

Timescape versus Λ CDM — precision tests of emerging spatial curvature

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The timescape cosmology returns to first principles, to explain apparent cosmic acceleration in the statistical regime of general relativity. As inhomogeneities in density and expansion grow, they back react on the average cosmic expansion, which differs from conventional FLRW models. Crucially, dynamical spatial curvature arises as time-varying gradients of the kinetic energy of expansion, depending directly on the volume fraction of cosmic voids.

The timescape expansion history is close to Λ CDM, but with differences at a precision which we are now finally probing. Whereas Λ CDM is increasingly challenged, independent observational tests now favour timescape. In particular, the recent DESI evidence for “evolving dark energy” gives a dark energy “equation of state” $w(z)$ consistent with timescape’s non-FLRW evolution, as predicted in 2009. Projections made in 2014 for the Euclid mission showed that Euclid will distinguish FLRW expansion histories from those with emerging spatial curvature, including timescape, by the definitive Clarkson-Bassett-Lu (CBL) test. The CBL test consists of two parts: the first part requiring over 1000 precise type Ia supernova luminosity distance measurements was completed in our recent analysis of the Pantheon+ data, finding very strong Bayesian evidence ($\ln B > 5$) in favour of timescape over Λ CDM. Furthermore, even restricting the sample to redshifts beyond any conventional scale of statistical homogeneity, $z > 0.075$, timescape is preferred over Λ CDM with $\ln B > 1$. This was confirmed independently by the DES survey.

The second part of the CBL test involving Euclid BAOs over a redshift range, $0.7 < z < 2.0$, requires geometric new tools. Since the ratio of dark matter to baryonic matter must be recalibrated for timescape, this requires that we revisit cosmological perturbation theory. Our team has now developed a framework for analysing the growth of perturbations on generic averaged backgrounds, without assuming an exact global Λ CDM evolution, but only causality on the subhorizon scales on which matter and geometry are directly coupled.

In this talk I will outline results to date, and discuss the remaining challenges to test a fundamentally new paradigm for cosmology with the same precision as Λ CDM by 2030.

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Clasificación de la sesión : Morning Session (Thursday)