Your Title

Zur Erlangung des akademischen Grades eines

Doktors der Naturwissenschaften

an der Fakultät für Physik des
Karlsruher Instituts für Technologie (KIT)

genehmigte

Dissertation

von

M. Sc. Paul Filip

aus Breisach am Rhein

Tag der mündlichen Prüfung:

Referent: Prof. Dr. Ralph Engel

Korreferent: Prof. Dr. Your Coref

Betreuer: Dr. David Schmidt

use ’eingereichte’ for hand in, use ’genehmigte’ for final version.

Abstract

Zusammenfassung

Resumen

Acronyms

This is a list of alphabetically sorted acronyms used within this work.

CMB cosmic microwave background radiation 9
CR cosmic ray 9
EAS extensive air shower
SD Surface detector

Contents

English Abstract iii

Deutsche Zusammenfassung v

Resumen español vii

1 Introduction 5

2 Chapter: Types of section distinctions 7
2.1 Section . . . 7
2.1.1 Subsection . . . 8
2.2 References and labels . . . 8
2.2.1 Labels . . . 8
2.2.2 Referencing labels . . . 8
2.2.3 Citations . . . 8
2.3 Acronyms . . . 9
2.4 Units . . . 9
2.5 Figures . . . 10
2.6 Tables . . . 13
2.7 Mathematical and decay equations . . . 13
2.8 Reminders . . . 14
2.9 Miscellaneous . . . 14

remove todos

Todo list

use 'eingereichte' for hand in, use 'genehmigte' for final version. ii
remove todos 1
more recent spectrum? proper citation to whom? 14
Figure: 14

CHAPTER 1

Introduction

CHAPTER 2

Chapter: Types of section distinctions

```
\chapter{Chapter: Types of section distinctions}
\blindtext
\section{Section}
\blindtext
\subsection{Subsection}
\blindtext
\subsubsection{Subsubsection}
\blindtext
```

Hello, here is some text without a meaning. This text should show what a printed text will look like at this place. If you read this text, you will get no information. Really? Is there no information? Is there a difference between this text and some nonsense like “Huardest gefburn”? Kjift – not at all! A blind text like this gives you information about the selected font, how the letters are written and an impression of the look. This text should contain all letters of the alphabet and it should be written in of the original language. There is no need for special content, but the length of words should match the language.

2.1 Section

Hello, here is some text without a meaning. This text should show what a printed text will look like at this place. If you read this text, you will get no information. Really? Is there no information? Is there a difference between this text and some nonsense like “Huardest gefburn”? Kjift – not at all! A blind text like this gives you information about the selected font, how the letters are written and an impression of the look. This text should contain all letters of the alphabet and it should be written in of the original language. There is no need for special content, but the length of words should match the language.

2.1.1 Subsection

Hello, here is some text without a meaning. This text should show what a printed text will look like at this place. If you read this text, you will get no information. Really? Is there no information? Is there a difference between this text and some nonsense like "Huardest gefburn"? Kjift – not at all! A blind text like this gives you information about the selected font, how the letters are written and an impression of the look. This text should contain all letters of the alphabet and it should be written in of the original language. There is no need for special content, but the length of words should match the language.

Subsubsection

Hello, here is some text without a meaning. This text should show what a printed text will look like at this place. If you read this text, you will get no information. Really? Is there no information? Is there a difference between this text and some nonsense like "Huardest gefburn"? Kjift – not at all! A blind text like this gives you information about the selected font, how the letters are written and an impression of the look. This text should contain all letters of the alphabet and it should be written in of the original language. There is no need for special content, but the length of words should match the language.

2.2 References and labels

2.2.1 Labels

Make sure to label sections to refer back to throughout your work. Make it an intuitive name.

```
\label{sec:cosmicrays}
\label{subsec:crs_eas}
```

2.2.2 Referencing labels

Use cref instead of ref; it smartly labels if it's a section, chapter, figure, table, etc. Fig. 2.1.

```
\cref{fig:crs_eas_heitler1}
\cref{subsec:fd}
```

2.2.3 Citations

If you have a ton of reference, just list them with commas. Latex will properly format [**? ?**]:

```
\cite{Abraham2009b,Abraham2009,Abraham2010a,Abraham2010,Abreu:2011zze,Abreu
    ↪ :2011zzd,Abreu:2011vm,Abreu:2011ki,Abreu:2011fb,Settimo:2012zz,Auger
    ↪ :2012yc,Auger:2012an,Acounis:2012dg,Abreu:2012zz,Abreu:2012zg,Abreu
    ↪ :2012ybu,Abreu:2012pi,Abreu:2012oza,Abreu:2012aniso,Abreu:2011md,
    ↪ Abreu:2013zbq,Abreu:2013qtw,Abreu:2013qfa,Abreu:2013kif,Abreu:2013env,
```

```
↪ Aab:2014qva,Aab:2014pza,Aab:2014kda,Aab:2014ila,Aab:2014gua,Aab:2014
↪ esa,Aab:2014dua,Aab:2014dha,Aab:2014caa,Aab:2014bha,Aab:2014aea,
↪ ThePierreAuger:2014nja,PierreAuger:2014yba,Aab2015a,Aab2015,Aab:2015
↪ kma}
```

2.3 Acronoyms

There's a neat package called acronyms that will handle them for you. Alex had already set this in the acronym.tex. Just define your acronyms here as he did.

- To use the acronym like CR[1], use:

  ```
  \ac{CR}
  ```

- To define the acronym in the text—*cosmic microwave background radiation* (CMB), use:

  ```
  \acfi{CMB}
  ```

  If you want this to be the only place in your chapter where the acronym is defined, you need to write:

  ```
  \acfi{CMB}\acused{CMB}
  ```

  as the acronym package does not automatically count this as a definition.

- To makes the acronym plural. CAVEAT is that acronyms ending in an S will add an extra S which is not typically used in English.

  ```
  \acp{CR}
  ```

- Sometimes acronyms require more complicated definitions, you can define them in the main document and call them throughout. Alex has already defined QGSJET-II.03 and Offline:

  ```
  \qgsjet
  \Offline
  ```

2.4 Units

For defining units, use the SI package, as it will consistently format for you. It sometimes may not recognize something like Mpc.

Examples:

- 10^{20} eV

[1] cosmic ray

- $12\,\mathrm{km}^2$ for multiple units
- $90\,\%$ for precentages
- $\approx 5\times10^{19}\,\mathrm{eV}$
- $37\,\mathrm{g\,cm}^{-2}$ for grammage
- $30\,\mathrm{GeV}$ if GeV is not recognized, specify by metric prefix
- $3\times10^{15}\,\mathrm{eV}$
- $30\,\%$ to $60\,\%$ a way to consistently format ranges
- $\mathrm{km}^2\,\mathrm{sr\,yr}$

```
\SI{e20}{\eV}
\SI{12}{\square\km}
\SI{90}{\percent}
$\approx \SI{5e19}{\eV}$
\SI{37}{\grammage}
\SI{30}{\giga\eV}
\SI{3e15}{\eV} 3{\times}10^{19}
\SIrange{30}{60}{\percent}
$\si{\square\km \steradian \year}$
```

2.5 Figures

In a PhD thesis you should always use only `[t]` (top) figure placement. Also note that due to the `\graphicspath{{figures/}}` command in the preamble, the file paths are relative to the `./figures` directory which can thus be dropped from the line. If you also ommit the filename extension (e.g. `.pdf` or `.jpg`) your source file will be compilable with both, `latex` and `pdflatex`.

```
\begin{figure}[h]
  \centering
  \includegraphics[width=0.8\textwidth]{intro/heitler}
  \caption{Illustration of an \ac{EAS}' particle components.}
  \label{fig:crs_eas_heitler1}
\end{figure}
```

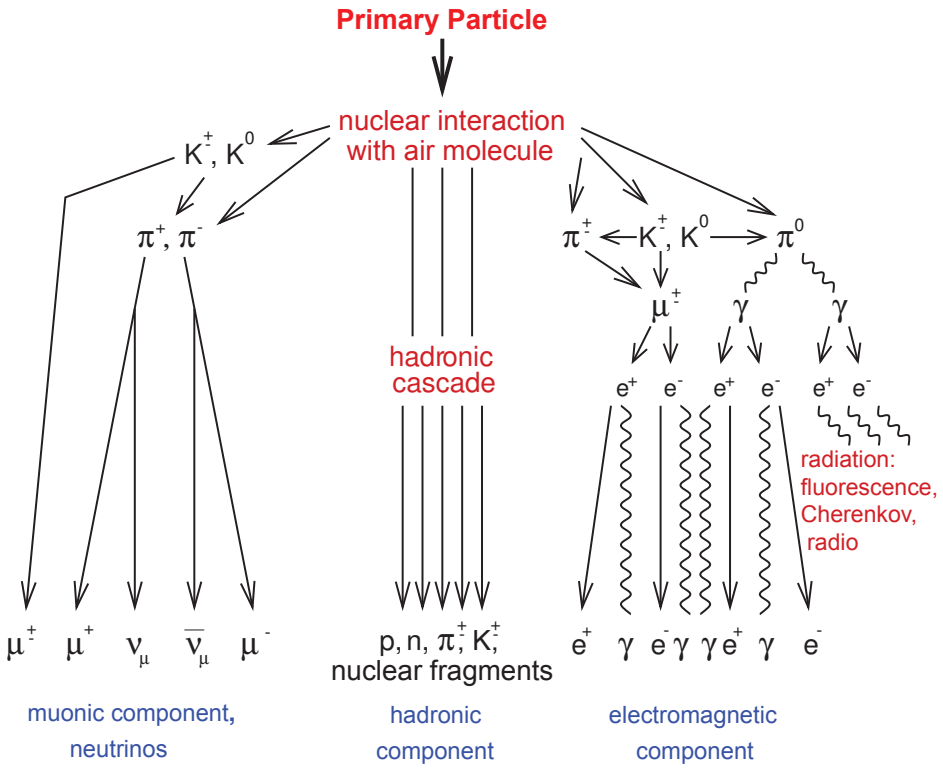


Figure 2.1: Illustration of an EAS[2'] particle components.

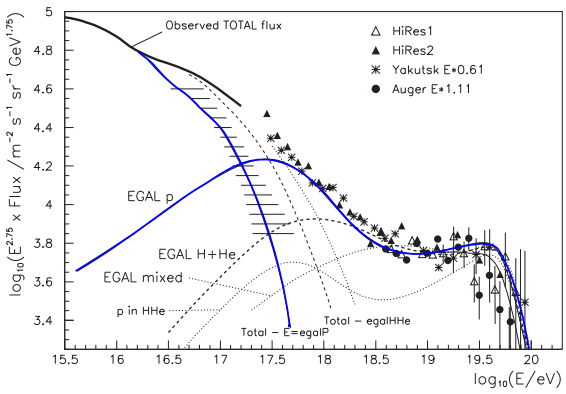
Use `subref` to reference elements within a figure for your text or captions.

```
\begin{figure}[t]
  \centering
  \subfloat[]{\includegraphics[width=0.48\textwidth]{intro/Berezinsky2}
  \label{plot:crs_ankle_berezinsky}
  }\hspace{0.2cm}
  \subfloat[]{\includegraphics[width=0.48\textwidth]{intro/Hillas2}
  \label{plot:crs_ankle_hillas}
  }
  \caption[]{Visualization of the \subref{plot:crs_ankle_berezinsky} pair
      ↪ production dip \cite{berezinskycr} and \subref{plot:
      ↪ crs_ankle_hillas} mixed composition \cite{hillascr} scenarios that
      ↪ describe the ankle feature.}
  \label{fig:crs_ankle}
\end{figure}
```

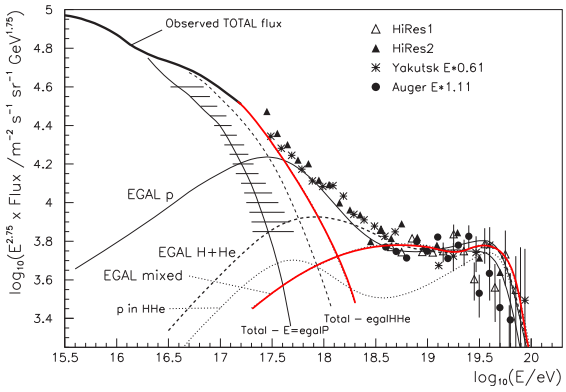
If you need a footnote in a figure, you have to use `footnotemark`

```
\begin{figure}[t]
  \centering
```

[3] As discussed further in the reconstruction Chapter, quality cuts are performed on reconstructed data from the SD[4]. One of these cuts is known as the 6T5-trigger; it requires that the detector with the highest signal has all of its 6 closest neighbors working at the time of the event. Similarly, a 5T5 only requires 5 of the closest neighbors to be working.

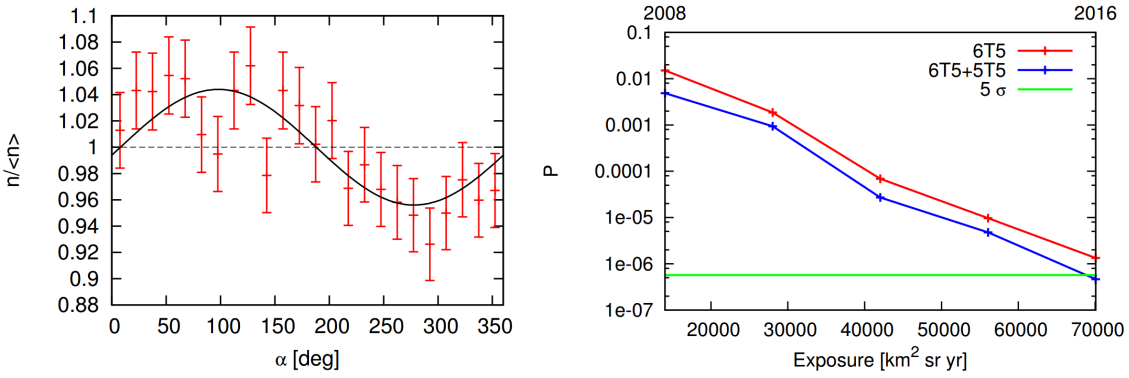


(a)



(b)

Figure 2.2: Visualization of the (a) pair production dip [**?**] and (b) mixed composition [**?**] scenarios that describe the ankle feature.



(a) **(b)**

Figure 2.3: (a) (b) Probability for the amplitude of the dipole to arise from an isotropic distribution as a function of the integrated exposure of the Pierre Auger Observatory. Various data sets with different tank triggers are shown [3][**?**].

```
\subfloat[]{\includegraphics[height=5cm]{intro/auger_dipole}
\label{plot:pao_dipole}}
\subfloat[]{\includegraphics[height=5cm]{intro/auger_dipole_sig}
\label{plot:pao_dipole_sig}}
```

```
  \caption[]{\subref{plot:pao_dipole} \subref{plot:pao_dipole_sig}
     ↪ Probability for the amplitude of the dipole to arise from an
     ↪ isotropic distribution as a function of the integrated exposure of
     ↪ the Pierre Auger Observatory. Various data sets with different tank
     ↪  triggers are shown \footnotemark \cite{Mollerach2016_1}.
  }
\label{fig:pao_dipole}
\end{figure}
\footnotetext{As discussed further in the reconstruction Chapter, quality
   ↪ cuts are performed on reconstructed data from the \ac{SD}. One of
   ↪ these cuts is known as the 6T5-trigger; it requires that the detector
   ↪  with the highest signal has all of its 6 closest neighbors working
   ↪ at the time of the event. Similarly, a 5T5 only requires 5 of the
   ↪ closest neighbors to be working.}
```

2.6 Tables

Table 2.1: Dipole components and direction in equatorial components [**?**].

E/EeV	$d_\perp$	d_z	d	α	δ
4-8	-0.024 ± 0.010	0.006 ± 0.006	0.025 ± 0.009	$-75° \pm 15°$	$82° \pm 57°$
> 8	-0.026 ± 0.015	0.060 ± 0.010	0.065 ± 0.011	$-24° \pm 12°$	$100° \pm 10°$

2.7 Mathematical and decay equations

For decay equations, use align

$$\gamma_{\mathrm{CMB}} + \mathrm{p} \rightarrow \Delta^+ \rightarrow \mathrm{p} + \pi^0 ,$$
$$\gamma_{\mathrm{CMB}} + \mathrm{p} \rightarrow \Delta^+ \rightarrow \mathrm{n} + \pi^+ .$$

```
\begin{align*}
  \gamma_\mathrm{CMB} + p \rightarrow & \Delta^+ \rightarrow p + \pi^0 \,
     ↪ ,\\
  \gamma_\mathrm{CMB} + p \rightarrow & \Delta^+ \rightarrow n + \pi^+ \, .
\end{align*}
```

For writing $5.5\,\sigma$, use

```
\sig{5.5}
```

2.8 Reminders

Use to dos so that you don't have to dig through latex code. [inline] makes it so it takes up the line and isn't hanging off the page

- To add a todo inline like this

more recent spectrum? proper citation to whom?

```
\todo[inline]{more recent spectrum? proper citation to whom?}
```

- To generate this for missing figures:


```
\missingfigure{}
```

- To generate a list of all your todos and their page numbers, use

```
\listoftodos
```

2.9 Miscellaneous

- 4.6×10^{-7}

```
$4.6{\times}10^{-7}$
```

- For degrees 148.4°

```
\ang{148.4} or 148.4^\circ
```

- For formatting numbers otherwise in text, −2.0

```
\num{-2.0} or $-2.0$
```

- Superscripts for text like 20th

```
20\textsuperscript{th}
```

- For marking out text —~~Due to the clean room environment~~, use:

```
\deleted{Due to the clean room environment}
```

This may be useful for editing your thesis later.

List of Figures

2.1 Illustration of an EAS' particle components. 11

List of Tables

2.1 Dipole components and direction in equatorial components [**?**]. 13

Bibliography

[1] J. Abraham *et al.* (Pierre Auger Collab.), Pierre Auger Collaboration, Limit on the diffuse flux of ultrahigh energy tau neutrinos with the surface detector of the pierre auger observatory, Phys. Rev. D 79 (10) (2009) 102001. doi:10.1103/PhysRevD.79.102001.

[2] J. Abraham *et al.* (Pierre Auger Collab.), Upper limit on the cosmic-ray photon fraction at eev energies from the pierre auger observatory, Astroparticle Physics 31 (6) (2009) 399 – 406. doi:DOI:10.1016/j.astropartphys.2009.04.003.
URL http://www.sciencedirect.com/science/article/B6TJ1-4W6Y349-1/2/fa58b1b24ace553d6d47e135f06059e1

[3] J. Abraham *et al.* (Pierre Auger Collab.), Measurement of the energy spectrum of cosmic rays above 10^{18} eV using the Pierre Auger Observatory, Physics Letters B 685 (4-5) (2010) 239 – 246. doi:DOI:10.1016/j.physletb.2010.02.013.
URL http://www.sciencedirect.com/science/article/B6TVN-4YC2XC7-3/2/69021ee5b6b08f24e4343776c82fb3ed

[4] J. Abraham *et al.* (Pierre Auger Collab.), Pierre Auger Collaboration, Measurement of the Depth of Maximum of Extensive Air Showers above 10^{18} eV, Phys. Rev. Lett. 104 (9) (2010) 091101. doi:10.1103/PhysRevLett.104.091101.

[5] P. Abreu, et al., Pierre Auger Collaboration, A Search for Ultra-High Energy Neutrinos in Highly Inclined Events at the Pierre Auger Observatory, Phys.Rev. D84 (2011) 122005. arXiv:1202.1493, doi:10.1103/PhysRevD.85.029902,10.1103/PhysRevD.84.122005.

[6] P. Abreu, et al., Pierre Auger Collaboration, The Lateral Trigger Probability function for the ultra-high energy cosmic ray showers detected by the Pierre Auger Observatory, Astropart.Phys. 35 (2011) 266–276. arXiv:1111.6645, doi:10.1016/j.astropartphys.2012.02.005,10.1016/j.astropartphys.2011.08.001.

[7] P. Abreu, et al., Pierre Auger Collaboration, Anisotropy and chemical composition of ultra-high energy cosmic rays using arrival directions measured by the Pierre Auger

Observatory, JCAP 1106 (2011) 022. arXiv:1106.3048, doi:10.1088/1475-7516/2011/06/022.

[8] P. Abreu, et al., Pierre Auger Collaboration, The effect of the geomagnetic field on cosmic ray energy estimates and large scale anisotropy searches on data from the Pierre Auger Observatory, JCAP 1111 (2011) 022. arXiv:1111.7122, doi:10.1088/1475-7516/2011/11/022.

[9] P. Abreu, et al., Pierre Auger Collaboration, Advanced functionality for radio analysis in the Offline software framework of the Pierre Auger Observatory, Nucl.Instrum.Meth. A635 (2011) 92–102. arXiv:1101.4473, doi:10.1016/j.nima.2011.01.049.

[10] P. Abreu, et al., Pierre Auger Collaboration, Measurement of the Cosmic Ray Energy Spectrum Using Hybrid Events of the Pierre Auger Observatory, Eur.Phys.J.Plus 127 (2012) 87. arXiv:1208.6574, doi:10.1140/epjp/i2012-12087-9.

[11] P. Abreu, et al., Pierre Auger Observatory Collaboration, A Search for Point Sources of EeV Neutrons, Astrophys.J. 760 (2012) 148. arXiv:1211.4901, doi:10.1088/0004-637X/760/2/148.

[12] P. Abreu, et al., Pierre Auger Collaboration, Large scale distribution of arrival directions of cosmic rays detected above 10^{18} eV at the Pierre Auger Observatory, Astrophys.J.Suppl. 203 (2012) 34. arXiv:1210.3736, doi:10.1088/0067-0049/203/2/34.

[13] P. Abreu, et al., Pierre Auger Collaboration, Results of a self-triggered prototype system for radio-detection of extensive air showers at the Pierre Auger Observatory, JINST 7 (2012) P11023. arXiv:1211.0572, doi:10.1088/1748-0221/7/11/P11023.

[14] P. Abreu, et al., Pierre Auger Collaboration, Search for point-like sources of ultra-high energy neutrinos at the Pierre Auger Observatory and improved limit on the diffuse flux of tau neutrinos, Astrophys.J. 755 (2012) L4. arXiv:1210.3143, doi:10.1088/2041-8205/755/1/L4.

[15] P. Abreu, et al., Pierre Auger Collaboration, Description of Atmospheric Conditions at the Pierre Auger Observatory using the Global Data Assimilation System (GDAS), Astropart.Phys. 35 (2012) 591–607. arXiv:1201.2276, doi:10.1016/j.astropartphys.2011.12.002.

[16] P. Abreu, et al., Pierre Auger Collaboration, Constraints on the origin of cosmic rays above 10^{18} eV from large scale anisotropy searches in data of the Pierre Auger Observatory, Astrophys.J. 762 (2012) L13. arXiv:1212.3083, doi:10.1088/2041-8205/762/1/L13.

[17] P. Abreu, et al., Pierre Auger Collaboration, Antennas for the Detection of Radio Emission Pulses from Cosmic-Ray, JINST 7 (2012) P10011. arXiv:1209.3840, doi:10.1088/1748-0221/7/10/P10011.

[18] P. Abreu, et al., Pierre Auger Collaboration, The Rapid Atmospheric Monitoring System of the Pierre Auger Observatory, JINST 7 (2012) P09001. arXiv:1208.1675, doi:10.1088/1748-0221/7/09/P09001.

[19] P. Abreu, et al., A search for anisotropy in the arrival directions of ultra high energy cosmic rays recorded at the Pierre Auger Observatory, JCAP (2012).

[20] P. Abreu, et al., Pierre Auger Collaboration, Search for signatures of magnetically-induced alignment in the arrival directions measured by the Pierre Auger Observatory, Astropart.Phys. 35 (2012) 354–361. arXiv:1111.2472, doi:10.1016/j.astropartphys.2011.10.004.

[21] P. Abreu, et al., Pierre Auger Collaboration, Ultrahigh Energy Neutrinos at the Pierre Auger Observatory, Adv.High Energy Phys. 2013 (2013) 708680. arXiv:1304.1630, doi:10.1155/2013/708680.

[22] P. Abreu, et al., Pierre Auger Collaboration, Techniques for Measuring Aerosol Attenuation using the Central Laser Facility at the Pierre Auger Observatory, JINST 8 (2013) P04009. arXiv:1303.5576, doi:10.1088/1748-0221/8/04/P04009.

[23] P. Abreu, et al., Pierre Auger, Identifying Clouds over the Pierre Auger Observatory using Infrared Satellite Data, Astropart.Phys. 50-52 (2013) 92–101. arXiv:1310.1641, doi:10.1016/j.astropartphys.2013.09.004.

[24] P. Abreu, et al., Pierre Auger Collaboration, Bounds on the density of sources of ultra-high energy cosmic rays from the Pierre Auger Observatory, JCAP 1305 (05) (2013) 009. arXiv:1305.1576, doi:10.1088/1475-7516/2013/05/009.

[25] P. Abreu, et al., Pierre Auger Collaboration, Interpretation of the Depths of Maximum of Extensive Air Showers Measured by the Pierre Auger Observatory, JCAP 1302 (2013) 026. arXiv:1301.6637, doi:10.1088/1475-7516/2013/02/026.

[26] A. Aab, et al., Pierre Auger Collaboration, Origin of atmospheric aerosols at the Pierre Auger Observatory using studies of air mass trajectories in South America, Atmos.Res. (2014)arXiv:1405.7551, doi:10.1016/j.atmosres.2014.05.021.

[27] A. Aab, et al., Pierre Auger Collaboration, Muons in air showers at the Pierre Auger Observatory: Mean number in highly inclined events, Phys.Rev.D (2014)arXiv:1408.1421.

[28] A. Aab, et al., Pierre Auger Collaboration, Depth of Maximum of Air-Shower Profiles at the Pierre Auger Observatory: Measurements at Energies above $10^{17.8}$ eV, Phys.Rev.D (2014)arXiv:1409.4809.

[29] A. Aab, et al., Telescope Array Collaboration, Pierre Auger Collaboration, Searches for Large-Scale Anisotropy in the Arrival Directions of Cosmic Rays Detected above Energy of 10^{19} eV at the Pierre Auger Observatory and the Telescope Array, Astrophys.J. 794 (2) (2014) 172. arXiv:1409.3128, doi:10.1088/0004-637X/794/2/172.

[30] A. Aab, et al., Pierre Auger Collaboration, Reconstruction of inclined air showers detected with the Pierre Auger Observatory, JCAP 1408 (08) (2014) 019. arXiv:1407.3214, doi:10.1088/1475-7516/2014/08/019.

[31] A. Aab, et al., Pierre Auger Collaboration, Probing the radio emission from air showers with polarization measurements, Phys.Rev. D89 (2014) 052002. arXiv:1402.3677, doi:10.1103/PhysRevD.89.052002.

[32] A. Aab, et al., Pierre Auger Collaboration, Muons in air showers at the Pierre Auger Observatory: Measurement of atmospheric production depth, Phys.Rev. D90 (2014) 012012. arXiv:1407.5919, doi:10.1103/PhysRevD.90.012012,10.1103/PhysRevD.90.039904.

[33] A. Aab, et al., Pierre Auger Collaboration, Search for patterns by combining cosmic-ray energy and arrival directions at the Pierre Auger Observatory, Eur.Phys.J.C (2014)arXiv:1410.0515.

[34] A. Aab, et al., Pierre Auger Collaboration, A Targeted Search for Point Sources of EeV Neutrons, Astrophys.J. 789 (2014) L34. arXiv:1406.4038, doi:10.1088/2041-8205/789/2/L34.

[35] A. Aab, et al., Pierre Auger Collaboration, A search for point sources of EeV photons, Astrophys.J. 789 (2014) 160. arXiv:1406.2912, doi:10.1088/0004-637X/789/2/160.

[36] A. Aab, et al., Pierre Auger Collaboration, Depth of Maximum of Air-Shower Profiles at the Pierre Auger Observatory: Composition Implications, Phys.Rev.D (2014)arXiv:1409.5083.

[37] A. Aab, et al., Pierre Auger, Large Scale Distribution of Ultra High Energy Cosmic Rays Detected at the Pierre Auger Observatory With Zenith Angles up to 80 degrees, Astrophys. J. 802 (2) (2015) 111. arXiv:1411.6953, doi:10.1088/0004-637X/802/2/111.

[38] A. Aab, et al., Pierre Auger, Searches for Anisotropies in the Arrival Directions of the Highest Energy Cosmic Rays Detected by the Pierre Auger Observatory, Astrophys. J. 804 (1) (2015) 15. arXiv:1411.6111, doi:10.1088/0004-637X/804/1/15.

[39] A. Aab, et al., Pierre Auger, Muons in air showers at the Pierre Auger Observatory: Mean number in highly inclined events, Phys. Rev. D91 (3) (2015) 032003, [Erratum: Phys. Rev.D91,no.5,059901(2015)]. arXiv:1408.1421, doi:10.1103/PhysRevD.91.059901,10.1103/PhysRevD.91.032003.

[40] A. Aab, et al., Pierre Auger, Search for patterns by combining cosmic-ray energy and arrival directions at the Pierre Auger Observatory, Eur. Phys. J. C75 (6) (2015) 269. arXiv:1410.0515, doi:10.1140/epjc/s10052-015-3471-0.

[41] A. Aab, et al., Pierre Auger, Improved limit to the diffuse flux of ultrahigh energy neutrinos from the Pierre Auger Observatory, Phys. Rev. D91 (9) (2015) 092008. arXiv:1504.05397, doi:10.1103/PhysRevD.91.092008.

[42] V. Berezinsky, Transition from galactic to extragalactic cosmic rays, arXiv:0710.2750v2 (10 2007).
URL http://arxiv.org/abs/0710.2750v2

[43] A. M. Hillas, Cosmic Rays: Recent Progress and some Current Questions, arXiv:astro-ph/0607109 (2006). arXiv:arXiv:astro-ph/0607109.
URL http://arxiv.org/abs/astro-ph/0607109v2

[44] S. Mollerach, E. Roulet, O. Taborda, Evidence for a dipole above 8 EeV (June 2016).

[45] S. Mollerach, E. Roulet, O. Taborda, Further evidence for a dipole above 8 EeV (Oct. 2016).