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# Study on the combined estimate of the cosmic-ray composition and particle cross-sections at ultrahigh energies

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The mass composition is one of the key observables to understand the nature and origin of ultrahigh-energy cosmic rays (UHECRs). The study of hadronic interactions at energies well beyond human-made accelerators is a fundamental probe of elementary particle physics. In previous analyses, the properties of the hadronic interactions were estimated under the assumption of a certain mass composition, typically proton-dominated, and the cross-sections were calculated by fitting the tail of the $X_{\mathrm{max}}$ distribution. In such an analysis, the impact of a possible He-contamination on the cross-section measurement is quoted as a systematic uncertainty. Vice versa, the cosmic-ray mass composition is typically determined using air shower simulations by assuming the validity of the considered hadronic interaction models.

In this contribution, we present a fully self-consistent approach of varying the proton-proton cross-sections, with the nucleus-nucleus cross-sections being predicted via the Glauber theory, and making a full $X_{\mathrm{max}}$ distribution fit to get an independent and simultaneous estimation of the interaction cross-sections and cosmic-ray primary composition. We will discuss the degeneracy between mass composition and hadronic interactions and compare the sensitivity of the proposed method to the one of previous approaches.

## Keywords

Ultrahigh-energy cosmic rays; Mass composition; Interaction cross-sections

## Collaboration

## other Collaboration

## Subcategory

Theoretical Methods

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