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Probing the Flux of Ultra-High-Energy Neutral Particles at the Pierre Auger Observatory

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The Pierre Auger Observatory, the largest facility for detecting ultra-high-energy cosmic rays (UHECRs), enables detailed studies of extensive air showers over a wide energy range, from 50 PeV up to and beyond 100 EeV. Its hybrid design, combining a surface detector array, fluorescence detector, and underground muon detectors, allows the reconstruction of shower properties with high precision. This makes it possible to search for rare signatures of neutral particles such as photons and neutrinos, despite the overwhelming background from hadronic cosmic rays. Ultra-high-energy photons and neutrinos are expected as secondary products in interactions of UHECRs with background radiation, and possibly also from top-down scenarios such as the decay of super-heavy dark matter. In this contribution, we present results from a variety of searches based on 20 years of Phase I data. These include diffuse flux searches, directional searches toward candidate astrophysical sources, and investigations of transient events. The analyses employ both hybrid techniques, combining data from multiple detector systems, and searches using only the surface detector array to exploit its large exposure at the highest energies. To date, there has not yet been a statistically significant detection of photon- or neutrino-induced showers. Consequently, upper limits on their fluxes place strong constraints on models of cosmic-ray origin, source evolution, and scenarios involving exotic physics such as dark matter decay.

Collaboration you are representing

Pierre Auger Collaboration

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