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Constraining axion-like particles with the diffuse gamma-ray flux measured by the Large High Altitude Air Shower Observatory

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The detection of very high-energy neutrinos by the IceCube experiment supports the existence of a comparable gamma-ray counterpart from the same cosmic accelerators. Under the likely assumption that the sources of these particles are of extra-galactic origin, even for transparent sources the photon flux would be significantly absorbed during its propagation over cosmic distances. However, in the presence of photon mixing with ultra-light axion-like-particles (ALPs), this expectation would be strongly modified. Notably, photon-ALP conversions in the source would produce an ALP flux which propagates unimpeded in the extra-galactic space without being absorbed. Then, the back-conversion of ALPs in the Galactic magnetic field leads to a diffuse high-energy photon flux. In this context, the recent detection of the diffuse high-energy photon flux by the Large High Altitude Air Shower Observatory (LHAASO) allows us to exclude at the 95% CL an ALP-photon coupling $g_{a\gamma} > 3.0 - 6.0 \times 10^{-11} \text{ GeV}^{-1}$ for $m_a < 4 \times 10^{-7} \text{ eV}$, depending on the magnetic field in the source and on the original gamma-ray spectrum. This new bound is complementary with other ALP constraints from very-high-energy gamma-ray experiments and the sensitivity of future experiments.

Collaboration name

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