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Strangeness in cosmic ray - air interactions and the Muon Puzzle

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High-energy cosmic ray experiments consistently report an excess of secondary cosmic ray muons at ground level, defying predictions from prevalent high-energy interaction models: a phenomenon known as the "Muon Puzzle". The universal enhancement of strangeness and baryon production in p-p, p-Pb, and Pb-Pb collisions seen by the ALICE collaboration [Nat. Phys. 13, 535 (2017)] could provide an important key to solving the muon puzzle. It has also been shown in [PRD 107, 094031 (2023)] that decreasing the energy fraction lost to photons through π^0 and η decays can increase muon production. Proposed solutions, thus involve exploring increased strange particle yield or hadronic energy fraction during air showers. This study investigates these factors and their cross-correlation in the final state particles across various systems and energies available at the CERN Large Hadron Collider (LHC), utilizing simulation models such as EPOS LHC, SYBILL 2.3d, QGSJET II-04, and PYTHIA 8. Results are presented, accompanied by an outlook on forthcoming Oxygen-Oxygen and proton-oxygen collisions at the LHC.

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