

Physics and astrophysics of ultra-high energy cosmic rays: recent results from the Pierre Auger Observatory

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Ultra-high-energy cosmic rays (UHECRs) are the highest energy messengers in the universe, with energies up to 10^{20} eV. Studies of astrophysical particles (nuclei, electrons, neutrinos and photons) at their highest observed energies have implications for fundamental physics as well as astrophysics. The primary particles interact in the atmosphere (or in the Earth) and generate extensive air showers. Analysis of those showers enables one not only to estimate the energy, direction and most probable mass of the primary cosmic particles, but also to obtain information about the properties of their hadronic interactions at an energy more than one order of magnitude above that accessible with the current highest energy human-made accelerator.

The Pierre Auger Observatory, located in the province of Mendoza, Argentina, is the biggest cosmic ray experiment ever built. The Observatory was designed as a hybrid detector covering an area of 3000 km^2 and it has been taking data for more than twenty years.

In this talk a selection of the latest results is presented: the cosmic ray energy spectrum, searches for a directional anisotropy and studies of mass composition (including the photon and neutrino searches). Finally, the current upgrade ("AugerPrime") of the Observatory, which is mostly aimed at improving the sensitivity to the particle type and mass of ultra-high energy cosmic rays, is described.

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