H_0 crisis: Systematics of distance calibrators or the end of ΛCDM?

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1 Talk-Abstract

The Hubble expansion rate as a function of the redshift $H(z)$ can be derived by measuring cosmological luminosity or angular diameter distances. These distances are measured using apparent luminosity or angular scale observations of objects that have fixed absolute luminosity or fixed comoving size (distance calibrators) assumed known in the context of standard physical mechanisms.

The most useful early universe distance calibrator is the scale r_s of the sound horizon at recombination which can be observed at the recombination redshift (z=1100) through the CMB anisotropy spectrum and at low redshifts (z=O(1)) through Baryon Acoustic Oscilations (BAO) of the large scale structure power spectrum.

The most useful late universe calibrator is the absolute magnitude M of Type Ia supernovae calibrated eg by using Cepheid variable stars. The form of H(z) measured using late universe calibrators is offset by the H(z) measured using early universe calibrators by 9%. This difference is statistically significant at a level of more than 4σ and is known as the H_0 problem for standard ΛCDM cosmology as it also affects the present value of $H(z)(H(z=0)=H_0)$[5, 2, 6]. I will review the origin and the observational status of this problem. I will also discuss physical mechanisms that can explain this 9% difference in the value of H_0 by modifying the early universe calibrator r_s (early universe models[4]), by modifying the form of $H(z)$ away from ΛCDM at late times (late universe models I[1]) or by modifying the late universe calibrator M (late universe models II[3]).

2 Date-Time

Friday December 18 at 12:00 (Greece)
Click here for the Zoom link (authentication required).

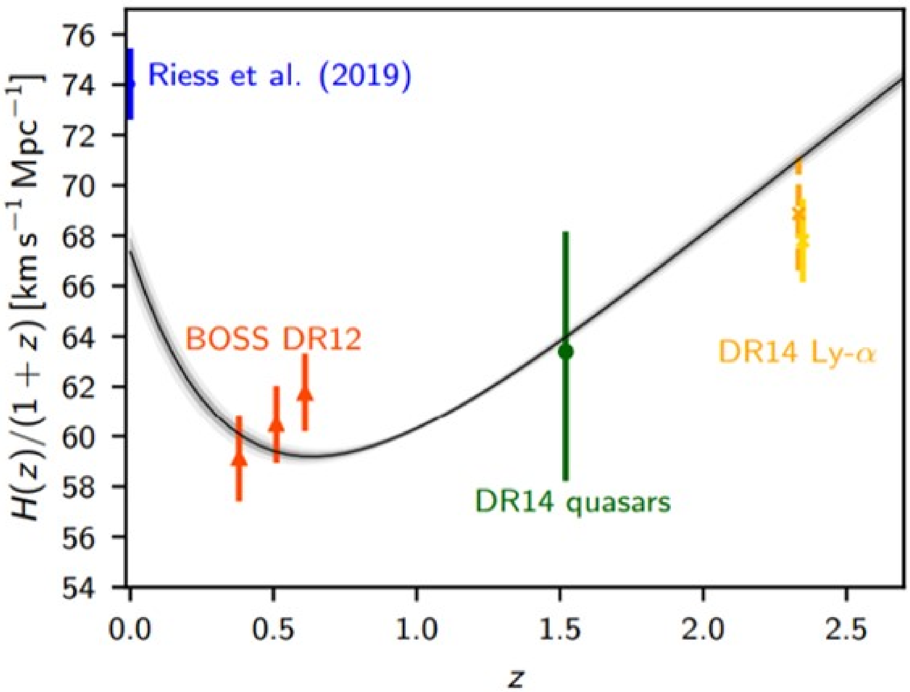

Figure 1: The Hubble expansion rate $H(z)$ from early universe calibrator compared to the value of $H(z = 0)$ obtained using the late universe calibrator M (blue datapoint point). The other datapoints shown (BAO) are calibrated using the early universe calibrator.

References

[1] G. Alestas, L. Kazantzidis, and L. Perivolaropoulos. H_0 tension, phantom dark energy, and cosmological parameter degeneracies. *Phys. Rev. D*, 101(12):123516, 2020.

[2] Jose Luis Bernal, Licia Verde, and Adam G. Riess. The trouble with H_0. *JCAP*, 10:019, 2016.

[3] Lavrentios Kazantzidis and Leandros Perivolaropoulos. Is gravity getting weaker at low z? Observational evidence and theoretical implications. 7 2019.

[4] Vivian Poulin, Tristan L. Smith, Tanvi Karwal, and Marc Kamionkowski. Early Dark Energy Can Resolve The Hubble Tension. *Phys. Rev. Lett.*, 122(22):221301, 2019.

[5] Adam G. Riess, Stefano Casertano, Wenlong Yuan, Lucas M. Macri, and Dan Scolnic. Large Magellanic Cloud Cepheid Standards Provide a 1% Foundation for the Determination of the Hubble Constant and Stronger Evidence for Physics beyond ΛCDM. *Astrophys. J.*, 876(1):85, 2019.

[6] L. Verde, T. Treu, and A.G. Riess. Tensions between the Early and the Late Universe. *Nature Astron.*, 3:891, 7 2019.