arXiv:2601.20293

Model independent test of the FLRW metric and the curvature in light of DESI DR2

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Abstract

We perform a data-driven test of the FLRW metric and the flatness of the Universe, independently of any Dark Energy model, and in light of the latest DESI DR2 results. We use Pantheon+ and DES Dovekie SNIa data to reconstruct the distance modulus, dimensionless comoving distance and Hubble parameter, using an iterative smoothing algorithm. Then, combining the various reconstructions with the recent BAO measurements from DESI DR2, we perform the $\mathcal{O}_k$ diagnostic, a litmus test of the FLRW metric and the flatness of the Universe. We obtain robust results that do not depend on Dark Energy models and test some of the underlying hypotheses of the concordance model. We find that when the reconstructed $\mathcal{O}_k$ diagnostic is consistent with the FLRW metric, then the median value of $\Omega_{k,0}$ over all reconstructions that provide an improved fit relative to the flat ΛCDM model are: $\Omega_{k,0}^{\rm med} = 0.045^{+0.045}_{-0.081} \pm 0.038$ for the Pantheon+ & DESI DR2 data combination, $\Omega_{k,0}^{\rm med} = 0.095^{+0.063}_{-0.136} \pm 0.063$ for the same data but with the Pantheon+ SNIa cut at redshift $z = 1.13$, which is the maximum redshift of the DES Dovekie data, and $\Omega_{k,0}^{\rm med} = -0.102^{+0.099}_{-0.005} \pm 0.043$ for DES Dovekie & DESI DR2. The first uncertainties correspond to the spread in $\Omega_{k,0}$ over all reconstructions, followed by the median 1σ error. Our results are consistent with flatness and Planck 2018 within 3σ.