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Single source scenario describing the very end of the cosmic-ray energy spectrum

The energy spectrum of cosmic rays is steeply falling with a suppression of the flux at the highest energies caused by energy losses during propagation or by reaching the maximum power of cosmic accelerators. The energy spectrum at the highest energies is currently measured with high precision by two experiments, Telescope Array in the Northern hemisphere and Pierre Auger Observatory in the Southern hemisphere. However, the measured shapes of the two energy spectra differ at the highest energies. One possible explanation of such discrepancy between the two spectra might be the fact that both experiments observe different cosmic-ray sources at the highest energies. In our work, we study the possibility of explaining the shape of the energy spectrum above $10^{19.5}$ eV measured by the Pierre Auger Observatory with a single (dominant) source. Using numerical simulations in CRPropa3 of cosmic ray propagation in the Universe we show possible features of such a single source that would be able to create a shape of the energy spectrum compatible with the measurement including limitations on the source distance, spectral index and mass composition. In case of a low-mixed heavy mass composition on the Earth, we find that a single dominant source can produce the shape of the energy spectrum compatible with the observed one only for lower rigidity cutoffs $\log_{10}$(R/V) < 19.2 and spectral indices $\gamma \geq 2$ of the source distant within ≈10 Mpc from the Earth.

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