A brief review of attempts to solve the Hubble tension

What is it all about ?

➢ **Introduction**

➢ **Possible solutions:**

- Primordial Gravitational Waves (GWs)
- Errors on the measurements
- Coupled Dark Sector

➢ **Conclusion**

Introduction

Depending on the method:

$$H_0 = 66.93 \pm 0.62 \ km.s^{-1}.Mpc^{-1}$$ **by the Planck data group**

$$H_0 = 73.24 \pm 1.74 \ km.s^{-1}.Mpc^{-1}$$ **according to Riess et al.**

It's a 3.4σ discrepancy, so what's going on ?

Possible solution: Primordial GWs

Modify early universe physics:
Primordial GWs have an impact on the effective number of relativistic degrees of freedom

$$N_{eff} = 3.046 + \left[3.046 + \frac{8}{7} \left(\frac{11}{4} \right)^{\frac{4}{3}} \right] \frac{A_s r}{24 n_t} \left(\frac{k_{UV}}{k_*} \right)^{n_t}$$

$$\rho_{tot} = \rho_\gamma \left(1 + \frac{7}{8} \left(\frac{4}{11} \right)^{\frac{4}{3}} N_{eff} \right)$$

Get to $H_0 = 68.62^{+0.57}_{-1.20} \, km.s^{-1}.Mpc^{-1}$

Possible solution: Errors on the measurements

Shanks et al. argue that Riess et al. made measurement errors

$$H = \frac{v}{D}$$

Correct errors to increase D and decrease v
Get to $H_0 = 67.6 \pm 1.52 \; km.s^{-1}.Mpc^{-1}$

But later Riess et al. explain how this is wrong in a new paper

Possible solution: Coupled Dark Sector

Dark Energy is the leading factor of accelerated expansion:
   Parametrize energy flow DM → DE

$$\nabla_\mu T^\mu_{(de)\nu} = \frac{Q_\nu^{(de)}}{a} \text{ and } \nabla_\mu T^\mu_{(dm)\nu} = \frac{Q_\nu^{(dm)}}{a}$$

With

$$Q^\nu_{(dm)} = \xi \, H \rho_{de} \, u^\nu_{(dm)} = -Q^\nu_{(de)}$$

Tension solved with $\xi = -0.26^{+0.16}_{-0.12}$ (at 95% CL) for ΛCDM model

Even better in wCDM model with $w = -1.184 \pm 0.064$ (at 95% CL)

Conclusion

So far, no real solution to the tension …

But new physics might be the best lead !

What would be your solution ?

Bibliography

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