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Study of axion-like particle effects on the transparency of the universe to gamma rays with the Fermi Large Area Telescope

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High energy γ-ray photons emitted by astrophysical sources are absorbed by pair production with the diffuse extragalactic background light (EBL), which results in a decrease of the transparency of the universe to γ rays. Multiple extensions of the Standard Model predict the existence of axion-like particles (ALPs), a new type of pseudoscalar particles that can couple to photons in the presence of magnetic fields. Once an ALP is produced, it can travel cosmological distances without being affected by the EBL, leading to a modification of the transparency of the universe to γ rays. If the ALPs oscillate back into gamma rays close to Earth, a boost of the photon flux above a certain critical energy can be expected. In this work we study the opacity of the universe to γ rays with 80 months of data from the Fermi Large Area Telescope. The energy of the highest-energy photon is determined for each γ-ray source in the 2FHL catalog above redshifts z=0.1. By simulating the expected highest-energy photon distributions in the presence and absence of ALPs it is possible to constrain the ALPs parameters for different values of the intergalactic magnetic field strength.

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