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A Numerical Approach to Angular Distributions in Hadronic Cascades

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Hadronic interactions of highly energetic projectiles in matter induce rich cascades of daughter particles, an example being atmospheric neutrinos produced in cosmic ray air showers. Fully analytical modelling of such cascades, due to the amount and the complexity of the coupled processes involved, is infeasible, while Monte Carlo simulations remain computationally expensive. These complications are mitigated in the numerical Matrix Cascade Equation (MCEq) code, which reaches Monte Carlo-like precision at extremely low computational costs. Previously, the MCEq framework has included longitudinal-only development of the hadronic cascades.

To accurately model secondaries at MeV-GeV energies in particle cascades, we extends the one-dimensional cascade equation solver to 2D by including angular development. The distributions are computed via the Fourier spectral method and compared to those produced with the Monte Carlo cascade codes. The potential applications of this study include fast numerical calculations of particle fluxes in air showers and atmospheric lepton flux calculations, which will benefit simulation chains of the cosmic ray and neutrino experiments.

Keywords

atmospheric air showers; cosmic rays; hadronic cascades; low energy; atmospheric neutrinos; atmospheric muons; cascade equations; MCEq; neutrino flux

Collaboration

other Collaboration

Subcategory

Theoretical Methods

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