

## WHISPERS FROM THE DARK UNIVERSE – PARTICLES & FIELDS IN THE GRAVITATIONAL WAVE ERA

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## First Pulsar Polarization Array Limits on Ultralight Axion-like Dark Matter

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Ultralight Axion-Like Dark Matter (ALDM) is characterized by its wave-like nature on astronomical scales and has a potential to address small-scale structure problems in local galaxies. As linearly polarized pulsar light travels through the ALDM galactic halo, its position angle can oscillate due to cosmic birefringence induced by the ALDM Chern-Simons coupling to electromagnetic field. Pulsar Polarization Array (PPA) is a powerful tool for detecting such an effect by cross-correlating the polarization signals across pulsars, and hence the ultralight ALDM. In this paper, we develop a framework to analyze the time-series data of PPA. We then conduct the first PPA analysis on ultralight ALDM, using the polarization data from 22 pulsars in the third data release of Parkes Pulsar Timing Array. For the mass range of  $10^{-23} - 10^{-21}$  eV, our results surpass existing ones, pushing the limits on the ALDM Chern-Simons coupling to approximately  $10^{-14} - 10^{-12}$   $\text{GeV}^{-1}$ . Furthermore, we demonstrate that the cross-correlation of PPA data is crucial for characterizing the nature of the derived limits.

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