connection to the sources by a new reading key

Abstract:
UHECR events are nearly four hundred. We overlap their arrival events on TeVs γan anisotropies and known sources finding some key connections with nearby AGN and a few galactic sources; their bending confirm a light nuclei UHECR. We report also first hint of coherently bent and diluted UHECR events from Virgo.
UHECR Astronomy: a pocker game
Composition-B_map- GZK-CosmicMass_Map

1) Because UHECR are charged particles (and because there are NOT magnetic monopoles) ...the large scale magnetic fields are making a distorted (coherently or random) bending maps in a smeared sky

2) The bending depends on energy and on the composition and for the latter

3) Different GZK cut off and distances and spectra energy

4a) $Fe$: too much bending $\Rightarrow$ No UHECR
The meaning of the UHECR Hot Spots
A Light Nuclei Nearby Astronomy

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arXiv:1412.1573
EPJ Web Conf. 99 (2015) 08002

Abstract. In this paper we review all the up-to-date Ultra High Energy Cosmic Ray (UHECR) events reported by AUGER, the Telescope Array (TA) and AGASA in common coordinate maps. We also confirm our earliest (2008-2013) model, where UHECRs mostly comprise light nuclei (namely He, Be, B), which explains the Virgo absence and confirms M82 as the main source for the Northern TA Hot Spot. Many more sources, such as NGC253 and several galactic sources, are possible candidates for most of the 376 UHECR events. Several correlated maps, already considered in recent years, are reported to show all the events, with their statistical correlation values.
UHECR: WHY LIGHT NUCLEI?
Infrared Galaxy maps, **GALACTIC coordinate**, versus first data
The **SCANDAL of VIRGO ABSENCE** (AUGER-Science 2007)
North and South at 50 EeV

The very PERSISTENT SCANDAL (celestial coordinates) of VIRGO ABSENCE

TA 6 Years + Auger 10 Years

ATTENTION: MOLWEIDE versus HADER—Celestial HADER here-GALACTIC LATER
UHECR because of GZK cut off must be in a near (40 Mpc).. Universe (4 Gpc)
Iron UHECR are much bent (90 degree) hiding any UHECR Astronomy, Light Nuclei suffer of a more severe GZK cut off (4-10 Mpc) but minor smearing deflections
The lightest nuclei: the best filter to mask Virgo
Energy spectrum - what is causing the suppression?

$E^3 J(E) \text{ [eV}^2 \text{ km}^{-2} \text{ sr}^{-1} \text{ yr}^{-1}]$

$E_{\text{ankle}} = 5.3 \times 10^{18} \text{ eV}$

$E_{1/2} = 4.3 \times 10^{19} \text{ eV}$

GZK cutoff or photodisintegration or sources reached their maximum energy?
COMPOSITION PUZZLE : the history

• For a decade AUGER claimed: Fe+p composition (2004-2014)
• TA claimed only proton UHECR (2005-2015)
• This year last AUGER declaration: UHECR are

• We suggested 2008-mostly
• He (lightest nuclei)
Our old claim: Lightest Nuclei, Virgo, the Cen A smeared


• EPJ Web Conf. 99 (2015) 08002
Origin of Ankle and Flux Suppression?

\[ E \text{ [eV]} \]

\[ 10^{18} \quad 10^{19} \quad 10^{20} \]

\[ E^3 \dot{J}(E) \quad \text{eV}^2 \text{km}^{-2} \text{sr}^{-1} \text{yr}^{-1} \]

\[ 10^{36} \quad 10^{37} \quad 10^{38} \]

\[ \log_{10}(E/eV) \]

\[ 17.5 \quad 18.0 \quad 18.5 \quad 19.0 \quad 19.5 \quad 20.0 \quad 20.5 \]

TA 2013 preliminary
Auger 2013 preliminary

\[ \Delta E/E = 14\% \]

Kampert & Tinyakov, CRP 15 (2014) 318; Aloisio, Berezinsky & Blasi, JCAP 1410 (2014) 10, 02
Composition Fit ($X_{\text{max}}$ distribution)
Bending By Random or Coherent B

Random Deflections inside our Galaxy and along horizontal Galactic Plane in vertical axis toward Cen A by LIGHTEST NUCLEI: He, Li, Be

The mean random angle bending $H e_4^2, L i_6^3, B e_8^4$, ( ) by spiral galactic magnetic fields along the plane is $\delta_{rm} \geq$:

1. $11.3^\circ \cdot \frac{Z}{Z_{He^2}} \cdot \frac{6 \cdot 10^{19} eV}{E_{CR}} \left( \frac{B}{3 \cdot \mu G} \right) \sqrt{\frac{L}{20 kpc}} \sqrt{\frac{l_c}{kpc}}$ (1)

2. $16.95^\circ \cdot \frac{Z}{Z_{Li^3}} \cdot \frac{6 \cdot 10^{19} eV}{E_{CR}} \left( \frac{B}{3 \cdot \mu G} \right) \sqrt{\frac{L}{20 kpc}} \sqrt{\frac{l_c}{kpc}}$ (2)

3. $22.6^\circ \cdot \frac{Z}{Z_{Be^4}} \cdot \frac{6 \cdot 10^{19} eV}{E_{CR}} \left( \frac{B}{3 \cdot \mu G} \right) \sqrt{\frac{L}{20 kpc}} \sqrt{\frac{l_c}{kpc}}$ (3)

This Lightest Nuclei for Highest Cosmic Rays model implies and foresees among the other, additional clustering of UHECR events around the nearest AGN Cen-A
North and South at 50 EeV

The PERSISTENT SCANDAL (celestial coordinates) of VIRGO ABSENCE

TA 6 Years + Auger 10 Years

ATTENTION: MOLWEIDE versus HADER—Celestial HADER here-GALACTIC LATER
Past 2008-2009 foreseen maps (observed on 2011)
Cen A and Virgo Absence

Coherent and random UHECR Spectroscopy of Lightest Nuclei along CenA: ...
Foreseen He fragility and D, p: fragments and multiplet

- UHECR He at 60 EeV flying few Mpc maybe broken into fragments:
- Half energy and half mass $\rightarrow$ same Lorentz deflection (as p, D, 30-40 EeV)
- A fourth of energy and half a charge: double deflection (p, 20 EeV) Correlated in angle spread and direction
A new input from AUGER: arxiv1107.4805

Multiplets tail around Cen A at 20 EeV

for the presence of multiplets arising from magnetic deflections in the present data.

Keywords: Pierre Auger Observatory, ultra-high energy cosmic rays, magnetic fields, multiplets.

1 Introduction given by
latest 251 AUGER UHECR (blue) with additional 72+15=87 latest TA (72 red and 15 green) records. A few potential sources are labeled.
ARGO E ICECUBE over TA and AUGER

FIG. 2: ARGO-YBJ sky-map in equatorial coordinates for events with $N_{strip} > 25$. The maps have been smoothed with an angle given by the PSF of the detector. *Plot (a)*: statistical significance of the observation in s.d. The boxes represent the
Hawc anisotropy 2: Virgo and C? 

Observation of Cosmic-Ray Anisotropy with HAWC
The Source Jets
AGN and NS (BH ?)

- Cen A
- M82
- Vela
- Crab
- SS433
- NGC 253
- D.Galaxy Fornax
Gamma COMPTON:OSSE halo
AUGER over Planck IR Galactic Map: The GC role

Figure 12. As above, in Mollweide Projection, Galactic Coordinate map for 231 AUGER UHECR, 72+15=87 TA, 58 AGASA
Galactic spur

Figure 12. As above, in Mollweide Projection. Galactic Coordinatem
Light nuclei solving the AUGER puzzles: the Cen-A imprint--2008

• D Fargion
• Published 30 September 2008

2008 • Physica
neutrino

cascade events only
p-value = 18 %
UHECR versus UHE neutrino

Figure 13. All oldest UHECR by AGASA, AUGER, TA, in galactic Mollweide coordinate with several candidate sources with label: blue AUGER, red 72 events by TA, green last 15
Overlapping Highest and Lower UHECR in Galactic Coordinate versus newest 54 ICECUBE Highest Energy Neutrino
Summary

• We overlap nearly 400 UHECR and their arrival events on different maps as TeVs gamma anisotropies and known sources, finding some first key connections with nearby

• AGN Cen A, M82, NGC 253, and Fornax Dwarf galaxy.

• Their bending confirm a light nuclei UHECR as most recent AUGER simulations on UHECR compositions.
Thank you for the *sharp* attention
FIG. 2: ARGO-YBJ sky-map in equatorial coordinates for events with $N_{strip} > 25$. The maps have been smoothed with an angle given by the PSF of the detector. Plot (a): statistical significance of the observation in s.d. The boxes represent the...
End
Planck
Synchrotron Emission

Figure 12. As above, in Mollweide Projection, Galactic Coordi-
UHE ZeV neutrino scattering on 0.4 eV relic neutrino showering Z resonance
FIG. 5: The fractional CR excess with respect to the estimated background is shown for different shower multiplicities: (a) 25 - 39, (b) 40 - 99, (c) 100 - 249, (d) 250 - 629 fired strips on the ARGO-130 central carpet. *Mollweide projections.*
Figure 12. As above, in Mollweide Projection, Galactic Coordi-
Crab source or Milagro hot spot?

**WHERE THE ANISOTROPY COME FROM?**

**Figure 5:** Relative intensity of Region A for 4 different energy-proxy bins. The square mark denotes the location of the centroid of Region A as reported by Milagro ($\alpha = 69.4^\circ$, $\delta = 13.8^\circ$) at 10 TeV. The median energy of the data in each plot from left to right is $1.7^{+6.6}_{-1.3}$ TeV, $3.2^{+10.9}_{-2.4}$ TeV, $5.6^{+14.2}_{-3.9}$ TeV, and $14.1^{+28.7}_{-9.9}$ TeV.
Figure 12. As above, in Mollweide Projection, Galactic Coordinate map for 231 AUGER UHECR, 72+15=87 TA, 58 AGASA
Equatorial Coordinates - 15° smoothing

Figure: significance sky map smoothed out at a 15° angular scale.
FIG. 2: ARGO-YBJ sky-map in equatorial coordinates for events with $N_{\text{strip}} > 25$. The maps have been smoothed with an angle given by the PSF of the detector. Plot (a): statistical significance of the observation in s.d. The boxes represent the
Fig. 1. Overview on the brightness of the sky outside the lower terrestrial atmosphere and at high ecliptic and galactic latitudes. The zodiacal emission and scattering as well as the integrated light of stars are given for the South Ecliptic Pole ($l = 276^\circ$, $b = -30^\circ$). The bright magnitude cut-off for the stellar component is $V = 6.0$ mag for $0.3 - 1 \mu m$. In the infrared, stars brighter than 15 Jy between 1.25 and 4.85 µm and brighter than 85 Jy at 12 µm are excluded. No cut-off was applied to the UV data, $\lambda \leq 0.3 \mu m$. The interstellar cirrus component is normalized for a column density of $10^{20}$ H-atoms cm$^{-2}$ corresponding to a visual extinction of 0.053 mag. This is close to the values at the darkest patches in the sky. Source for the long-wavelength data, $\lambda \geq 1.25 \mu m$, are COBE DIRBE and FIRAS measurements as presented by Désert et al. (1996). The IR cirrus spectrum is according to the model of Désert et al. (1990) fitted to IRAS photometry. The short-wavelength data, $\lambda \leq 1.0 \mu m$, are from the following sources: zodiacal light: Leinert & Grün (1990); integrated starlight: $\lambda \leq 0.3 \mu m$, Gondhalekar (1990), $\lambda \geq 0.3 \mu m$, Mattila (1980); cirrus: $\lambda = 0.15 \mu m$, Haikala et al. (1995), $\lambda = 0.35 - 0.75 \mu m$, Mattila & Schur (1990), Mattila (1979). The geocoronal Lyman $\alpha(121.6 \text{ nm})$ and the OI($130.4, 135.6 \text{ nm}$) line intensities were as measured with the Faint Object Camera of the Hubble Space Telescope at a height of 610 km (Cauet al. 1994). The various references for the airglow emission can be found in Sect. 6.
latest 231 AUGER UHECR (blue) with additional 72+15=87 TA
Overlapping Highest and Lower UHECR
Figure 2. Hammer Projection in Galactic coordinates for the latest 231 AUGER UHECR (blue) with additional 72+15=87 TA (72 blue and 15 green) and 58 AGASA (cyan) records, in a total of 376 events. A few potential sources are labeled.
Figure 2. Hammer Projection in Galactic coordinates for the latest 231 AUGER UHECR (blue) with additional 72+15=87 TA\textsuperscript{52}
Figure 12. As above, in Mollweide Projection, Galactic Coordinate map for 231 AUGER UHECR, $72 + 15 = 87$ TA, 58 AGASA
Lack of Fe nuclei

Stacked histograms

Fe distribution:
- too shallow (small $X_{\text{max}}$)
- peaks at smaller $X_{\text{max}}$ than data
- wider than data

⇒ Data need a distribution that is deeper (larger $X_{\text{max}}$) and narrower
Better fit quality for EPOS-LHC, but not for Sibyll 2.1 & QGSJET II-4
Hawc 2015 –TEVS-icrc

Figure 2: Relative subtraction of $I_c$ with $10^\circ$ smoothing.

Figure 3: Mollweide Projection in Celestial coordinates for the latest 231 AUGER UHECR (blue) with additional 72+15=87 latest TA (72 red and 15 green) records. A few potential sources flux after fit and the map is shown.
0.75 KeV
Fermi 2 years

Fermi two-year all-sky map
Figure 2. Hammer Projection in Galactic coordinates for the latest 231 AUGER UHECR (blue) with additional 72+15=87 TA (72 blue and 15 green) and 58 AGASA (cyan) records, in a total of 376 events. A few potential sources are labeled.
Radio plasma turbolence
Figure 12. As above, in Mollweide Projection, Galactic Coordi-
First TeVs-UHECR connections
2012
Can A persistence and Virgo
TA 6 Years + Auger 10 Years

No excess from Virgo

North: \( S_{\text{MAX}} = 5.19\sigma, \) (R.A, Dec.) = (148.4\(^\circ\), 44.5\(^\circ\))
South: \( S_{\text{MAX}} = 3.57\sigma, \) (R.A, Dec.) = (210.9\(^\circ\), -48.2\(^\circ\))
Radio Fountain
p + Fe hypothesis

- Mostly to mainly protons for $E < 10^{19}$ eV
- Poor quality fit: hadronic interaction models cannot describe data with p & Fe
  \[ \Rightarrow \text{hypothesis of only p and Fe not feasible} \] - something else required

Eun-Joo Ahn  Surprising results on the composition of the highest energy cosmic rays  JETP 2015