H_0 Discrepancy & Dark Matter

Nicolas Angelides ~ regnidorhcS.com

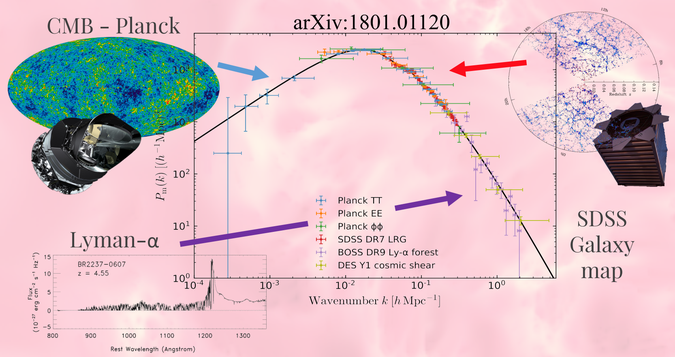
Dr Andrew Pontzen ~ Cosmology
Dr Chamkaur Ghag ~ HEP
Cosmoparticle Initiative

UCL

Two main ways to measure H_0

(Rate of Expansion of the Universe today)

Fit ΛCDM using P(k) data

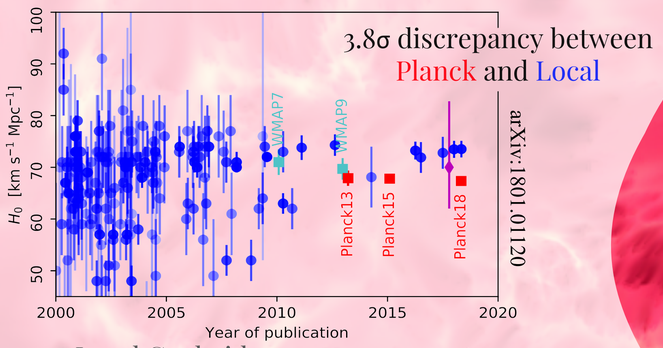


Local Distance Ladder

1. Use parallax to study Cepheids; variable stars that oscillate (empirically proven) Luminosity ∝ Period
2. Find Cepheids in distant galaxies. Using light dissipation you know distance to galaxy
3. Find Standard Candles in same galaxy and measure redshift
4. Redshift & Distance ↠ H_0

Hubble Space Telescope

H_0 Through the Years



Local Cepheids ● $H_0 = 73.5 \pm 1.62$
Ligo ◆ $H_0 = 70.0^{+12.0}_{-8.0}$
ΛCDM Fit ■ $H_0 = 67.66 \pm 0.42$

Source of Discrepancy

Systematics on either measurement (?)

Cepheid Calibration:
Metallicity variations, photometry biases (claims robustness to a few percent). Model is as simple as it gets

CMB Calibration of ΛCDM:
Early universe physics affect H_0 through **unaccounted particle interactions** or inaccurate relative densities.

E. Hubble

TS – like DM interaction **(Blue)** may indeed bridge H_0 discrepancy as it provides degenerative changes to P(k).
Full pipeline under development

Degenerate modification to P(k)

Early universe physics & value of Ho both change shape of P(k)

ΛCDM + Early universe DM interaction → Same fit curve for P(k) → Modified H_0

(a) DM-Baryon
Calculation done
Zero effect to leading order.

or

(b) DM-Photon
Theoretical calculation similar to *Thomson Scattering* ™ (TS)

or

(a) or (b) & DM-DM
To have any effect DM needs to couple to radiation or baryons. (future work).

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arXiv:1104.2932

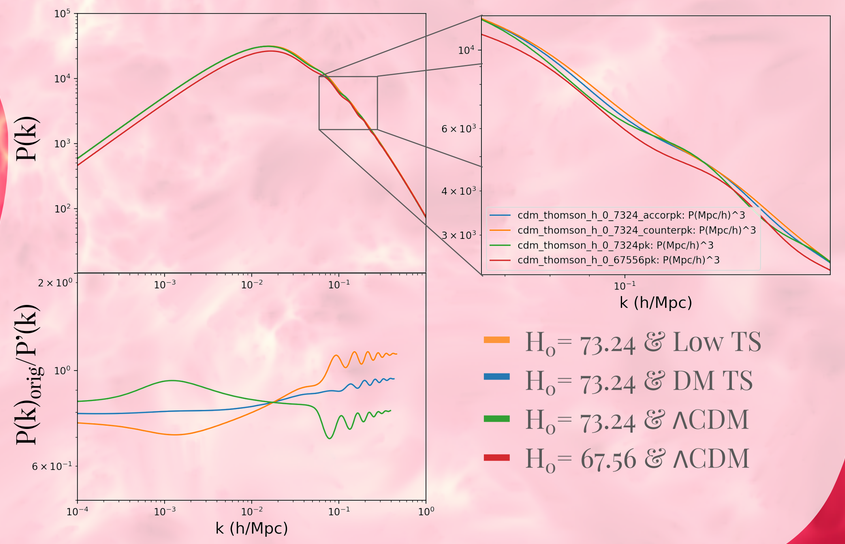
Cosmic Linear Anisotropy Solving System. From theoretical model of early universe to observables; P(k)

DM-Photon

This is interaction **conserves energy** within the two populations but allows for **momentum exchange**

Behaviour of P(k) given different H_0 & TS combinations

Minimal modification to CLASS (not yet physical)



- $H_0 = 73.24$ & Low TS
- $H_0 = 73.24$ & DM TS
- $H_0 = 73.24$ & ΛCDM
- $H_0 = 67.56$ & ΛCDM