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Probing Axionic Instabilities in the late Universe via CMB-B mode

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We study the cosmological signatures of a completely secluded dark sector consisting of axion-like particles (ALPs) with anomalous coupling to a dark Abelian gauge boson. The lighter ALP starts rolling during matter domination and produces dark photons through tachyonic instabilities. The resulting exponential growth in dark photon quanta sources tensor and scalar perturbations which are uncorrelated with the inflationary initial perturbation. These perturbations generate temperature and polarization (E and B mode) anisotropies in the CMB. We constrain the parameter space of the ALP-dark photon system using the CMB measurement from Planck and B mode constraints from the BICEP-Keck array. For most of the viable parameter space, the B mode signal is well within the reach of future B mode experiments. Additionally, this scenario exhibits intrinsic CP violation and produces non-zero EB correlation in the CMB spectrum. We analyze the CP violating signature in light of the recent measurement of cosmic birefringence from Planck data which shows striking deviation from CP symmetry.

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