

LHAASO-KM2A 精确测量 0.3 到 30PeV 的宇宙线全粒子能谱和平均对数质量

We present the measurements of all-particle energy spectrum and mean logarithmic mass of cosmic rays in the energy range of 0.3-30 PeV using data collected from LHAASO-KM2A between September 2021 and December 2022, which is based on a nearly composition-independent energy reconstruction method, achieving unprecedented accuracy. Our analysis reveals the position of the knee at $3.67 \pm 0.05 \pm 0.15$ PeV. Below the knee, the spectral index is found to be $-2.7413 \pm 0.0004 \pm 0.0050$, while above the knee, it is $-3.128 \pm 0.005 \pm 0.027$, with the sharpness of the transition measured with a statistical error of 2%. The mean logarithmic mass of cosmic rays is almost heavier than helium in the whole measured energy range. It decreases from 1.7 at 0.3 PeV to 1.3 at 3 PeV, representing a 24% decline following a power law with an index of $-0.1200 \pm 0.0003 \pm 0.0341$. This is equivalent to an increase in abundance of light components. Above the knee, the mean logarithmic mass exhibits a power law trend towards heavier components, which is reversal to the behavior observed in the all-particle energy spectrum. Additionally, the knee position and the change in power-law index are approximately the same. These findings suggest that the knee observed in the all-particle spectrum corresponds to the knee of the light component, rather than the medium-heavy components.

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