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Constraining Lorentz Invariance Violation using the muon content of extensive air showers measured at the Pierre Auger Observatory

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Lorentz symmetry requires the space-time structure to be the same for all observers, but, on the other hand, various quantum gravity theories suggest that it may be violated when approaching the Planck scale. Even a small violation of Lorentz Invariance (LI) could easily affect the Ultra High Energy Cosmic Rays (UHECRs) propagation on a cosmological scale. Moreover, at the extreme energies, like those available in the collision of UHECRs with atmosphere, one should also expect a change in the interactions and, therefore, in the development of extensive air showers. For the first time, this effect has been studied using the muon content of air showers measured at the Pierre Auger Observatory. After having introduced Lorentz Invariance Violation (LIV) as a perturbation term in the single particle dispersion relation, a library of simulated showers with different energies, primary particles and LIV strengths has been produced. Leading to a change in the energy threshold of particle decays, the modification of the energy-momentum relation allows hadronic interactions of neutral pions that contribute to the growth of the hadronic cascade. As a consequence, an increase in the number of muons and a decrease in their intrinsic fluctuations are expected. Comparing the Monte Carlo expectations with the muon fluctuation measurements from the Pierre Auger Observatory, limits on LIV parameters have been derived and presented in this contribution.

Keywords

Extensive Air Showers; Muon content; Lorentz Invariance Violation; etc.

Collaboration

Auger

other Collaboration

Subcategory

Experimental Results

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