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Numerical simulation of atmospheric neutrino production

This work presents a numerical simulation of the energy spectrum of atmospheric neutrinos. We model the propagation of Galactic Cosmic Ray (GCR) protons from the magnetosphere boundary to near-Earth space, followed by their subsequent interactions with the Earth's atmosphere, leading to the production of secondary particles. The simulation is performed using the GT software package [1], developed within our research group.

A comparison with similar studies [2] demonstrates good agreement and confirms the reliability of the performed calculations. Thanks to its modular structure, the GT package allows for easy replacement of the used magnetospheric models, atmospheric models, and nuclear interaction models (Geant4 physics lists) with others. This flexibility enables a comprehensive investigation of systematic uncertainties attributed to these factors. Such an analysis is of significant interest for the interpretation and processing of measurements from both current and future neutrino observatories.

[1] Golubkov, V. S., and A. G. Mayorov. "Software for numerical calculations of particle trajectories in the Earth's magnetosphere and its use in processing PAMELA experimental data." Bulletin of the Russian Academy of Sciences: Physics 85.4 (2021): 383-385.

[2] Honda, M., et al. "Atmospheric neutrino flux calculation using the NRLMSISE-00 atmospheric model." Physical Review D 92.2 (2015): 023004.

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