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Dark matter search with a MeerKAT Pulsar Polarisation Array

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The timing residuals of pulsar emissions have been used before to search for a stochastic Gravitational Wave Background (GWB), with several PTA collaborations recently reporting strong evidence for the Hellings and Downs correlation curve that would be characteristic of a GWB signal. In a similar manner, we analyse the polarisation data of a large population of pulsars observed with MeerKAT through the Thousand Pulsar Array programme, with the goal of finding evidence for the presence of an ultralight dark matter field within the Galaxy. This dark matter field, which would be composed of ultralight particles with mass around $\sim 10^{-22}$ eV, is predicted to couple to the electromagnetic field and have a birefringent dispersion relation, which ultimately results in the rotation of the polarisation angle (PA) of any linearly polarised light. Thus, by correlating the polarisation residual measurements from an array of pulsars, we should be able to distinguish a dark matter-related signal from other astrophysical sources of PA rotation. We present our current characterisation of the polarisation time series data and a set of new constraints on the coupling strength of the dark matter, which is the strongest in the current literature for the mass range of $\sim 10^{-23} - 10^{-21}$ eV.

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