shock and complete cycles of Fermi acceleration. Additionally, it has been proposed that non—thermal particles placed upstream of a shock can also be energized. This process, already discussed in Bell 1978, is known as diffusive shock reacceleration, and has recently been shown to be of importance, as for example to account for the non-trivial behavior of the secondary-to-primary Boron-to-Carbon ratio.

In this contribution, we propose to discuss the importance of particle reacceleration at SNR shocks, and on the subsequent gamma—ray emission from reaccelerated particles.

Primary author: Dr CRISTOFARI, Pierre (GSSI)

Co-author: BLASI, Pasquale (GSSI)

Presenter: Dr CRISTOFARI, Pierre (GSSI)

Contribution ID: **65** Type: **not specified**

Studies of a possible large-scale anisotropy of UHECRs with future orbital detectors

Monday, 7 October 2019 16:30 (30 minutes)

We study capabilities of future orbital detectors of ultra-high-energy cosmic rays (UHECRs) like KLYPVE (K-EUSO) and POEMMA to reveal a large-scale anisotropy of their arrival directions at energies beyond ~50 EeV assuming a nearby active galactic nucleus provides a noticeable fraction of the total flux. We find that such a detector with a uniform exposure of the whole celestial sphere will be able to reveal an anisotropy at high confidence level providing it registers ~300 or more UHECRs and the fraction of the flux coming from a nearby source is of the order of 10%. We also demonstrate that such an anisotropy does not manifest itself clearly at energies above ~8 EeV, contrary to the dipole anisotropy found recently by the Pierre Auger Observatory, so that it can escape from being found by the existing ground-based experiments.

Primary authors: KALASHEV, Oleg (Institute for Nuclear Research RAS, Moscow, Russia); PSHIRKOV, Maxim (Moscow, INR & Sternberg Astron. Inst.); ZOTOV, Mikhail

Presenter: ZOTOV, Mikhail

Contribution ID: **66** Type: **not specified**

Cosmic-Ray Anisotropy and Extended Gamma-Ray Emissions as Probes of Cosmic-Ray Transport

Thursday, 10 October 2019 11:40 (40 minutes)

We calculate the shape of the anisotropy of TeV-PeV cosmic-rays (CR) in different models of the interstellar turbulence. In general, the large-scale CR anisotropy (CRA) is not a dipole, and its shape can be used as a probe of the turbulence and CR transport properties. The 400 TeV and 2 PeV data sets of IceTop can be fitted with Goldreich-Sridhar turbulence and a broad resonance function, but other possibilities are not excluded. We then present our first numerical calculations of the CRA down to 3 TeV energies in 3D Kolmogorov turbulence. At these low energies, the large-scale CRA aligns well with the direction of local magnetic field lines around the observer. In this type of turbulence, the CR intensity is flat in a broad region perpendicular to field lines. Even though the CRA is quite gyrotropic, we show that the local configuration of the turbulence around the observer does result in the appearance of weak, "non-gyrotropic" small-scale anisotropies, which contain information on the local turbulence level.
Finally, we show how extended gamma-ray emissions around CR sources can be used to extract information on the interstellar turbulence and CR transport properties. As an example, we use HAWC measurements to place constraints on the properties of the magnetic fields within $\simeq 25$ pc from Geminga pulsar. We also study the impact of CR-driven instabilities on the turbulence around CR sources, and show how one could use gamma-ray emissions to study these instabilities.

Primary author: Dr GIACINTI, Gwenael (MPIK Heidelberg)

Presenter: Dr GIACINTI, Gwenael (MPIK Heidelberg)

Contribution ID: **69** Type: **not specified**

Anisotropy Variability Induced by the Chaotic Behavior of Cosmic Rays in Magnetic Bottles.

Wednesday, 9 October 2019 16:10 (30 minutes)

Cosmic rays propagate through the galaxy and in doing so, magnetic fields can generate chaotic behavior in their trajectories. Occasionally, these particles can get temporarily trapped in magnetic bottles, which affect the overall description of their propagation. As a result, anisotropy in the arrival distribution at Earth can emerge. In this work, we will show how the chaotic behavior of particles can be characterized by using the Finite-Time Lyapunov Exponents. Concretely, we will study cosmic rays trapped in a magnetic bottle that is subjected to different time perturbations, using the heliosphere as our motivation. Here, we also suggest that time-variability in the anisotropy can be a relevant factor in the understanding of how cosmic rays arrive at the Earth.

Primary authors: LOPEZ-BARQUERO, Vanessa (University of Wisconsin-Madison); DESIATI, Paolo (University of Wisconsin-Madison)

Presenter: LOPEZ-BARQUERO, Vanessa (University of Wisconsin-Madison)

Contribution ID: **70** Type: **not specified**

Relativistic charged particle diffusion in turbulent fields: synthetic vs dynamically-generated fields

Wednesday, 9 October 2019 15:10 (30 minutes)

The transport of high-energy cosmic rays in the Galaxy (energy about 10^{17} eV for protons) can be approached by means of numerical simulations, where relativistic charged test-particles propagate in a prescribed turbulent magnetic field. Thanks to the improvement in the computing capabilities, it is nowadays possible to investigate the particle propagation by using direct computations of the electromagnetic field performed through magnetohydrodynamic (MHD) simulations.

Here, by comparing the results obtained by adopting a synthetic model of turbulence or the fields produced through MHD simulations, we are able to analyze several important features, such as the rigidity dependence of the diffusion coefficient with and without a background magnetic field, the role of compressible fluctuations as well as the effects produced by intermittency.

Primary authors: PEZZI, Oreste (GSSI); BLASI, Pasquale (GSSI); EVOLI, Carmelo (GSSI); SERVIDIO, Sergio (Università della Calabria); PRIMAVERA, Leonardo (Università della Calabria)

Presenter: PEZZI, Oreste (GSSI)

Contribution ID: **71** Type: **not specified**

Effects of the Galactic magnetic field on the spectrum, composition and arrival direction of cosmic rays

Thursday, 10 October 2019 17:10 (30 minutes)

The energy spectrum of cosmic rays is one of the central measurements in cosmic ray physics. Mostly following a power law relation, it contains small breaks at the higher end of the energy range. Of particular importance are the so-called “knee” at around 5 PeV, where the spectrum softens, the “ankle” at around 5 EeV, where it hardens again, and a high-energy cut-off at around 50 EeV. The energy range between the knee and the ankle is where the transition from Galactic cosmic rays (GCRs) to extragalactic cosmic rays (EGCRs) is expected to occur; the knee is considered to be the point where the maximum rigidity of known GCR accelerators is reached for protons, whereas the ankle is thought to represent the point where the extragalactic component begins to dominate, as all Galactic accelerators are exhausted past this point. However, fits to the spectrum using current Galactic and extragalactic acceleration and propagation models, fail to describe the measured flux in this region, leaving the details of the transition poorly understood.
I wish to present results from simulations with the Monte Carlo-based cosmic ray propagation software CRPropa3 of the effects of the Galactic magnetic field (GMF) on cosmic rays that are expected from the rigidity-dependence of the degree of deflection in a magnetic field. They include the shielding of EGCRs from the Galaxy for low rigidities and a concentration effect in the Galactic plane for intermediate rigidities
as well as the gradual escape of GCRs from the Galaxy with increasing rigidity, due to the increasing strength of the GMF increases towards lower Galactic latitudes. These effects all occur at ridigites within the transition region and beyond the ankle, so this study may provide a better understanding of the transition from GCRs to EGCRs by potentially reproducing observed features in the spectrum, composition and the arrival direction distribution, such as the spectral hardening, the “lightening” of the composition and anisotropies.

Primary author: KÄÄPÄ, Alex (University of Wuppertal)

Presenter: KÄÄPÄ, Alex (University of Wuppertal)

Contribution ID: **72** Type: **not specified**

Anisotropy results from Telescope Array

Monday, 7 October 2019 14:30 (30 minutes)

The latest results of anisotropy searches with the Telescope Array will be presented, including the current status of the hot spot, spectrum declination dependence, search for energy-ordered clusters, correlation with supergalactic plane.

Primary author: TINIAKOV, Petr (Universite Libre de Bruxelles)

Presenter: TINIAKOV, Petr (Universite Libre de Bruxelles)

Contribution ID: **73** Type: **not specified**

The origin of the ultra-high energy cosmic-ray dipole

Friday, 11 October 2019 09:00 (40 minutes)

Although their astrophysical sources remain a mystery, new measurements brought by experiments such as the Pierre Auger Observatory and Telescope Array have radically improved our knowledge of the ultra-high energy cosmic-rays (UHECRs). I will present new results on the interpretation of the first significant UHECR anisotropy: a ~7% dipole, recently reported by Auger for cosmic rays above 8 EeV.

Primary author: GLOBUS, Noemie (New York University/Flatiron Institute)

Presenter: GLOBUS, Noemie (New York University/Flatiron Institute)

Contribution ID: **74** Type: **not specified**

MHD turbulence effects on energetic particle transport and acceleration

Thursday, 10 October 2019 11:00 (40 minutes)

TBA

Primary author: MATTHAEUS, William (University of Delaware)

Presenter: MATTHAEUS, William (University of Delaware)

Contribution ID: **76** Type: **not specified**

Observation and Interpretation of Small-Scale Cosmic-Ray Anisotropies

Thursday, 10 October 2019 09:00 (40 minutes)

The arrival directions of Galactic cosmic rays are highly isotropic. This is expected from the presence of turbulent magnetic fields in our Galactic environment that repeatedly scatter charged particles during propagation. However, various cosmic ray observatories have identified weak anisotropies of various angular sizes and with relative intensities of up to a level of 1 part in 1,000. Whereas large-scale anisotropies are generally predicted by standard diffusion models, the appearance of small-scale anisotropies down to an angular size of 10 degrees is surprising. In this talk I will summarise the current experimental status of Galactic cosmic ray anisotropies and review theoretical ideas for the origin of small-scale anisotropies.

Primary author: AHLERS, Markus (Niels Bohr Institute)

Presenter: AHLERS, Markus (Niels Bohr Institute)

Contribution ID: **77** Type: **not specified**

Magnetic fields in the Milky Way

Wednesday, 9 October 2019 14:30 (40 minutes)

I will present a quick summary of the current state of knowledge of interstellar magnetic fields in the Milky Way. I will focus on their turbulent component, which plays a decisive role in the acceleration, propagation and confinement of cosmic rays. I will discuss some recent observational breakthroughs, describe the theoretical tools that were developed to interpret radio observations, and summarize what we have ultimately learned from the new observations/

Primary author: KATIA, Ferrière (Observatoire Midi-Pyrenées, Toulouse (France))

Presenter: KATIA, Ferrière (Observatoire Midi-Pyrenées, Toulouse (France))

Contribution ID: **78** Type: **not specified**

Surveying the Interstellar Magnetic Field within 40 parsecs with Polarized Starlight

Thursday, 10 October 2019 16:00 (40 minutes)

An international group of scientists is mapping the configuration of the very local interstellar magnetic field (ISMF) utilizing high-sensitivity measurements of starlight that becomes linearly polarized while traversing a medium containing magnetically aligned interstellar dust grains. High-sensitivity polarization data for over 500 nearby stars reveal that the local interstellar medium within 40 pc contains magnetic filaments, some extending over 90 degrees in angle. We discuss the relation between these filaments and kinetically-defined local interstellar clouds, and similarities between a filament and the ISMF shaping the heliosphere as deduced from the IBEX ribbon of energetic neutral hydrogen atoms. The polarizations indicate that magnetic filaments, common throughout the interstellar medium, also extend into the immediate solar environment. These new polarization data have been collected at eight observatories located in both the northern and southern hemispheres; half of the new polarization data were collected with the DIPOL instruments.

Primary author: FRISCH, Priscilla C. (University of Chicago)

Presenter: FRISCH, Priscilla C. (University of Chicago)

Contribution ID: **79** Type: **not specified**

Modelling interstellar turbulence with anisotropy studies: options and difficulties

Thursday, 10 October 2019 12:20 (40 minutes)

We report on recent simulations of small-scale anisotropy and its relation to the properties of interstellar turbulence. Emphasis will be placed on potential systematics in Monte-Carlo simulations of particle trajectories. We also describe a possible avenue to distinguish the contributions of the heliosphere and the local interstellar medium to the observed small-scale anisotropy of TeV-band cosmic rays.

Primary author: POHL, Martin

Presenter: POHL, Martin

Contribution ID: **80** Type: **not specified**

Global Anisotropies in TeV Cosmic Rays Related to the Sun's Local Galactic Environment from IBEX

Wednesday, 9 October 2019 11:40 (40 minutes)

The Interstellar Boundary Explorer (IBEX) observes enhanced Energetic Neutral Atom emission from a narrow "ribbon" centered on the local interstellar medium (LISM) magnetic field direction. IBEX has improved knowledge of the local interstellar velocity based on interstellar atom measurements and provides global views of the structure of the evolving heliosphere.
These determinations are consistent with the interstellar modulation of high energy (TeV) cosmic rays and diffusive propagation from supernova sources revealed in global anisotropy maps of ground-based high-energy cosmic-ray instruments (Milagro, Asγ and IceCube). We discuss recent observations of the global heliosphere, the ribbon, and the properties of the local interstellar medium, which have implications for observed global anisotropies in TeV cosmic rays.

Primary author: Dr SCHWADRON, Nathan (University of New Hampshire, Princeton University)

Presenter: Dr SCHWADRON, Nathan (University of New Hampshire, Princeton University)

Contribution ID: **81** Type: **not specified**

Cosmic ray propagation in the Galaxy: the role of self-confinement

Tuesday, 8 October 2019 11:00 (40 minutes)

Understanding the transport of charged particles in the Galaxy is fundamental to solve the mystery of the origin of Galactic cosmic rays (CR) and to asses their role in several Galactic processes. Recent results from direct experiments, especially AMS-02 and PAMELA, are revealing a fine structure in the CR spectrum which is difficult to explain in the standard picture of Galactic propagation. Some of these features could be understood when the self generated turbulence is taken into account. When CR propagate through a plasma they can trigger the streaming instability which produces resonant Alfvén waves modifying the diffusive properties of the plasma and changing the CR transport itself in a complex non-linear fashion. In this talk I will highlight the role of this self-generated turbulence in several context of the CR journey: during the escape from their sources, close to molecular clouds and during the escape from the Galactic disk.

Primary author: MORLINO, Giovanni (Gran Sasso Science Institute)

Presenter: MORLINO, Giovanni (Gran Sasso Science Institute)

Contribution ID: **82** Type: **not specified**

Anisotropies in the flux of cosmic ray leptons

Tuesday, 8 October 2019 09:00 (40 minutes)

The cosmic electrons and positrons have been measured with unprecedented statistics up to several hundreds GeV, thus permitting to explore the role that close single sources can have in shaping the flux at different energies.
The Fermi-LAT Collaboration has provided a new energy spectrum for the upper bounds on the e+ + e- dipole anisotropy. This observable can bring information on the emission from local Galactic sources, notably measured with high precision at radio frequencies. We develop a framework in which e+ and e- measured at Earth from GeV up to tens of TeV energies have a composite origin. We discuss in particular the constraints imposed by the most recent data on the e+ + e- dipole anisotropy.

Primary author: DONATO, Fiorenza (University of Turin)

Co-authors: MANCONI, Silvia; DI MAURO, Mattia (NASA)

Presenter: DONATO, Fiorenza (University of Turin)

Contribution ID: **83** Type: **not specified**

Full-Sky Cosmic-Ray Anisotropy with HAWC and IceCube

Monday, 7 October 2019 12:20 (40 minutes)

We present the joint analysis of the arrival direction distribution of Galactic cosmic rays by the High-Altitude Water Cherenkov and IceCube Neutrino observatories at the same median primary particle energy of 10 TeV. The combined sky map and angular power spectrum largely eliminate biases that result from partial sky coverage. The trajectories and observed distribution of particles are distorted by magnetic structures of scales comparable to their gyro-radii such as the heliosphere and the local interstellar magnetic field. We infer the direction of the interstellar magnetic field from the boundary between large scale excess and deficit regions. Using the field direction, we then estimate the 'vertical' dipole component of the large scale anisotropy which is generally not observable by ground-based detectors.

Primary authors: DÍAZ VÉLEZ, Juan Carlos (University of Wisconsin-Madison); DESIATI, Paolo (University of Wisconsin-Madison); AHLERS, Markus (Niels Bohr Institute)

Presenter: DÍAZ VÉLEZ, Juan Carlos (University of Wisconsin-Madison)

Contribution ID: **85** Type: **not specified**

Recent Cosmic Ray Observations from Voyagers 1 and 2

Wednesday, 9 October 2019 09:40 (40 minutes)

Voyagers 1 and 2 are now both in the interstellar medium. Voyager 1 crossed the heliopause on 25 August 2012 and Voyager 2 recently crossed on 5 November 2018. We find that the energy spectra of H, He, and electrons, which for the first time are being measured unaffected by the effects of solar modulation, are essentially identical at the two spacecraft. This implies that there are no significant gradients of these particles over a distance of ~167 AU in the local interstellar medium. We review some of the results contained in Cummings et al., ApJ, 2016, including the estimates of the energy density of cosmic rays and of the ionization rates of atomic H in the interstellar medium by cosmic rays. We also present preliminary spectra of a significant number of isotopes. With respect to the crossings of the heliopause by the two spacecraft, we compare observations at Voyager 2 with those at Voyager 1 and report on several differences. Finally, we report on the anisotropy of a few hundred MeV protons, which is observed by Voyager 1 much of the time in the local interstellar medium.
This work was supported by NASA under contract NNN12AA01C.

Primary author: CUMMINGS, Alan (Caltech, Pasadena US)

Co-authors: STONE, Edward (Caltech, Pasadena US); HEIKKILA, Bryant (Goddard Space Flight Center); LAL, Nand (Goddard Space Flight Center)

Presenter: CUMMINGS, Alan (Caltech, Pasadena US)

Contribution ID: **86** Type: **not specified**

On Cosmic Ray transport in the magnetized Interstellar Medium: a bias towards microphysics.

Tuesday, 8 October 2019 09:40 (40 minutes)

Under the effect of magnetic turbulence Cosmic Rays (CRs) adopt a random walk during their journey from their sources to the Earth. The talk addresses the interplay between the turbulence and Cosmic Rays. At first we will examine the effect of turbulence over Cosmic Ray transport through the derivation of diffusion coefficients. We will discuss the impact of the turbulence injected at large scales. Then we will discuss the effect of Cosmic rays over turbulence through the triggering of different plasma instabilities. These effects are likely important for the propagation of CRs with energies below a few hundred of GeV. But we will see that in sources self-generated turbulence is mandatory to explain CR acceleration. Finally we will discuss how to handle in the same framework CR transport and turbulence generation, this is now possible mainly because of some recent progresses in some numerical modeling combining kinetic and magnetohydrodynamics. In each these three steps we will discuss some connection to the study of CR anisotropy.

Primary author: MARCOWITH, Alexandre (Universite Montpellier)

Presenter: MARCOWITH, Alexandre (Universite Montpellier)

Contribution ID: **87** Type: **not specified**

Opening talks

Monday, 7 October 2019 09:00 (40 minutes)

Contribution ID: **88** Type: **not specified**

Recent Advances in (Galactic) Cosmic Ray Observations

Monday, 7 October 2019 09:40 (40 minutes)

Primary author: Prof. DE MITRI, Ivan (Gran Sasso Science Institute (GSSI) and INFN)

Presenter: Prof. DE MITRI, Ivan (Gran Sasso Science Institute (GSSI) and INFN)

Contribution ID: **89** Type: **not specified**

Discussion

Friday, 11 October 2019 11:40 (1h 20m)

Primary author: MOSKALENKO, Igor (Stanford)

Contribution ID: **90** Type: **not specified**

Local sources, the Local Bubble and the CR anisotropy

Friday, 11 October 2019 09:40 (40 minutes)

The contribution of a single source to the observed cosmic ray (CR) dipole anisotropy depends only on the fraction the source contributes to the total CR intensity, its age and its distance, but not on the energy. Therefore the observation of a constant dipole anisotropy indicates that importance of single, local sources. I review some source types suggested as, e.g., Vela, a 2 Myr old supernova or young pulsars, and their signatures. Finally, I discuss how this picture is modified if the magnetic field structure of the Local Bubble distorts the CR flux.

Primary author: KACHELRIESS, Michael (NTNU)

Presenter: KACHELRIESS, Michael (NTNU)

Contribution ID: **91** Type: **not specified**

Time-dependent models for cosmic ray propagation

Friday, 11 October 2019 11:00 (40 minutes)

TBA

Primary author: MOSKALENKO, Igor (Stanford)

Presenter: MOSKALENKO, Igor (Stanford)

Contribution ID: **92** Type: **not specified**

Cosmic Ray Anisotropies with space-based detectors

Monday, 7 October 2019 11:00 (40 minutes)

In the last years, Cosmic Ray Physics has profited from the rise in space research and space-based experiments are currently providing direct measurements with unprecedented precision. In particular, the measurement of the anisotropy may provide complementary information to the features observed in the spectra of
several cosmic ray species.
In this talk, an overview of the latest results on the cosmic ray anisotropy studies performed by space-based detectors will be presented.

Primary author: VELASCO, Miguel Angelo (CIEMAT)

Presenter: VELASCO, Miguel Angelo (CIEMAT)

Contribution ID: **93** Type: **not specified**

Anisotropy of ultra-high energy cosmic rays

Monday, 7 October 2019 11:40 (40 minutes)

Important observational results have been recently reported on the angular distributions of cosmic rays at ultra-high energies, calling into question their perception a decade ago. The extragalactic origin of the particles has been determined observationally. While no discrete source of ultrahigh-energy cosmic rays has been identified so far, the noose is tightening around nearby extragalactic objects. These results together with their in-progress interpretations are summarized in this contribution, covering both large-scale and small-scale anisotropies from sub-EeV energies to the highest ones. Some prospects are finally discussed.

Primary author: DELIGNY, Olivier (Institut de Physique Nucléaire d'Orsay)

Presenter: DELIGNY, Olivier (Institut de Physique Nucléaire d'Orsay)

Contribution ID: **94** Type: **not specified**

What can the cosmic ray composition tell us about the acceleration site

Wednesday, 9 October 2019 09:00 (40 minutes)

I will present some thoughts about the possible relation between the acceleration site of Galactic cosmic rays and the “anomalies” observed in their bulk source composition (like the Ne22/Ne20 excess and the recently detected abundance of radioactive Fe60).

Primary author: PRANTZOS, Nikos (IAP)

Presenter: PRANTZOS, Nikos (IAP)

Contribution ID: **95** Type: **not specified**

Cosmic ray small-scale anisotropies in quasi-linear theory

Thursday, 10 October 2019 09:40 (40 minutes)

The paradigm for wave-particle interactions in cosmic ray physics, quasi-linear theory, cannot describe the small-scale anisotropies observed with high-precision observatories like IceCube and HAWC. This can be traced back to the loss of two-particle correlations when only the ensemble-averaged phase-space density is modelled.

After a brief review of standard quasi-linear theory, we consider two-particle correlations in a systematic and perturbative approach. We determine the angular power spectrum as the steady state of a differential equation describing the correlated transport of pairs of particles. As an example, we consider a toy model of isotropic turbulence and verify our result with numerical simulations. Our angular power spectrum compares favourably with data from the IceCube and HAWC observations.

Primary author: MERTSCH, Philipp (RWTH Aachen University)

Presenter: MERTSCH, Philipp (RWTH Aachen University)

Contribution ID: **96** Type: **not specified**

Discussion

Tuesday, 8 October 2019 12:30 (30 minutes)