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Main results of the Pierre Auger Observatory and prospects for the upgrade AugerPrime

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The Pierre Auger Observatory is the largest facility ever constructed to study ultrahigh-energy cosmic rays. Its main goal is to get clues about the nature and origin of the highest-energy cosmic rays observed so far - above 10^{18} eV. The Auger Observatory is situated at a privileged location in the Argentinean pampas, near the town of Malargüe (35.2°S) at 1400 m above sea level. Two complementary techniques are exploited to detect air showers induced by primary cosmic rays of extreme energies impinging on Earth and interacting in the atmosphere: surface detector and fluorescence telescope arrays, covering an area of 3000 km^2 . Over the years, new detectors and facilities have been installed to enrich the quality of the measurements.

Operated by an international collaboration of about 400 scientists from 100 institutions in 17 countries, the Auger Observatory has continuously taken data since 2004. Brazilian scientists participate in the Auger Collaboration since its beginning in 1995 and count with the support of RENAFEA since the creation of the network. The experimental data gathered by the Auger Observatory measuring cosmic rays, photons, and neutrinos to high-energy particle interactions have challenged our understanding of the Universe at the highest energy frontier. In parallel, the data have allowed setting limits to phenomena predicted from different theories, such as axions, superheavy dark matter particles, and Lorentz invariance violations.

Recently, the Observatory has produced ground-breaking results in astrophysics, such as the first detection of an anisotropic signal and the measurement of the energy spectrum with unprecedented resolution showing unknown structures.

In this talk, we will report the main results already obtained and highlight the future of the Pierre Auger Observatory with the new detectors for the upgrade AugerPrime in course. AugerPrime focuses on achieving mass-composition sensitivity for each air shower measured by its upgraded surface detector through multi-hybrid observations. The participation of the Brazilian community will also be addressed.

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