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Cosmic chronometers to calibrate the ladders and measure the curvature of the Universe. A model-independent study

Tuesday, 9 July 2024 17:00 (30 minutes)

We use the state-of-the-art data on cosmic chronometers (CCH) and the Pantheon+ compilation of supernovae of Type Ia (SNIa) to test the constancy of the SNIa absolute magnitude, M, and the robustness of the cosmological principle (CP) at $z < 2$ with a model-agnostic approach. We do so by reconstructing $M(z)$ and the curvature parameter $\Omega_k(z)$ using Gaussian Processes. Moreover, we use CCH in combination with data on baryon acoustic oscillations (BAO) from various galaxy surveys (6dFGS, BOSS, eBOSS, WiggleZ, DES Y3) to measure the sound horizon at the baryon-drag epoch, r_d, from each BAO data point and check their consistency. Given the precision allowed by the CCH, we find that $M(z)$, $\Omega_k(z)$ and $r_d(z)$ are fully compatible (at $< 68\%$ C.L.) with constant values. This justifies our final analyses, in which we put constraints on these constant parameters under the validity of the CP, the metric description of gravity and standard physics in the vicinity of the stellar objects, but otherwise in a model-independent way. If we exclude the SNIa contained in the host galaxies employed by SH0ES, our results read $M = (-19.314^{+0.086}_{-0.108})$ mag, $r_d = (142.3 \pm 5.3)$ Mpc and $\Omega_k = -0.07^{+0.12}_{-0.15}$, with $H_0 = (71.5 \pm 3.1)$ km/s/Mpc (68% C.L.). These values are independent from the main data sets involved in the H_0 tension, namely, the cosmic microwave background and the first two rungs of the cosmic distance ladder. If, instead, we also consider the SNIa in the host galaxies, calibrated with Cepheids, we measure $M = (-19.252^{+0.024}_{-0.036})$ mag, $r_d = (141.9^{+5.6}_{-4.9})$ Mpc, $\Omega_k = -0.10^{+0.12}_{-0.15}$ and $H_0 = (74.0^{+0.9}_{-1.0})$ km/s/Mpc. At present, the error bars provided by this model-agnostic approach are still too large to arbitrate the tension. With the advent of upcoming surveys, the proposed method can serve both as a discriminator of models beyond the ΛCDM and as an independent means of testing the calibration of the direct and inverse cosmic distance ladders.

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