CLAF/ICTP-SAIFR Latin-American Astroparticle Physics School

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Home | Lecturers | Posters | Registration | Program | Videos and Files | Photos | Venue | Additional Information

- **Bastos, Victor** (Instituto de Física de São Carlos(IFSC) – Universidade de São Paulo (USP), Brazil): *Study of Ultra-High-Energy Cosmic Ray Propagation and Air Shower Formation*

Over the years, numerous observatories have been built to detect different regions of the cosmic energy spectrum, including the highest energies originating from deep space. The most energetic of these particles are classified as ultra-high-energy cosmic rays (UHECRs), primarily composed of protons and heavier nuclei, with energies at or above 1 EeV. Identifying the sources of UHECRs remains a significant challenge, mainly due to the deflection they experience from magnetic fields both during propagation and potentially at their acceleration sites. Despite this difficulty, some observatories—such as the Pierre Auger Observatory—are dedicated to tracing their possible origins. The objective of this work is to compare observational data from the Pierre Auger Observatory with results from Monte Carlo simulations that model the full trajectory of UHECRs, from their sources to Earth. For this purpose, I use CRPropa to simulate cosmic ray propagation through space, and both CORSIKA and FLUKA to simulate the resulting air showers generated when these particles interact with Earth's atmosphere. By combining data from the Pierre Auger Offline framework with the outputs of these simulations, the goal is to reconstruct a model of UHECR trajectories that closely matches observational results. Such a model could eventually be used to more reliably infer the origins of detected UHECRs.