



**ENCONTRO
DE PRIMAVERA**
Sociedade Brasileira de Física

30 de setembro a 03 de outubro de 2025
Campus da UFMA, em São Luís - MA



LOCAL FR-I RADIO GALAXIES AS SOURCES OF UHECRS: INSIGHTS FROM ACCELERATION MODELING AND OBSERVATIONAL CONSTRAINTS

Andressa Colaço*, Gabriel de Azeredo, Isadora Parillo, Cainã de Oliveira, Vitor de Souza
Instituto de Física de São Carlos, Universidade de São Paulo

* *andressacolaco@usp.br*

Ultra-High Energy Cosmic Rays (UHECRs) comprise the most energetic particles ever detected, providing a unique probe into the Universe's most extreme environments. However, their origins remain elusive. UHECRs are deflected by astrophysical magnetic fields and lose energy through pion photoproduction, limiting both directional tracing and the distance they can travel. These effects, combined with recent anisotropy observations, suggest that nearby sources—within 20 Mpc—likely play a dominant role in shaping the observed UHECR spectrum. This points to the need for source-specific studies to decode the UHECR sky. This work presents a focused investigation of the three nearest radio-loud Active Galactic Nuclei (AGN) — Centaurus A, Virgo A, and Fornax A — all Fanaroff-Riley Type I (FR-I) radio galaxies with sufficient jet power to accelerate particles to ultra-high energies. By modeling their contribution to the UHECR spectrum above the ankle ($10^{18.7}$ eV), we aim to assess whether these sources can account for the data measured by the Pierre Auger Observatory (PAO). Our model is based on the acceleration expected on jets of FR-I galaxies, using modified power-law spectra. We simulate UHECR propagation, incorporating realistic energy loss mechanisms from background radiation and cosmological effects, weighting the results by the source's physical parameters, primarily jet power and maximum rigidity. The model introduces a free parameter for the fraction of jet kinetic power converted into UHECRs, enabling a physically motivated fit to observational data. A population of additional radio galaxies is also modeled to account for diffuse background contributions and improve robustness. Our preliminary results demonstrate that just around 10% of the jet power from these nearby AGN is sufficient to reproduce the observed UHECR flux. Centaurus A emerges as the leading contributor for a light primary composition, in agreement with anisotropy studies, though tensions with composition data highlight the need for refined source modeling. This study strengthens the case for local radio galaxies as key contributors to the UHECR spectrum and underscores the value of targeted modeling in resolving long-standing questions in astroparticle physics. By bridging source physics and observational constraints, we aim to provide a compelling framework for interpreting UHECR data and advance the search for their origin.