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Search for gamma-ray spectral modulations in Galactic pulsars as a result of photon-ALPs mixing.

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Well-motivated extensions of the standard model predict ultra-light and fundamental pseudo-scalar particles (e.g., axions or axion-like particles: ALPs). Similarly to the Primakoff-effect for axions, ALPs can mix with photons and consequently be searched for in laboratory experiments and with astrophysical observations. Here, we search for energy-dependent modulations of high-energy gamma-ray spectra which are the evidential signatures of photon-ALPs mixing. To verify this, we analyze the data recorded with the Fermi-LAT from Galactic pulsars selected to have a line of sight crossing spiral arms at a large pitch angle. For the six selected Galactic pulsars, the energy spectrum is well described by a smooth model spectrum (a power-law with a sub-exponential cut-off) while a common fit of the ALPs parameters improves the goodness of fit in comparison to a smooth model spectrum with a significance of 4.6 σ. We determine the most-likely values for ALPs mass and photon-ALPs coupling constant which are by a factor of ≈ 3 larger than the current best limit on solar ALPs generation obtained with the CAST helioscope, although known modifications of the photon-ALP mixing in the high density solar environment could provide a plausible explanation for the apparent tension between the helioscope bound and the current indication for photon-ALPs mixing.

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