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Observation of a knee in the p+He energy spectrum below 1 PeV by measuring particle densities very close to the EAS core with the ARGO-YBJ experiment

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The CR spectrum has been studied by the ARGO-YBJ experiment in a wide energy range (TeVs \rightarrow PeVs). This study is particularly interesting because not only it allows a better understanding of the so called 'knee' of the energy spectrum and of its origin, but also provides a powerful cross-check among very different experimental techniques.

The unique detector features (full coverage, time resolution, large dynamic range) and location (4300 m above sea level) allowed both lowering the energy threshold down to the region covered by direct measurements and reaching the knee of the all-particle spectrum where data from many ground based experiment are available since long time. Moreover, the possibility of a detailed study of the particle distribution at ground in the first few meters from the shower axis, provided a new and efficient way of selecting events initiated from light mass primaries (i.e. protons and alpha particles), without relying on the muon signal, thus avoiding systematic dependencies on the adopted hadronic interaction model.

The resulting all-particle spectrum (measured in the energy range 100 TeV - 10 PeV) is in good agreement with both theoretical parametrizations and previous measurements, thus validating the selection and reconstruction procedures. The light-component (i.e. p + He) spectrum has been measured from 30 TeV up to about 5 PeV. The result, while being consistent with highest energy direct measurements, shows a clear indication of a bending below 1 PeV. This is in agreement with other two independent analysis of ARGO-YBJ data (one of them also using the Cherenkov signal as measured by a LHAASO telescope prototype), and provides new important inputs to acceleration/propagation models for galactic cosmic rays.

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778

Collaboration

ARGO-YBJ

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