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Muon g-2, Long-Range Muon Spin Force, and Neutrino Oscillations

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Recent studies have proposed using a geocentric muon spin force to account for the (g−2)μ anomaly, with the long-range force mediator being a light axion-like particle. The mediator exhibits a CP-violating scalar coupling to nucleons and a normal derivative coupling to muons. Due to the weak symmetry, this axion inevitably couples to neutrinos, providing potential impact on neutrino oscillations. By utilizing neutrino data from BOREXINO, IceCube DeepCore, Super-Kamiokande, and SNO, we have identified that atmospheric neutrino data can impose stringent constraints on the long-range muon spin force model and the (g−2)μ parameter space. Additionally, solar neutrino data places a strong limit on the model but provides a weaker constraint on the (g−2)μ parameter space due to a sign mismatch. With optimized data analysis techniques and the potential from future experiments, such as JUNO, Hyper-Kamiokande, SNO+, and IceCube PINGU, there exists a promising opportunity to achieve even greater sensitivities. Indeed, neutrino oscillations offer a robust and distinctive cross-check for the model, offering stringent constraints on the (g−2)μ parameter space.

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