Fermi Summer School 2017



Earth's Gamma-ray Emission in Geographical Coordinates with *Fermi*-LAT data

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If we can see gamma ray, what does Earth look like?



http://www.solarsystemscope.com/nexus/textures/tc-earth_texture/

Visible light

Gamma ray





Introduction

Results

Conclusions

What creates gamma-ray emission from Earth?



Motion of CRs in magnetic field



Introduction

Earth's magnetic field



Cutoff Rigidity





South Atlantic Anomaly (SAA)



- The SAA is a region where the geomagnetic field is weakest compared to other region at the same altitude.
- *Fermi* is designed to shut itself down automatically.



Fermi Large Area Telescope (LAT)

Results



Introduction

The LAT is a pair-conversion telescope, gamma-ray photon is converted to e+epair for detection.



Conclusions

Earth's gamma-ray detection



Data set

- o Data from 29/04/2009 to 21/01/2016
- Latest version of instrument response function and photon selection (Pass8 Source class)
- Zenith angle $cut = 112^{\circ}$, 115°
- 1° x 1° binning in latitude and longitude below 2 GeV,
 3° x 3° above 2 GeV



Flux calculation



Flux maps

Zenith cut = 112°



Zenith cut = 115°



Latitude

Latitude

2-10 GeV



Conclusions

- Gamma-ray emission from Earth is produced by interactions between cosmic rays and Earth's atmosphere.
- We have obtained preliminary pictures of Earth in gamma ray but more checks are required.





Cosmic Rays (CRs)

Cosmic rays (CRs) are high-energy particles (~10⁷ - ~10²⁰ eV) from space.

The composition of CRs

- ~90% protons
- ~9% alpha particles
- ~1% other particles such as electrons (e⁻), positrons (e⁺), gamma rays, and other ions



Results



Results

Zenith cut = 112°



Zenith cut = 115°



Results

Zenith cut = 112°



Zenith cut = 115°



2-10 GeV

