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Anisotropies in the arrival direction of ultra-high-energy cosmic rays measured by the Pierre Auger Observatory

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The Pierre Auger Observatory, in continuous operation since 2004, provides the largest statistics in the world on ultra-high-energy cosmic rays (UHECRs). The Observatory employs a hybrid technique: a surface detector (SD) consisting of 1660 water-Cherenkov detectors and covering an area of 3000 km² and 27 fluorescence telescopes. The distribution of UHECR arrival directions is expected to provide essential clues to understanding their origin despite the difficulties that arise from the deflection they suffer due to galactic and extragalactic magnetic fields. We show here the latest results of searches for anisotropies in the arrival directions of the UHECRs detected by the Pierre Auger Observatory over more than three decades in energy. We present analyses of the equatorial dipole component above 0.03 EeV. At energies above 4 EeV, where the SD is fully efficient, we obtain the dipolar and quadrupolar amplitudes. The most significant equatorial dipole amplitude obtained is that in the cumulative bin above 8 EeV, which is inconsistent with isotropy at the 6σ level. Above 4 EeV we find that the amplitude of the dipole increases with energy, and the direction of the dipole is consistent with an extragalactic origin of these anisotropies. The quadrupolar components are not statistically significant. At energies below 1 EeV, even though the equatorial dipole amplitudes are not significant, the phases determined in most of the bins are not far from the the Galactic Center suggesting a predominantly Galactic origin for anisotropies at these energies. Finally, we investigate the most energetic events, where flux excesses associated with individual UHECR sources could possibly be detected. We give the latest results for a search for localized excess and a correlation with different populations of nearby extragalactic objects above 32 EeV. We have found evidence for a deviation from isotropy at an intermediate angular scale of ~25 degrees at a 4σ significance level, for energies above ~40 EeV.

Primary authors: Mr GIACCARI, Ugo (IMAPP, Radboud University, Nijmegen); OBSERVATORIO PIERRE AUGER

Presenter: Mr GIACCARI, Ugo (IMAPP, Radboud University, Nijmegen)