

# Cosmic Ray Anisotropy Workshop 2023



**CRA** 2023

May 16-19, 2023  
Loyola University - Chicago

sixth Cosmic Ray Anisotropy Workshop



## Report of Contributions

Contribution ID: 7

Type: **not specified**

## Registration

*Tuesday, 16 May 2023 08:00 (30 minutes)*

Contribution ID: 8

Type: **not specified**

## Welcome

*Tuesday, 16 May 2023 08:30 (15 minutes)*

**Presenter:** ABBASI, Rasha (Loyola University Chicago)

Contribution ID: **10**

Type: **not specified**

## **Transport of Galactic Cosmic-Ray Nuclei**

*Tuesday, 16 May 2023 15:10 (35 minutes)*

**Presenter:** SCHROER, Benedikt

Contribution ID: 11

Type: **not specified**

## **Cosmic rays in a turbulent interstellar medium: Recent progress and open questions**

*Tuesday, 16 May 2023 16:15 (45 minutes)*

**Presenter:** MERTSCH, Philipp

Contribution ID: 12

Type: **not specified**

## **Indirect Measurements of galactic Cosmic Rays**

*Tuesday, 16 May 2023 11:45 (35 minutes)*

**Presenter:** DI SCIASCIO, Giuseppe

Contribution ID: 13

Type: **not specified**

## **Recent Progress in Direct Measurements of Cosmic Rays (remote)**

*Tuesday, 16 May 2023 10:05 (35 minutes)*

**Primary author:** SEO, Eun-Suk (University of Maryland)

**Presenter:** SEO, Eun-Suk (University of Maryland)

Contribution ID: 14

Type: **not specified**

## CR anisotropy with IceCube

*Tuesday, 16 May 2023 14:35 (35 minutes)*

**Presenters:** MCNALLY, Frank (Mercer University); ABBASI, Rasha (Loyola University Chicago)



Contribution ID: 15

Type: **not specified**

## **CR anisotropy with IceTop - Rasha Abbasi**

Contribution ID: **16**

Type: **not specified**

## Registration

*Wednesday, 17 May 2023 08:00 (45 minutes)*

Contribution ID: 17

Type: **not specified**

## **Selected Aspects of Magnetized Turbulence (with implications for CRs)**

*Wednesday, 17 May 2023 08:45 (45 minutes)*

**Presenter:** LAZARIAN, Alex

Contribution ID: **18**

Type: **not specified**

## **Second order Fermi Acceleration in Galaxy Clusters**

*Wednesday, 17 May 2023 09:30 (30 minutes)*

**Presenter:** BRUNETTI, Gianfranco

Contribution ID: 19

Type: **not specified**

## **CR Acceleration in Turbulent Magnetic Reconnection (remote)**

*Wednesday, 17 May 2023 10:00 (30 minutes)*

**Primary author:** DE GOUVEIA DAL PINO, Elisabete (IAG - Universidade de São Paulo)

**Presenter:** DE GOUVEIA DAL PINO, Elisabete (IAG - Universidade de São Paulo)

Contribution ID: 20

Type: **not specified**

## **Cosmic ray diffusion in anisotropic MHD turbulence**

*Wednesday, 17 May 2023 11:00 (30 minutes)*

**Presenter:** XU, Siyao

Contribution ID: 21

Type: **not specified**

## **Constraining the sources of ultra-high-energy cosmic rays with the Pierre Auger Observatory**

*Wednesday, 17 May 2023 12:00 (30 minutes)*

**Presenter:** BISTER, Teresa

Contribution ID: 22

Type: **not specified**

# Results from the High Altitude Water Cherenkov Observatory

*Wednesday, 17 May 2023 11:30 (30 minutes)*

**Presenter:** MOSTAFA, Miguel



Contribution ID: 23

Type: **not specified**

## **New Models of the Magnetic Field of the Galaxy**

*Wednesday, 17 May 2023 15:00 (30 minutes)*

**Presenter:** UNGER, Michael

Contribution ID: 24

Type: **not specified**

## **UHECR anisotropies**

*Wednesday, 17 May 2023 16:00 (45 minutes)*

**Presenter:** FARRAR, Glennys

Contribution ID: 25

Type: **not specified**

## Registration

*Thursday, 18 May 2023 08:00 (45 minutes)*

Contribution ID: 26

Type: **not specified**

## **Heliosphere in the Local Interstellar Medium**

*Thursday, 18 May 2023 08:45 (45 minutes)*

**Presenter:** POGORELOV, Nick

Contribution ID: 27

Type: **not specified**

## **The IBEX Ribbon and its Relation to the Solar-Interstellar Interaction (remote)**

*Thursday, 18 May 2023 09:30 (30 minutes)*

**Presenter:** ZIRNSTEIN, Eric

Contribution ID: 28

Type: **not specified**

## **Living in the Bubble: structure, formation, and how it affects us**

*Tuesday, 16 May 2023 14:00 (35 minutes)*

**Presenter:** MACONI, Efrem

Contribution ID: 29

Type: **not specified**

## **Review of the Local ISM**

*Thursday, 18 May 2023 11:00 (45 minutes)*

**Presenter:** LINSKY, Jeff

Contribution ID: **30**

Type: **not specified**

## **Cosmic ray pitch angle anisotropies in the Very Local Interstellar Medium**

*Thursday, 18 May 2023 10:00 (30 minutes)*

**Presenter:** RANKIN, Jaime



Contribution ID: **31**

Type: **not specified**

## **Turbulence in the local ISM**

*Thursday, 18 May 2023 11:45 (30 minutes)*

**Presenter:** FRATERNALE, Federico

Contribution ID: 32

Type: **not specified**

## **Modeling of cosmic-ray anisotropy at TeV energies in an MHD model heliosphere**

*Thursday, 18 May 2023 15:15 (30 minutes)*

**Presenter:** SAKO, Takashi

Contribution ID: 33

Type: **not specified**

## Heliosphere and TeV CR anisotropy

*Thursday, 18 May 2023 14:45 (30 minutes)*

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

**Presenter:** ZHANG, Ming (Florida Institute of Technology)

Contribution ID: 34

Type: **not specified**

## **Configuration of Interstellar Magnetic Field Surrounding the Heliosphere (remote)**

*Thursday, 18 May 2023 14:15 (30 minutes)*

**Presenter:** FRISCH, Priscilla

Contribution ID: 35

Type: **not specified**

## **Cross-correlation studies with UHECRs (remote)**

*Friday, 19 May 2023 09:30 (30 minutes)*

**Primary author:** URBAN, Federico

**Presenter:** URBAN, Federico

Contribution ID: 36

Type: **not specified**

## Local Sources of Cosmic Rays

*Friday, 19 May 2023 10:30 (30 minutes)*

**Presenter:** MOSKALENKO, Igor

Contribution ID: 37

Type: **not specified**

## **Wrapping up and Collecting thoughts on Cosmic Ray Astrophysics**

*Friday, 19 May 2023 11:00 (45 minutes)*

**Presenter:** BLASI, Pasquale

Contribution ID: **38**

Type: **not specified**

## **Cosmic Ray Anisotropy with the Telescope Array**

*Wednesday, 17 May 2023 14:30 (30 minutes)*

**Presenter:** KIM, Jihyun



Contribution ID: 39

Type: **not specified**

# Welcome

**Session Classification:** Cosmic ray anisotropy workshop

Contribution ID: 40

Type: **not specified**

## **The Relationship between the Local ISM Distribution and Milky Way Spiral Structure**

*Thursday, 18 May 2023 16:15 (45 minutes)*

**Presenter:** BENJAMIN, Robert

Contribution ID: 41

Type: **not specified**

## Modeling of cosmic-ray anisotropy at TeV energies in an MHD model heliosphere

Past and on-going cosmic-ray experiments have reported small ( $\sim 0.1\%$ ) anisotropies in the arrival directions of TeV cosmic rays observed at the Earth.

We are attempting to estimate anisotropic features at the heliospheric boundary by applying the idea of Liouville mapping to the data of the Tibet AS $\gamma$  experiment.

Our preliminary results have indicated small, possibly spurious, anisotropic structures, with angular scales of  $\sim 10^\circ$  in the cosmic-ray intensity distribution at the heliospheric boundary, and we expect that the higher-order residues of these structures at the heliospheric boundary could be removed if the stochastic scattering of cosmic-ray particles by magnetic irregularities inside the heliosphere are somehow taken into account in the mapping process.

In this presentation we will present the latest results of our improved intensity-mapping method.

**Primary author:** SAKO, Takashi

**Co-author:** ON BEHALF OF THE TIBET ASGAMMA COLLABORATION

**Presenter:** SAKO, Takashi

Contribution ID: 42

Type: **not specified**

## Review of the Local ISM

The local interstellar medium (LISM), consisting of neutral and ionized gas, dust, and magnetic fields, is the environment for the heliosphere and stellar astrospheres. LISM gas and magnetic fields penetrate deeply into these environments. The LISM consists of the partially ionized gas clouds extending to about 10 pc from the Sun, the surrounding Local Bubble with its fully ionized hydrogen gas extending to several hundred parsecs from the Sun, and interactions with the external Galaxy. Absorption in resonance lines, primarily in the ultraviolet, observed by the Hubble Space Telescope and in situ measurements by the Voyager, New Horizons, Ulysses, and IBEX spacecraft are providing important data concerning the composition and properties of the LISM. This talk will review what we have been learning about the LISM - its structures, thermal and non-thermal properties, turbulence, ionization, inhomogeneity, and pressure balance among its components. As the Sun speeds through the LISM at 25 km/s, large changes in the size and properties of the heliosphere occur when it passes through cold dense clouds, partially ionized gas, or fully ionized gas. Cosmic rays traverse the different structures in the LISM and are modified by these environments.

**Primary authors:** Prof. LINSKY, Jeffrey (University of Colorado); Prof. MOEBIUS, Eberhard (University of New Hampshire)

**Presenter:** Prof. LINSKY, Jeffrey (University of Colorado)

Contribution ID: 43

Type: **not specified**

## Results from TA

*Wednesday, 17 May 2023 14:00 (30 minutes)*

**Presenter:** ABU-ZAYYAD, Tareq

Contribution ID: 44

Type: **not specified**

## **IceCube: The first Decade of Neutrino Astronomy**

*Friday, 19 May 2023 08:45 (45 minutes)*

**Primary author:** HALZEN, Francis (University of Wisconsin–Madison)

**Presenter:** HALZEN, Francis (University of Wisconsin–Madison)

Contribution ID: 45

Type: **not specified**

## **Cosmic rays in a turbulent interstellar medium: Recent progress and open questions**

TBD

**Primary author:** MERTSCH, Philipp

**Presenter:** MERTSCH, Philipp

Contribution ID: 46

Type: **not specified**

## The IBEX Ribbon and its Relation to the Solar-Interstellar Interaction

NASA's Interstellar Boundary Explorer (IBEX), an Earth-orbiting Small Explorer spacecraft, measures energetic neutral atom (ENAs) produced primarily by charge exchange in the outer heliosphere. There are two main sources of ENAs. The first, called the "globally distributed flux", is formed from neutralization of interstellar pickup ions that were preferentially accelerated at the heliospheric termination shock and advected with the bulk plasma flow through the inner heliosheath. Once these ions experience charge exchange, they may travel back towards in the inner heliosphere and be detected by IBEX. The second main source, called the "Ribbon", is a narrow enhancement of ENA emissions circling the sky that come from outside the heliopause. It is widely believed that the Ribbon is ordered by the draping of the local interstellar magnetic field (ISMF) around the heliosphere and has allowed us to pinpoint the pristine (far from the heliosphere) ISMF strength and orientation. I will present a review of Ribbon modeling studies that analyze the relationship between the Ribbon and the draped ISMF, the importance of understanding particle pitch angle scattering outside the heliopause, and the evolving solar wind that serves as the primary source of the Ribbon flux through the secondary ENA process.

**Primary author:** ZIRNSTEIN, Eric (Princeton University)

**Presenter:** ZIRNSTEIN, Eric (Princeton University)



Contribution ID: 47

Type: **not specified**

## The curious maximum-rigidity distribution of ultra-high-energy-cosmic-ray accelerators

*Thursday, 18 May 2023 12:15 (30 minutes)*

A standard assumption among models of candidate source populations of ultra-high energy cosmic rays (UHECRs) is that all sources in a candidate source population accelerate particles to the same maximum energy. Motivated by the fact that candidate astrophysical accelerators exhibit a vast diversity in terms of their relevant properties, such as luminosity, Lorentz factor, and magnetic field strength, we study the compatibility of a population of sources with non-identical maximum cosmic-ray energies with the observed energy spectrum and composition of UHECRs at Earth. For this purpose, we compute the UHECR spectrum emerging from a population of sources with a power-law, or broken-power-law, distribution of maximum energies applicable to a broad range of astrophysical scenarios. We find that for a wide range of studied models, the maximum energies of the UHECR accelerators must be nearly identical in order to be compatible with the UHECR data, in stark contrast to the variance expected for the astrophysical source models considered. A substantial variance of the maximum energy is only consistent with the UHECR data if the maximum energies of the UHECR sources follow a broken power-law distribution with a very steep spectrum above the break. However, in this scenario, the individual source energy spectra must be unusually hard with increasing energy output as a function of energy. These findings have implications for the arrival-direction distribution of UHECRs.

**Primary author:** OIKONOMOU, Foteini (Norwegian University of Science and Technology)

**Co-authors:** Mr EHLERT, Domenik; Dr UNGER, Michael

**Presenter:** OIKONOMOU, Foteini (Norwegian University of Science and Technology)

Contribution ID: 48

Type: **not specified**

## **Turbulence and CR propagation (remote)**

*Tuesday, 16 May 2023 09:30 (35 minutes)*

**Presenter:** GIACINTI, Gwenael

Contribution ID: 49

Type: **not specified**

## Cosmic Ray Anisotropy with the Telescope Array

Ultra-high energy cosmic rays (UHECRs) are charged particles that are extremely energetic, with  $E > 10^{18}$  eV. They impinge on the Earth's atmosphere from outer space. The Telescope Array experiment, the largest UHECR observatory in the northern hemisphere, is situated in the western desert of Utah, USA, and has been collecting data continuously since May 2008. It is designed to detect extensive air showers (EAS) which are a cascade of subatomic particles induced by a primary UHECR particle interacting with the atmosphere. The Telescope Array uses two types of detectors: fluorescence detectors (FDs) and scintillator surface detectors (SDs). The FDs measure the scintillation light produced when the shower travels through the atmosphere's gas while the SDs sample the EAS's footprint at ground level. To understand the origin of UHECRs, we analyze the distribution of their arrival directions, looking for indications of anisotropic patterns. In this presentation, we summarize the results of the anisotropy study of UHECR events observed by the Telescope Array SD array, taking full advantage of its high duty cycle.

**Primary authors:** KIM, Jihyun (University of Utah); THE TELESCOPE ARRAY COLLABORATION, for

**Presenter:** KIM, Jihyun (University of Utah)

Contribution ID: 50

Type: **not specified**

## Observation of cosmic-ray anisotropy with LHAASO

Observation of cosmic-ray anisotropy with LHAASO

**Primary authors:** GAO, Wei (Institute of High Energy Physics); Prof. RUFFOLO, David (Mahidol University); LIU, Wei (IHEP); Mr HE, Jiayin (Purple Mountain Observatory, CAS)

**Presenter:** GAO, Wei (Institute of High Energy Physics)

Contribution ID: 51

Type: **not specified**

## **Observation of cosmic-ray anisotropy with LHAASO (remote)**

*Tuesday, 16 May 2023 11:10 (35 minutes)*

**Presenter:** WEI GAO

Contribution ID: 52

Type: **not specified**

## Recent Results in Cosmic-Ray Astrophysics

*Tuesday, 16 May 2023 08:45 (45 minutes)*

**Presenter:** EVOLI, Carmelo (Gran Sasso Science Institute)