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The Ankle, the Knee and the Principle of Constant Spectral Indices in Cosmic Ray Physics

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Measurements of the energy spectra of 11 nuclear species by the TRACER experiment in the energy band $10^{11} - 5 \times 10^{14} \text{ eV}$ result in a constant, common spectral index of 2.67 ± 0.05 . A similar figure has been reported by the CREAM experiment for Helium and Proton spectra in the same energy band. This index is equal within error bars with that of the all-particle spectrum measured at very high energy, in the band $3 \times 10^{18} - 3 \times 10^{19} \text{ eV}$, by the TA, Auger, HiRes, Yakutsk, Akeno-Agasa and Haverah Park experiments. The adoption of this universal index and the calculation of the cosmic-ray trajectories in the Galaxy with adequate parameters (gas density, magnetic field, size of the Galaxy and nuclear cross sections) lead to the remarkable determination of the energy of the knee at $3 \times 10^{15} \text{ eV}$ and that of the ankle at $3.5 \times 10^{18} \text{ eV}$ along with the correct shapes of the energy spectra of individual ions in the range $10^{11} - 3 \times 10^{19} \text{ eV}$. This highly distinctive outcome is used to constrain the galactic mechanism that accelerates cosmic rays which is still unknown.

Collaboration

– not specified –

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