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Testing effects of Lorentz Invariance Violation in the propagation of astroparticles with the Pierre Auger Observatory

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Lorentz Invariance Violation (LIV) can be studied in various sectors of high-energy particle physics. Since its effects are predicted to increase with energy, ultra-high energy cosmic rays and gamma rays are powerful probes for testing different LIV models. In this work, the unprecedented statistics and data quality collected by the Pierre Auger Observatory in the EeV range are used to explore LIV scenarios. A phenomenological approach of LIV is considered by introducing a generic modification of the energy dispersion relation of the particles, which is compatible with the Coleman and Glashow approach. This may affect the kinematics of the interactions in the extragalactic propagation and in the shower development in the atmosphere. To test this, a fit of the spectrum and composition observables considering LIV in the propagation of nuclei is used as a tool to show the sensitivity of the data to LIV. Also, under certain LIV assumptions for the GZK photons propagation, it is possible to constrain the violation using the photon flux limits. For the electromagnetic sector, while no constraints can be obtained in the absence of protons beyond 10^{19} eV, we obtain $\delta_{\gamma,0} > -10^{-21}$, $\delta_{\gamma,1} > -10^{-40}$ eV^{-1} and $\delta_{\gamma,2} > -10^{-58}$ eV^{-2} in the case of a subdominant proton component up to 10^{20} eV. For the hadronic sector, we study the best description of the data as a function of LIV coefficients and we derive constraints in the hadronic sector such as $\delta_{\mathrm{had},0} < 10^{-19}$, $\delta_{\mathrm{had},1} < 10^{-38}$ eV^{-1} and $\delta_{\mathrm{had}} < 10^{-57}$ eV^{-2} at 5σ CL.

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