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A Dynamical Axion Decay Constant with Modulus Kination

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We consider a QCD axion coming from the compactification of extra dimensional gauge fields. In this scenario, the QCD axion is around during inflation and seeds isocurvature. In the standard cosmic picture where reheating immediately follows inflation, CMB isocurvature bounds imply a low inflationary energy scale if the QCD axion were to comprise all of the dark matter. This poses an obstacle, known as the axion isocurvature problem, since it is difficult to construct low-scale inflation scenarios that are consistent with our observations of the CMB. We tackle this problem by considering an additional epoch between inflation and reheating: bulk-modulus kination. During this epoch, the axion decay constant is dynamical and decreases with time. In particular, we are interested in determining whether a large initial decay constant that supports high-energy inflation can decrease fast enough during bulk-modulus kination such that its final value is small enough to be consistent with CMB bounds. Towards this end, we investigate how the particle production of axions coupled to the modulus field can halt kination in order to determine the duration of this epoch and the associated change in the QCD axion decay constant.

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