Study on the Combined Estimate of the Cosmic-Ray Composition and Particle Cross Sections at Ultrahigh Energies

Executive Summary

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What is this contribution about?

In this contribution we present a method for the combined estimation of the cosmic-ray mass composition and hadronic interaction cross-sections.

Why is it relevant/interesting?

The mass composition is one of the key observables to understand the nature and origin of ultra-high energy cosmic rays and the study of hadronic interactions at energies well beyond human-made accelerators is a fundamental probe of elementary particle physics.

What has been done?

By modifying the proton-proton interactions we self-consistently rescale the nucleus-air cross-sections hence affecting the extensive air shower properties. Using the varied proton-proton cross-sections as an additional fit parameter, we perform a standard mass composition fit based on the distribution of depths of atmospheric shower maximum, X_{max}, resulting in the best-fit combination of composition fractions and proton-proton cross sections. Thus, we estimate the nucleus-nucleus interaction cross sections and mass composition simultaneously and independently without making underlying assumptions present in the separate analyses.

What is the result?

The combined analysis was tested on the simulated data with the varied proton-proton cross sections and the ratio between H and He fractions, and the performance was found satisfactory. For the proton-dominated composition the estimated proton-proton interaction cross sections are compatible with the values obtained using the standard approach. Besides, we also get the near-unbiased cross sections as well as the composition fractions at arbitrarily high helium contamination.