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Cosmic Birefringence from Neutrino and Dark Matter Asymmetries

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In light of the recent measurement of the nonzero Cosmic Microwave Background (CMB) polarization rotation angle from the Planck 2018 data, we explore the possibility that such a cosmic birefringence effect is induced by coupling a fermionic current with photons via a Chern-Simons-like term. We begin our discussion by rederiving the general formulae of the cosmic birefringence angle with correcting a mistake in the previous study. We then identify the fermions in the current as the left-handed electron neutrinos and asymmetric dark matter (ADM) particles, since the rotation angle is sourced by the number density difference between particles and antiparticles. For the electron neutrino case, with the value of the degeneracy parameter ξ_{ν_e} recently measured by the EMPRESS survey, we find a large parameter space which can explain the CMB photon polarization rotations. On the other hand, for the ADM solution, we consider two benchmark cases with $M_\chi = 5$ GeV and 5 keV. The former is the natural value of the ADM mass if the observed ADM and baryon asymmetry in the Universe are produced by the same mechanism, while the latter provides a warm DM candidate. In addition, we explore the experimental constraints from the CMB power spectra and the DM direct detections.

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