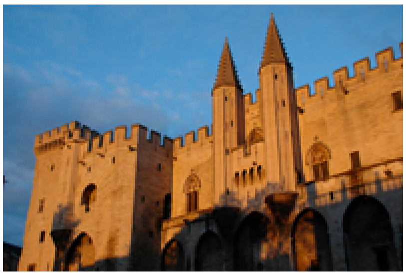

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Oscillating scalar fields and the Hubble tension: a resolution with novel signatures

Monday 7 December 2020 17:00 (20 minutes)

We present a detailed investigation of a sub-dominant oscillating scalar field ('early dark energy', EDE) in the context of resolving the Hubble tension. Consistent with earlier work, but without relying on fluid approximations, we find that a scalar field frozen due to Hubble friction until log10(z_c)~3.5, reaching $\rho_{\rm EDE}(z_c)/\rho_{\rm tot}$~10%, and diluting faster than matter afterwards can bring cosmic microwave background (CMB), baryonic acoustic oscillations, supernovae luminosity distances, and the late-time estimate of the Hubble constant from the SH0ES collaboration into agreement. A scalar field potential which scales as $V()$ ^{2n} with 2⊠n⊠3.4 around the minimum is preferred at the 68% confidence level, and the Planck polarization places additional constraints on the dynamics of perturbations in the scalar field. In particular, the data prefers a potential which flattens at large field displacements. An MCMC analysis of mock data shows that the next-generation CMB observations (i.e., CMB-S4) can unambiguously detect the presence of the EDE at very high significance. This projected sensitivity to the EDE dynamics is mainly driven by improved measurements of the E-mode polarization. We also explore new observational signatures of EDE scalar field dynamics: (i) We find that depending on the strength of the tensor-to-scalar ratio, the presence of the EDE might imply the existence of isocurvature perturbations in the CMB. (ii) We show that a strikingly rapid, scale-dependent growth of EDE field perturbations can result from parametric resonance driven by the anharmonic oscillating field for n≈2. This instability and ensuing potentially nonlinear, spatially inhomogenoues, dynamics may provide unique signatures of this scenario.

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