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Pierre Auger Observatory. From UHECR Observatory to Multidisciplinary Scientific Hub

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The Pierre Auger Observatory in Argentina was conceived as the world's largest facility dedicated to the study of ultra-high-energy cosmic rays (UHECRs). More than two decades of operation have transformed it into a broader scientific platform where frontier astroparticle physics, detector innovation, multi-messenger astronomy, geophysics, atmospheric science, and open data initiatives increasingly converge. Its original hybrid configuration, combining a 3000 km² surface array of water-Cherenkov detectors with fluorescence telescopes, has evolved over time, first through the low-energy extensions HEAT and the Infill array, and later through the underground muon detector, the radio detector, and AugerPrime, the Observatory's major upgrade. The resulting multi-hybrid observatory provides enhanced sensitivity to UHECR mass composition, extends searches for ultra-high-energy photons and neutrinos, and strengthens Auger's role in multi-messenger astronomy. This evolution extends beyond Auger itself. The Observatory has become a unique test environment—or scientific "playground"—where other collaborations can deploy, operate, and cross-calibrate new instrumentation using Auger infrastructure, coincident air-shower measurements, and the technical expertise of its personnel. Examples include FAST prototypes for next-generation fluorescence detection, layered water-Cherenkov detectors developed as part of the PEPS initiative, and the recently deployed ARISE radio array. The site has also supported complementary atmospheric and space-based investigations, notably cooperation with ESA's Aeolus mission, in which Auger fluorescence telescopes detected laser light emitted by the satellite's ALADIN lidar. Meanwhile, Auger data support studies of solar modulation, space weather, atmospheric conditions, and ionospheric ELVES, while its open-data and education programs broaden access to the facility. We present this evolution as an example of how long-term high-energy physics infrastructure in Latin America can become a multidisciplinary scientific hub, connecting fundamental science, emerging detector technologies, international collaborations, and regional capacity building.

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