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Interpreting the cosmic ray spectrum and composition measurements across the ankle and up to the highest energies with the data of the Pierre Auger Observatory

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In this work we investigate the astrophysical interpretation of the energy spectrum and mass composition data above 6×10^{17} eV as measured at the Pierre Auger Observatory.
Aiming at including the "ankle" feature observed at 5×10^{18} eV, we propose two simple scenarios in which it is generated as the superposition of different components. In both of them the flux above the ankle is dominated by the contribution of an extragalactic source population with a mixed mass composition; as for the below-ankle flux, we add either an extragalactic component of pure protons plus the high-energy tail of a Galactic component or a single additional extragalactic component with a mixed mass composition.
We discuss our capability to constrain the astrophysical models by studying the impact on the fit results of the main experimental systematic uncertainties and of the assumptions on the uncertain quantities affecting the cosmological source evolution, the propagation through the intergalactic medium and the air-shower development in atmosphere.
Our fit results show that the energy spectrum and mass composition data are reasonably reproduced if the mixed above-ankle component has a very hard spectrum with a low rigidity cutoff; while, as concerns the region below the ankle, a heavy mass composition is excluded in this energy range and a very soft spectrum with a scarcely constrained rigidity cutoff is estimated for the low-energy extragalactic component in both scenarios.
The consequences of the fit results on cosmogenic neutrinos and gamma-rays expectations are also evaluated and the constraining power of the corresponding current upper limits and expected future sensitivities on our astrophysical model are discussed.

Primary author: Dr GUIDO, Eleonora (Universität Siegen)

Co-author: ON BEHALF OF THE PIERRE AUGER COLLABORATION

Presenter: Dr GUIDO, Eleonora (Universität Siegen)