High-energy atmospheric neutrinos

Abstract

This paper investigates the effects of high-energy atmospheric neutrinos on cosmic ray spectra and propagation. The authors present new theoretical models for cosmic ray propagation and compare their results with experimental data. The models are based on a comprehensive approach that includes neutrino interactions and their impact on cosmic ray spectra. The results suggest that neutrinos play a significant role in shaping the observed cosmic ray spectra.

The method: Numerical simulations

The authors use a Monte Carlo approach to simulate the propagation of cosmic rays through the Earth's atmosphere. The simulations take into account neutrino interactions, including charged current and neutral current scattering, as well as absorption and pair production. The results are compared with experimental data from cosmic ray experiments.

Equations for the nuclear Z(E, N) functions

The authors derive equations for the nuclear Z(E, N) functions, which describe the energy loss of cosmic rays due to interactions with nucleons in the atmosphere. The equations are used to predict the energy spectrum of cosmic rays as a function of altitude.

Zenith-angle enhancement of the \( v_\mu + \bar{v}_\mu \) flux

The authors present a model for the zenith-angle enhancement of the \( v_\mu + \bar{v}_\mu \) flux, which is important for understanding the propagation of neutrinos through the Earth's atmosphere. The model takes into account the effects of neutrino interactions and absorption, as well as the refractive index of the atmosphere.

Neutrino flux depending on hadronic model

The authors investigate the dependence of the neutrino flux on different hadronic models. They find that the choice of hadronic model significantly affects the predicted neutrino flux, with models that include more complex nuclear interactions leading to higher fluxes.

Acknowledgements

This work was supported by the European Research Council under the European Union's Seventh Framework Programme (EU), Grant Agreement n° 291315.

References


Promising astrophysical neutrinos

The authors propose a model for the production of high-energy neutrinos in astrophysical sources, such as gamma-ray bursts and supernovae. The model includes a detailed description of the neutrino production process and its impact on cosmic ray propagation. The results suggest that astrophysical neutrinos may be a valuable probe for understanding the properties of these sources.

Primary cosmic ray spectra

The authors present a comprehensive model for the primary cosmic ray spectra, taking into account the effects of neutrino interactions and absorption. The model is compared with experimental data from cosmic ray experiments, and the results suggest a good agreement between theory and experiment.

Cosmic-ray spectrum weighted moments

The authors derive the moments of the cosmic-ray spectrum, which are important for understanding the energy distribution of cosmic rays. The moments are calculated using a Monte Carlo approach and are compared with experimental data from cosmic ray experiments.

Inelastic cross-section of p-p collisions

The authors present a model for the inelastic cross-section of p-p collisions, which is important for understanding the energy loss of cosmic rays in the atmosphere. The model is based on a comprehensive approach that includes inelastic and elastic scattering processes, as well as the effects of nuclear interactions.

Solution for the mean cascade

The authors derive a solution for the mean cascade, which describes the energy distribution of cosmic rays as a function of depth. The solution is based on a Monte Carlo approach and is compared with experimental data from cosmic ray experiments.