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Astrophysical interpretation of ultra-high-energy cosmic ray measurements at the Pierre Auger Observatory

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The Pierre Auger Observatory measures several characteristics of ultra-high-energy cosmic rays (UHECRs), in particular their energies, the shower maximum depths $X_{\rm max}$ of the air-shower profiles, and the arrival directions. Using the energy spectrum and the distributions of $X_{\rm max}$ in a combined fit, the parameters of homogeneously distributed UHECR sources can be constrained. We find that the data at the highest energies are well reproduced by an extragalactic source population dominating above the ankle that emits a mixed composition with a hard spectrum. Below the ankle, another light extragalactic population as well as a subdominant Galactic contribution is needed to explain the data.
In the case of very strong extragalactic magnetic fields between the closest sources and Earth, the spectral index of the high-energy population can be much softer and even in agreement with the expectations from shock acceleration. When taking into account also the arrival directions, it is revealed that adding a population of nearby starburst galaxies to the homogeneous background leads to an improvement of the model likelihood on the 4.5 sigma significance level. The energy-dependency of the arrival directions at the highest energies is well described by the modeled contribution from the starburst catalog or by that of the nearby radio galaxy Centaurus A.

Collaboration you are representing

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