universität innsbruck

Institute for Astro- & Particle Physics

Theoretical Astroparticle Physics Research group

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

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

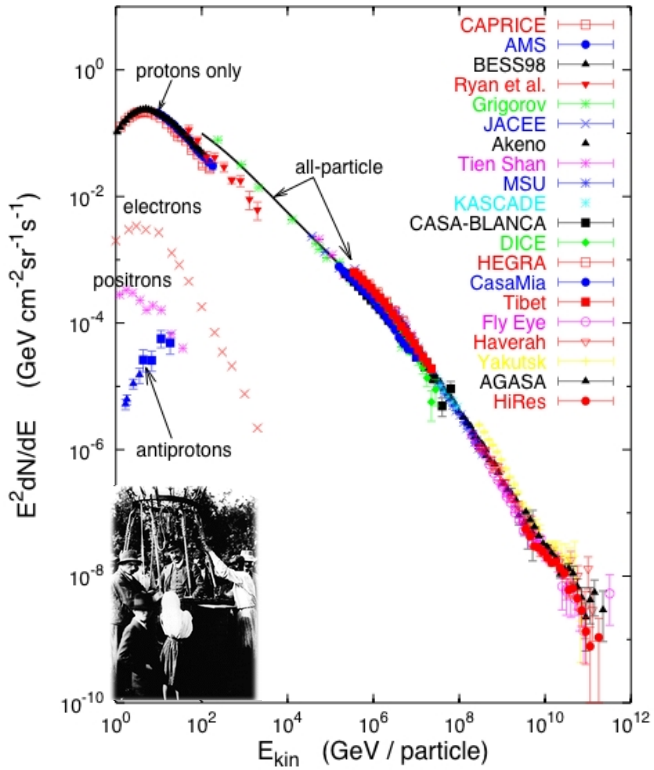
Located: Viktor-Franz-Hess building, 8th floor, south-western part

Topic for Bachelor thesis (SoSe 2026)

https://www.uibk.ac.at/de/astro/teaching/bachelor/

- The non-thermal Universe -

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



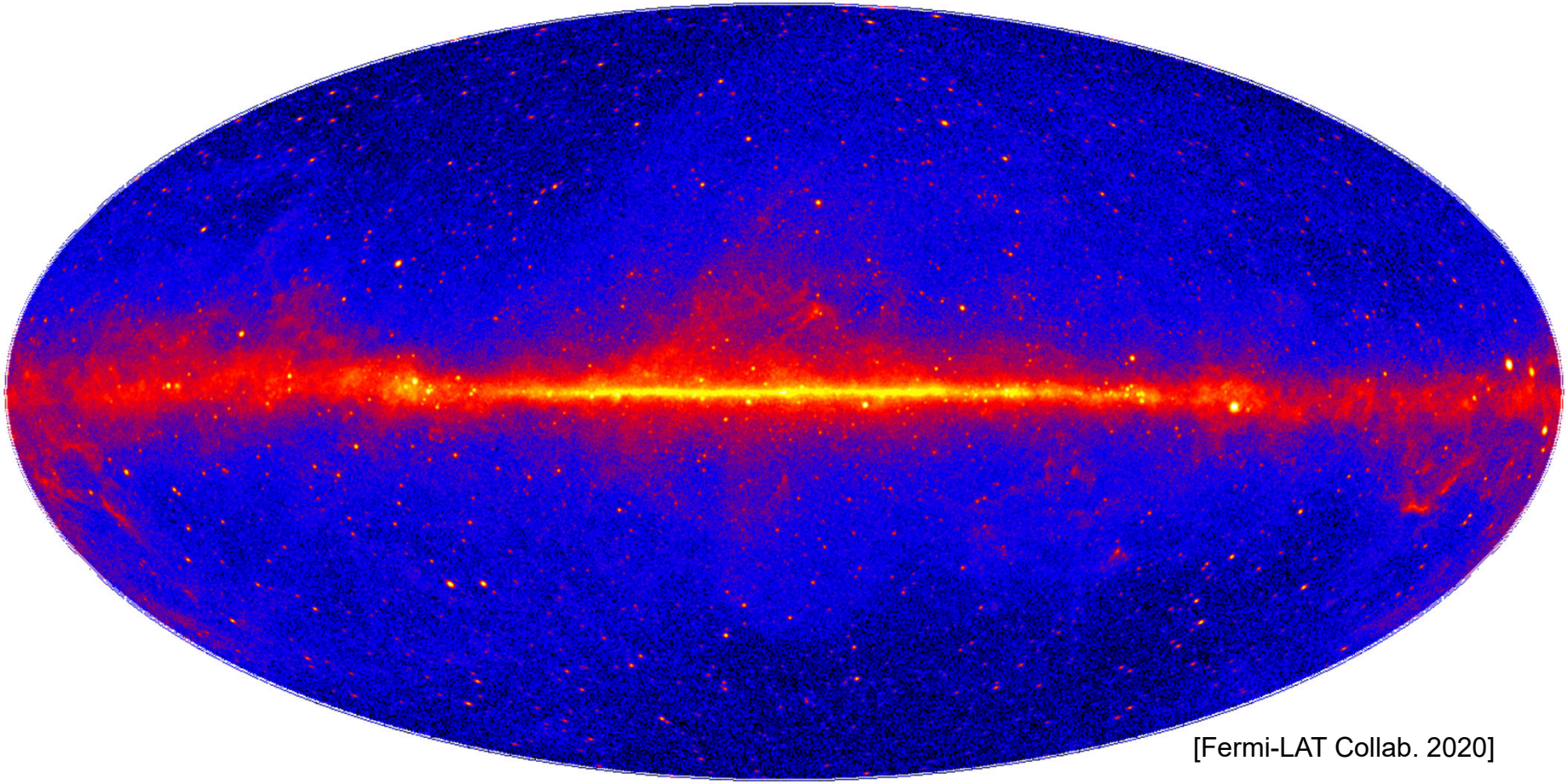
[adapted from: T. Gaisser 2005]

- **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?**
- **.....**

-> Understanding cosmic-ray interactions, cosmic-ray initiated radiation, cosmic-ray propagation & acceleration, ….

Signatures of the non-thermal Universe

The GeV-Sky

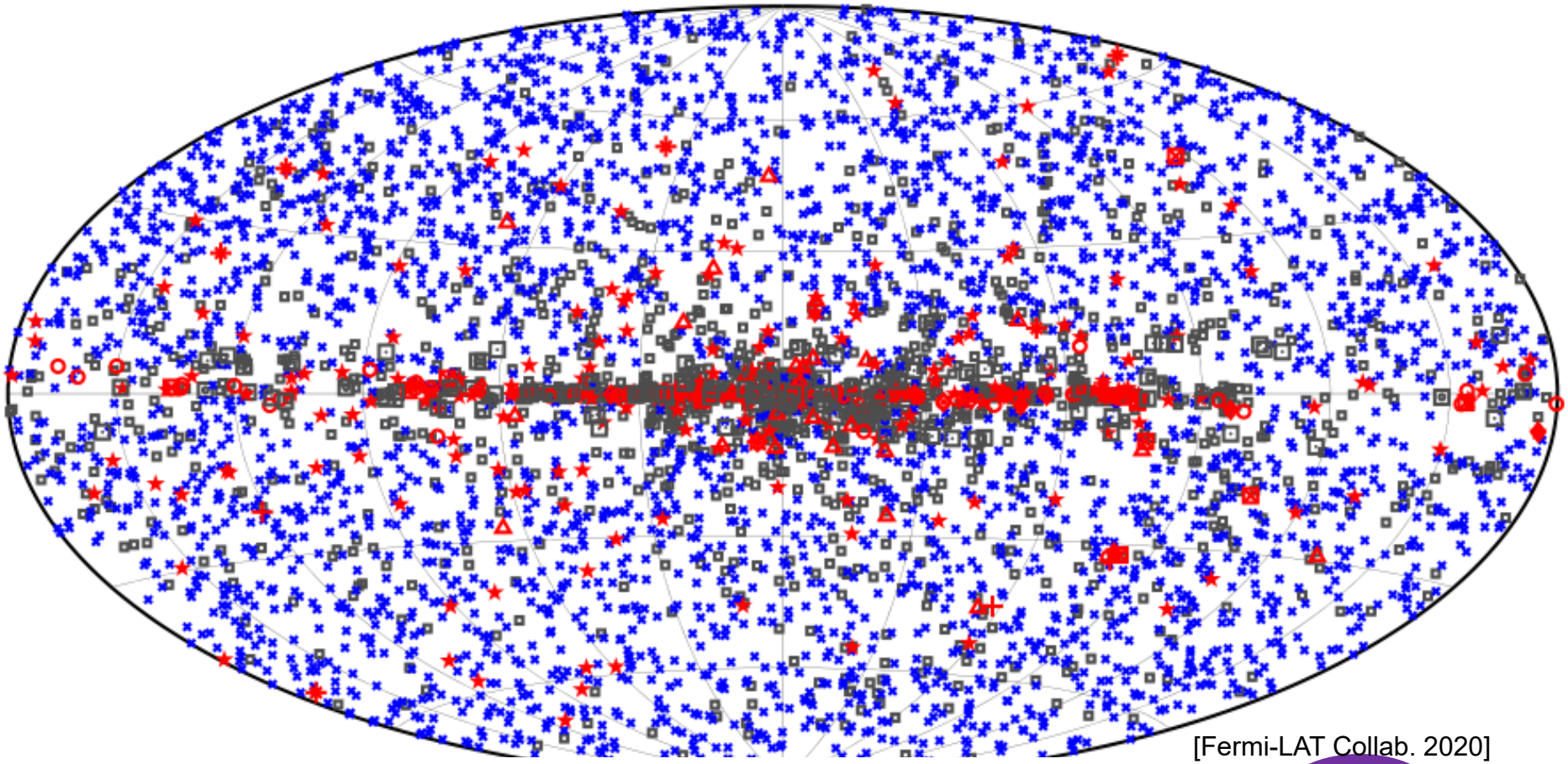


[Fermi-LAT Collab. 2020]

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

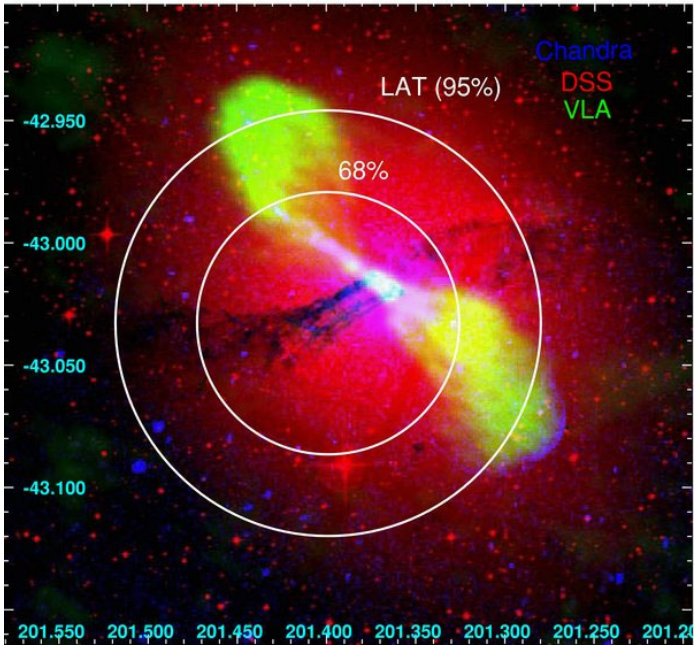
Signatures of the non-thermal Universe

The GeV-Sky



[Fermi-LAT Collab. 2020]

Gamma rays from radio galaxies:



[Fermi-LAT collab., 2010]

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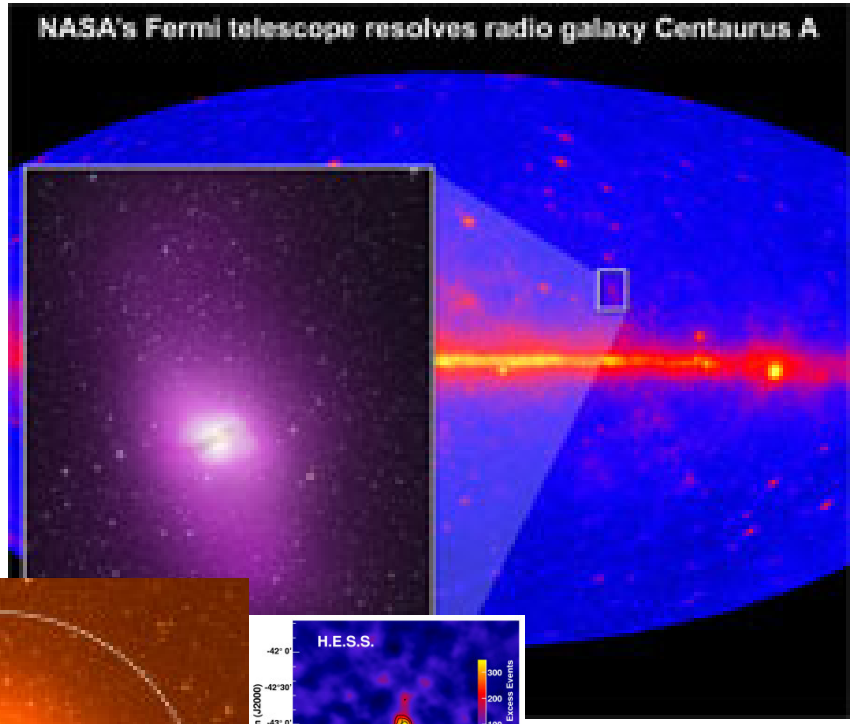
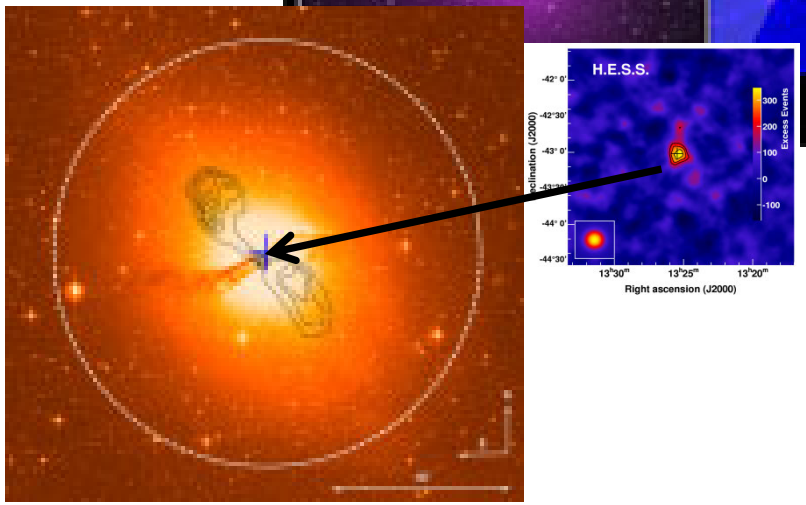


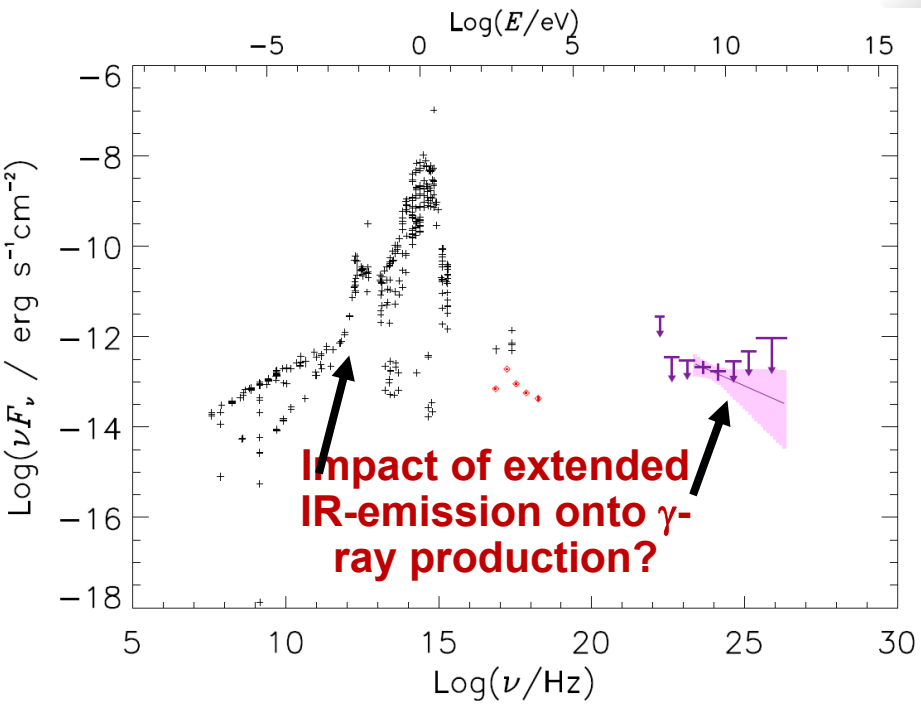
[LAT-collab. 2010]

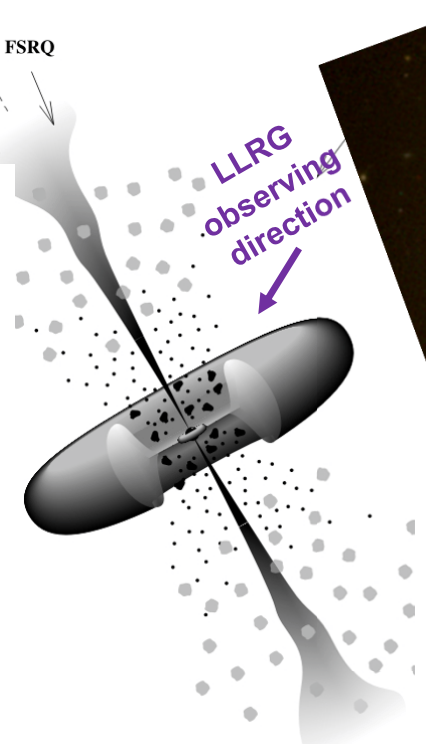


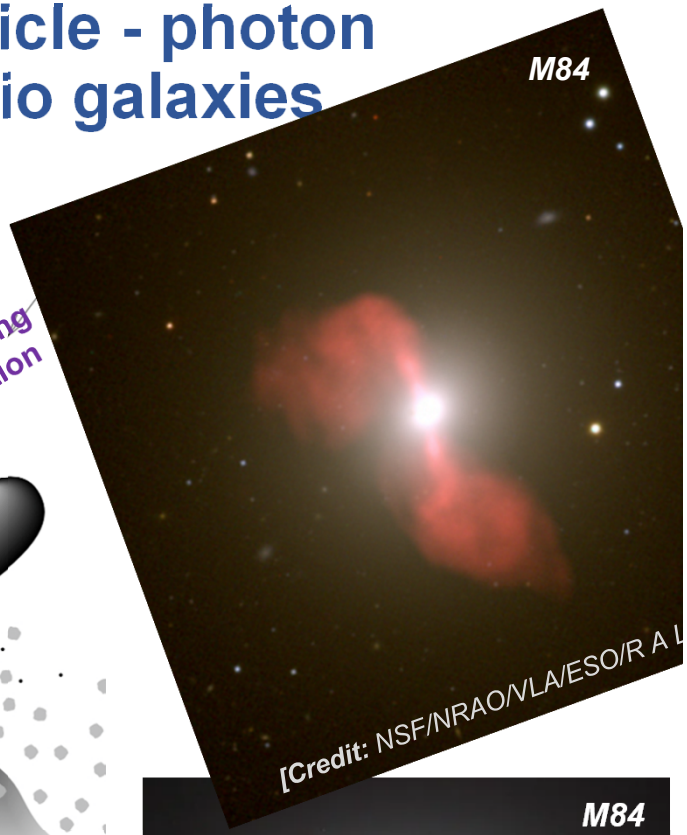
[HESS-collab., 2009]

Bachelor thesis topic:

- **Gamma rays from relativistic particle - photon interactions in low-luminosity radio galaxies**







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

Bachelor thesis topic:

- # Gamma rays from relativistic particle - photon interactions in low-luminosity radio galaxies

Abstract:

The γ-ray sky comprises thousands of energetic sources, amongst them **active galactic nuclei (AGN)** being the most numerous extragalactic population to date. Prominent **jets** of such systems have been identified as the most likely site of **γ-ray production**, although the question of the dominant production mechanism is still not settled.

Recently, the γ-ray flux scale of such detected systems have been extended to very low values ($\sim 10^{-13}$erg cm^{-2}s^{-1}), where **jetted low-luminosity AGN/radio galaxies (LLRG)** appear as weak γ-ray emitter. Unlike their prominent brothers, these often show a strong infrared (IR)-excess in their broadband spectrum, likely associated to extended emission from dust within the system.

This bachelor project investigates the **impact of this extended IR emission on the γ-ray production from relativistic particle - photon interactions in jetted LLRG.** For this purpose toy model extended morphologies of IR-emission shall be used to feed into the **cosmic-ray transport code CR-ENTREES** which contains all relevant production mechanisms of non-thermal photon distributions.

Requirements: Special Relativity kinematics & dynamics, some coding experience in a high-level programming language, interest in astroparticle physics

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