



Theoretical Astroparticle Physics Research group

[Head: Univ.-Prof. Dr. Anita Reimer]

https://www.uibk.ac.at/astro/research_groups/anita-reimer/index.html.en

Located: Viktor-Franz-Hess building, 8th floor, south-western part

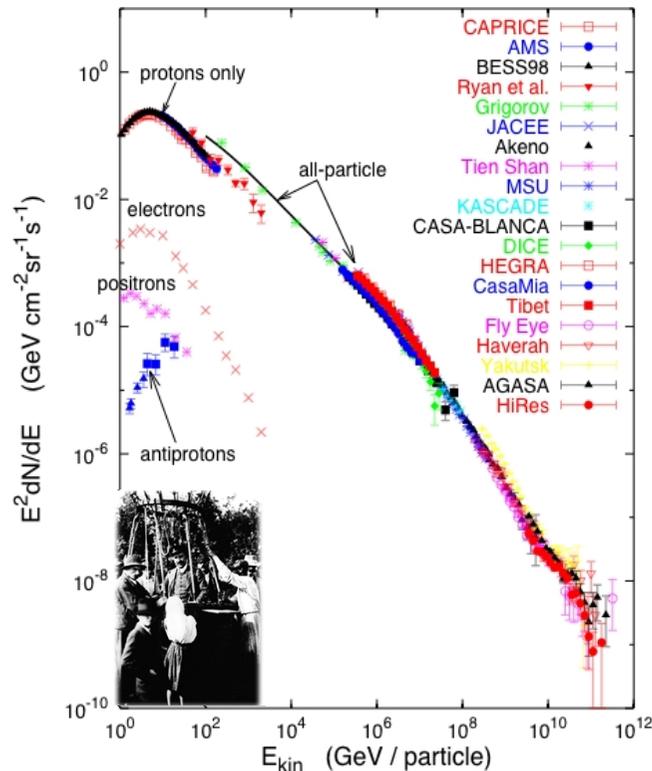
Topics for Bachelor thesis (SoSe 2022)

<https://www.uibk.ac.at/astro/teaching/bachelorarbeit/>

It is introduced ...

- The non-thermal Universe -

A non-thermal particle distribution: Allsky Cosmic-ray Spectrum



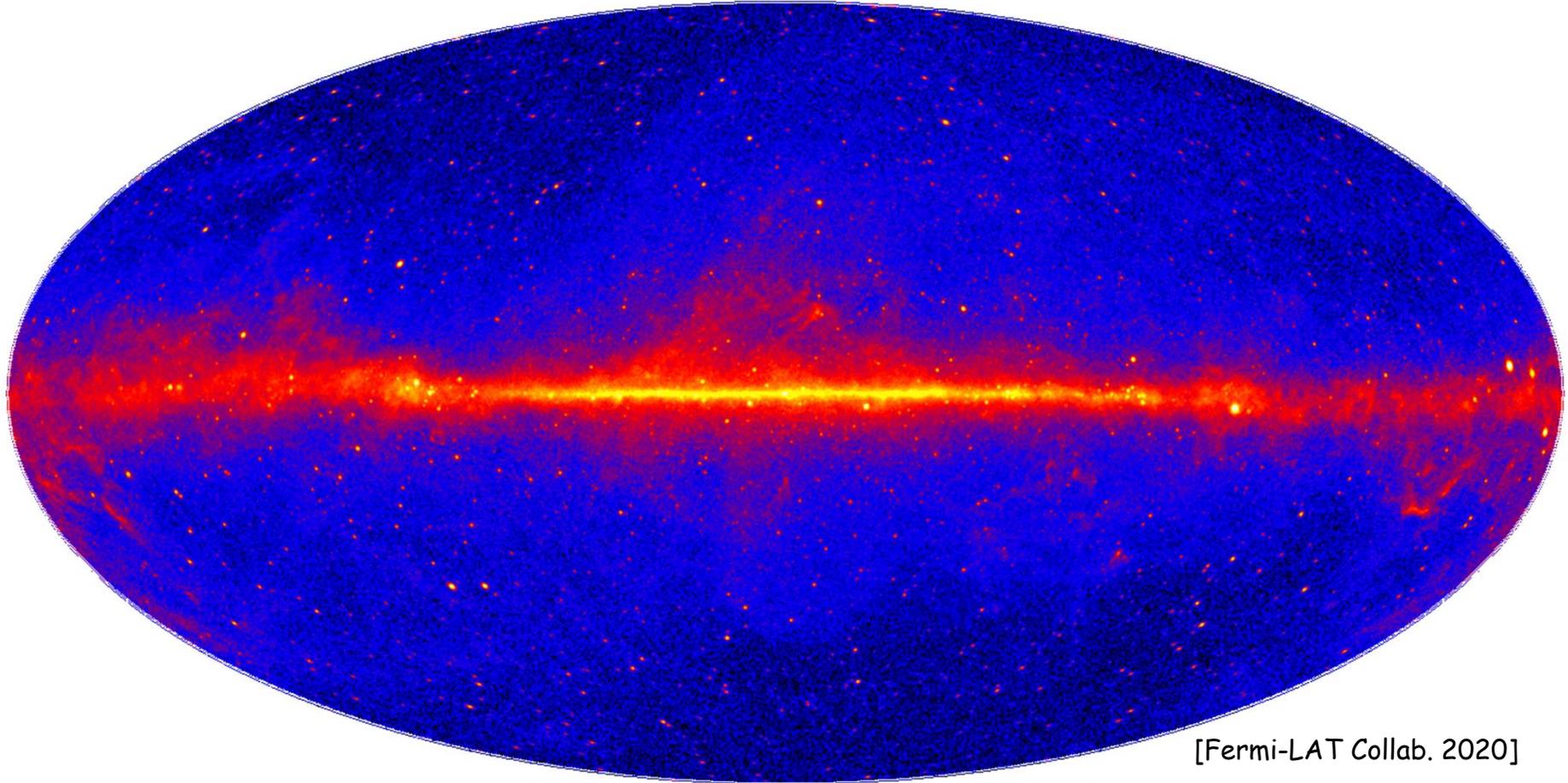
[adapted from: T. Gaisser 2005]

- Where are the sources of the cosmic rays?
- How are charged particles accelerated to cosmic-ray energies in various cosmic environments?
- How do cosmic-ray sources work?
- What are unambiguous signatures of cosmic-ray sources?
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-> Understanding cosmic-ray interactions, cosmic-ray initiated radiation, cosmic-ray propagation & acceleration,

Signatures of the non-thermal Universe

The GeV-Sky

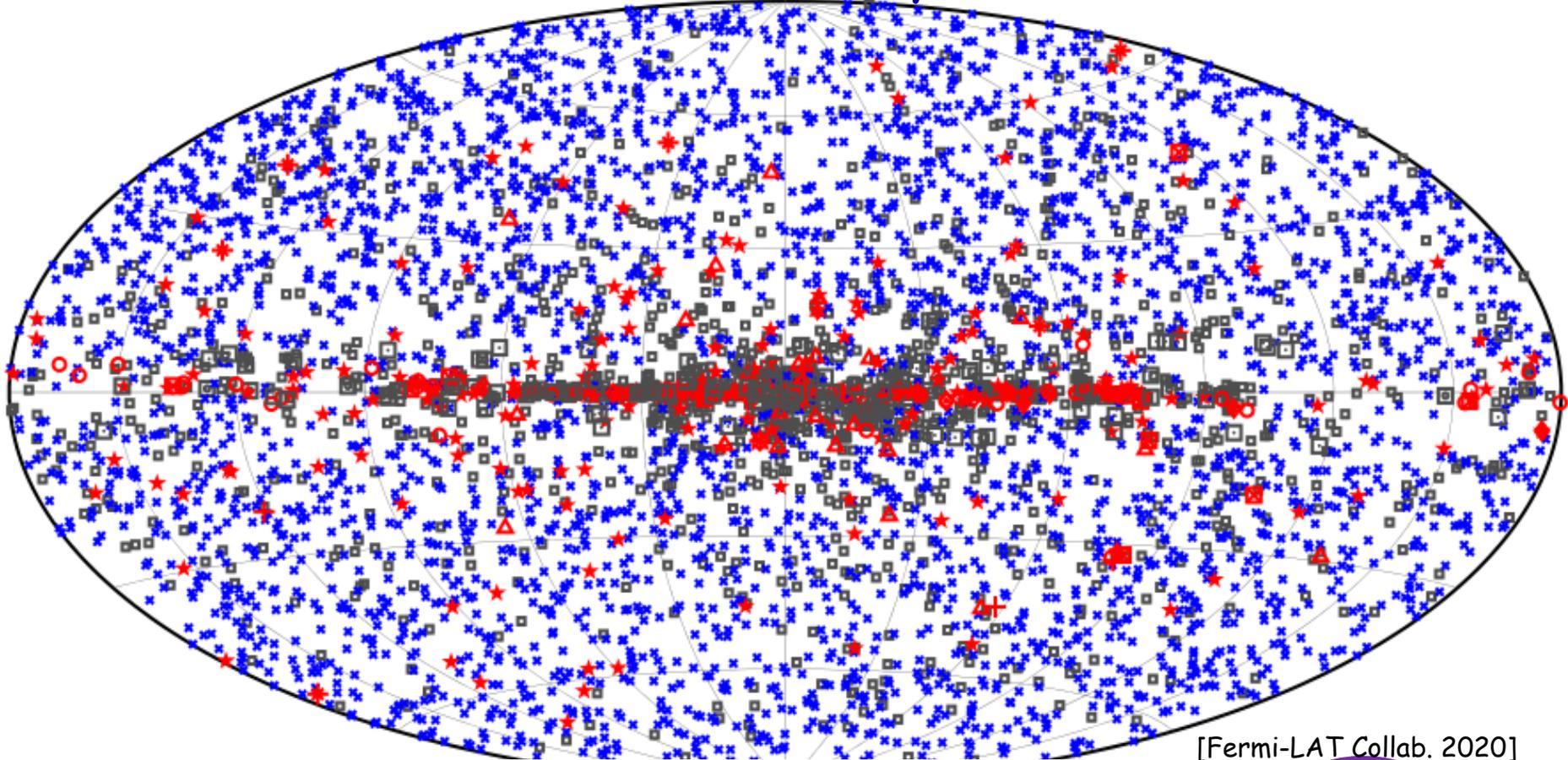


[Fermi-LAT Collab. 2020]

Energy Range: $E > 1$ GeV **The 4FGL All-Sky Map** Duration: 10 years

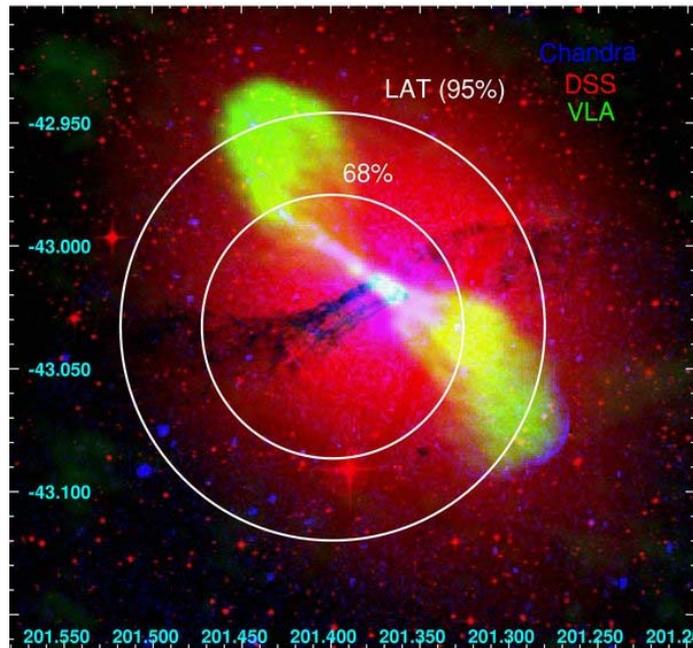
Signatures of the non-thermal Universe

The GeV-Sky



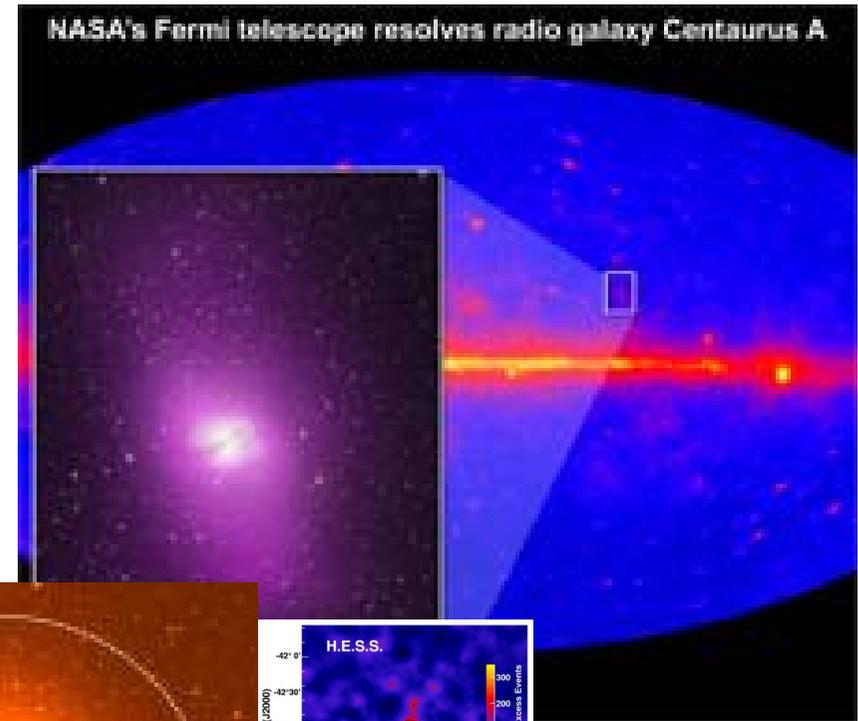
□ No association	▣ Possible association with SNR or PWN	★ AGN
★ Pulsar	△ Globular cluster	◆ PWN
⊠ Binary	+ Galaxy	⬢ Nova
★ Star-forming region	□ Unclassified source	

Gamma rays from radio galaxies:

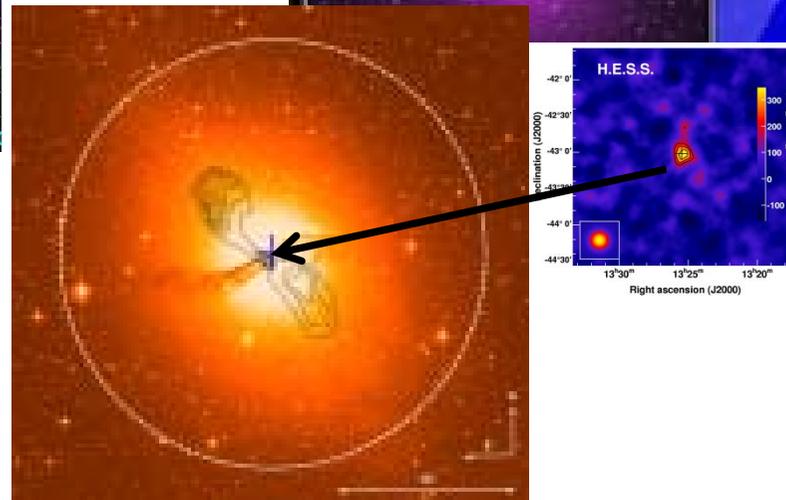


[Fermi-LAT collab., 2010]

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[LAT-collab. 2010]



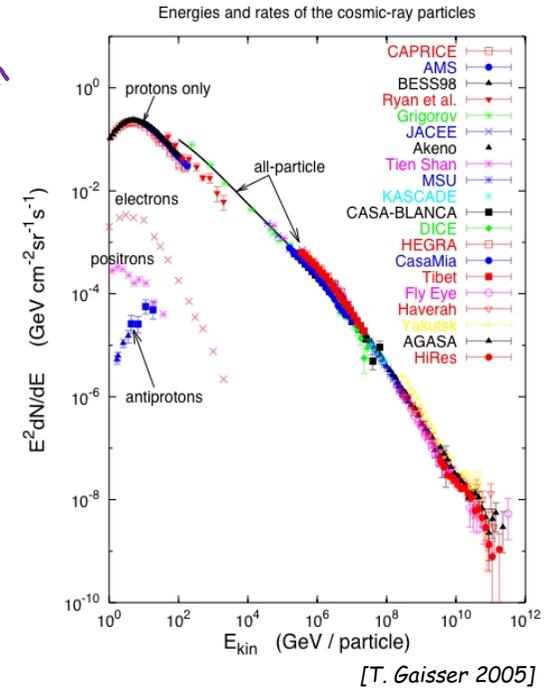
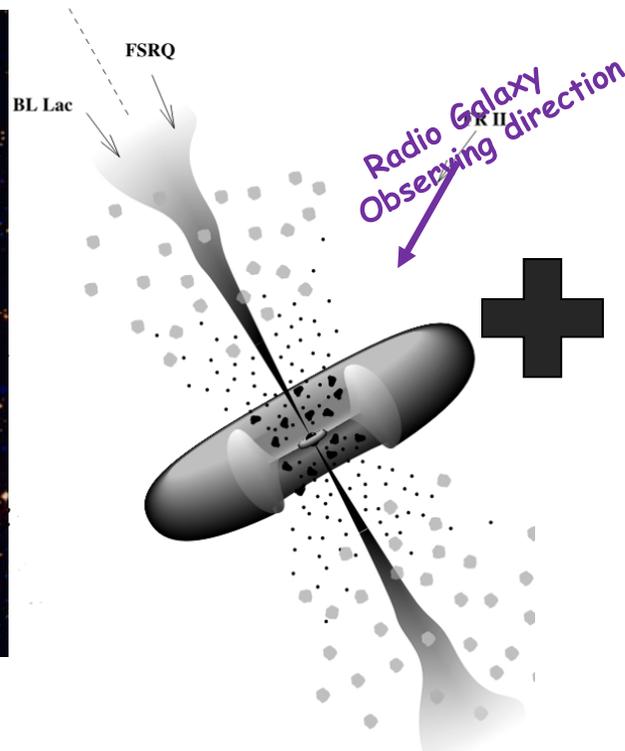
[HESS-collab., 2009]

Bachelor thesis topic:

- Pair production from cosmic ray - photon interactions in radio galaxies



[Credit: Chandra photo album]



[T. Gaisser 2005]

Photons

+ cosmic-ray nuclei

Bachelor thesis topic:

- **Pair production from cosmic ray - photon interactions in radio galaxies**

Abstract:

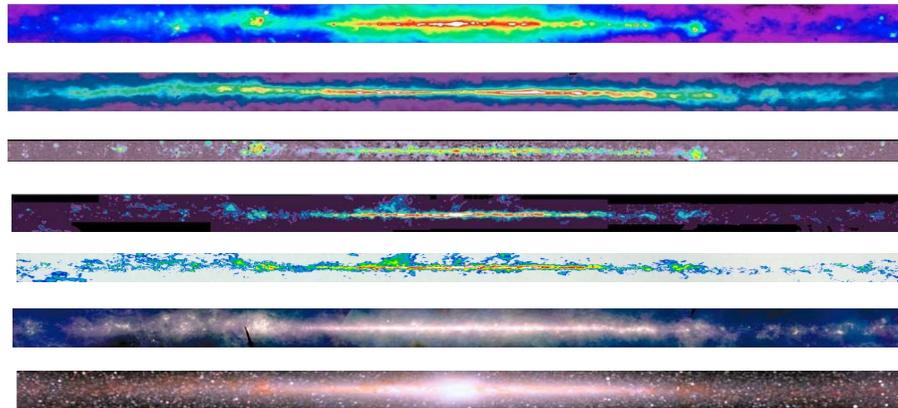
Cosmic rays are (mostly) charged particles bombarding Earth from space which can reach energies of more than 100 EeV. Recent data from the Pierre Auger Observatory reveal a gradual change of the cosmic ray mass composition from proton-dominated to nuclei-dominated starting around EeV energies. Many of the proposed counterpart sources of these energetic cosmic rays possess prominent radiation fields. Hence, cosmic rays may interact with photons in these sources, to produce electron-positron pairs by Bethe-Heitler pair production, which in turn can initiate pair cascades in this environment.

The bachelor project consists of understanding the **production of pairs through the interaction of heavy cosmic rays with photons** in general and **applied to radio galaxies**. In particular, the **goodness of the approximations for Bethe-Heitler pair production** published in Chodorowski et al (1992) shall be evaluated by comparing with the results of corresponding Monte-Carlo simulations using a photopair production event generator.

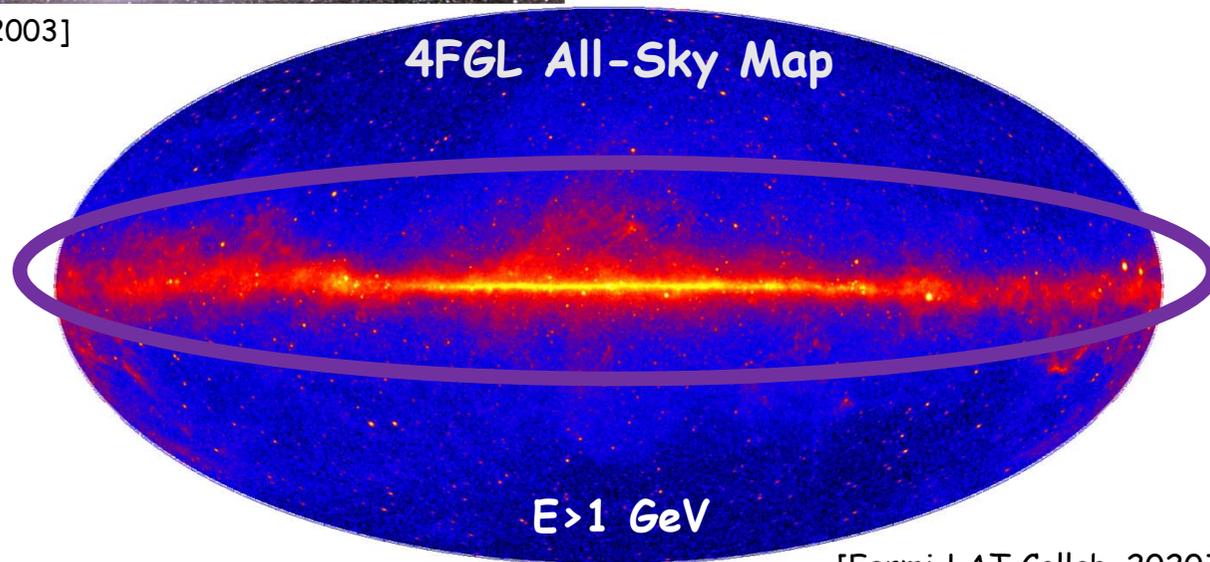
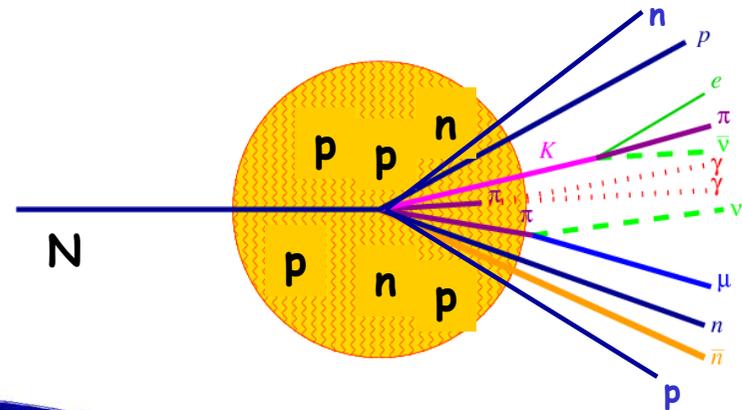
Supervisor: A. Reimer (anita.reimer(at)uibk.ac.at)

Bachelor thesis topic:

- **Inelastic interactions of cosmic rays with the interstellar medium in the Milky Way**



[Adapted from: Hunter 2003]



[Fermi-LAT Collab. 2020]

Bachelor thesis topic:

- **Inelastic interactions of cosmic rays with the interstellar medium in the Milky Way**

Abstract:

If humans would have eyes sensitive to gamma rays, a bright band would be "visible" in the southern night sky. These gamma rays are partly produced in inelastic interactions of cosmic rays (i.e., mostly charged particles reaching relativistic velocities) with matter distributed mainly in the disk of our Galaxy. Recent data imply that the fraction of heavy cosmic ray nuclei changes with energy. Hence, a good understanding of inelastic nuclear interactions, typically implemented in simulation tools such as the PICARD code, is needed to understand the observed gamma-ray spectrum.

The bachelor project consists of **understanding inelastic nuclear interactions of Galactic cosmic rays with matter** in general, and **applied to the Milky Way**. In particular, the **goodness of the approximations** for this process as implemented in the PICARD code shall be evaluated by comparing with the results of **simulations originating from nuclear interaction event generators**, with parameter settings as typical for the Milky Way.

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Bachelor-Seminar SoSe 2022

am Institut für Astro- & Teilchenphysik

Verbindliche Vorbesprechung:

Dienstag 8. März 2022, 12:15 Uhr in PR 8/18
Viktor-Franz-Hess Haus, 8. Stock

Für Vergabe von Themen (<https://www.uibk.ac.at/astro/teaching/bachelorarbeit/>)
bitte im Vorfeld Betreuer kontaktieren!