Preprint Series in Particles and Cosmos Physics

nº IPARCOS-UCM-24-032

The Dark Energy Survey Supernova Program: Slow supernovae show cosmological time dilation out to z~1

by R. M. T. White et al. (including J. Asorey)

June 2024

Plaza de las Ciencias, 1 28040 Madrid, Spain

www.ucm.es/iparcos/

IPARCOS

INSTITUTO DE FÍSICA
DE PARTÍCULAS Y DEL COSMOS

UNIVERSIDAD COMPLUTENSE MADRID

INSTITUTO DE FÍSICA
DE PARTÍCULAS Y DEL COSMOS

IPARCOS

Abstract

We present a precise measurement of cosmological time dilation using the light curves of 1504 type Ia supernovae from the Dark Energy Survey spanning a redshift range $0.1 \leq z \leq 1.2$. We find that the width of supernova light curves is proportional to $(1+z)$, as expected for time dilation due to the expansion of the Universe. Assuming type Ia supernovae light curves are emitted with a consistent duration Δt_{em}, and parameterising the observed duration as $\Delta t_{obs} = \Delta t_{em}(1+z)^b$, we fit for the form of time dilation using two methods. Firstly, we find that a power of $b \approx 1$ minimises the flux scatter in stacked subsamples of light curves across different redshifts. Secondly, we fit each target supernova to a stacked light curve (stacking all supernovae with observed bandpasses matching that of the target light curve) and find $b = 1.003 \pm 0.005$ (stat) ± 0.010 (sys). Thanks to the large number of supernovae and large redshift-range of the sample, this analysis gives the most precise measurement of cosmological time dilation to date, ruling out any non-time-dilating cosmological models at very high significance.

UNIVERSIDAD
COMPLUTENSE
MADRID