H_0 Controversy

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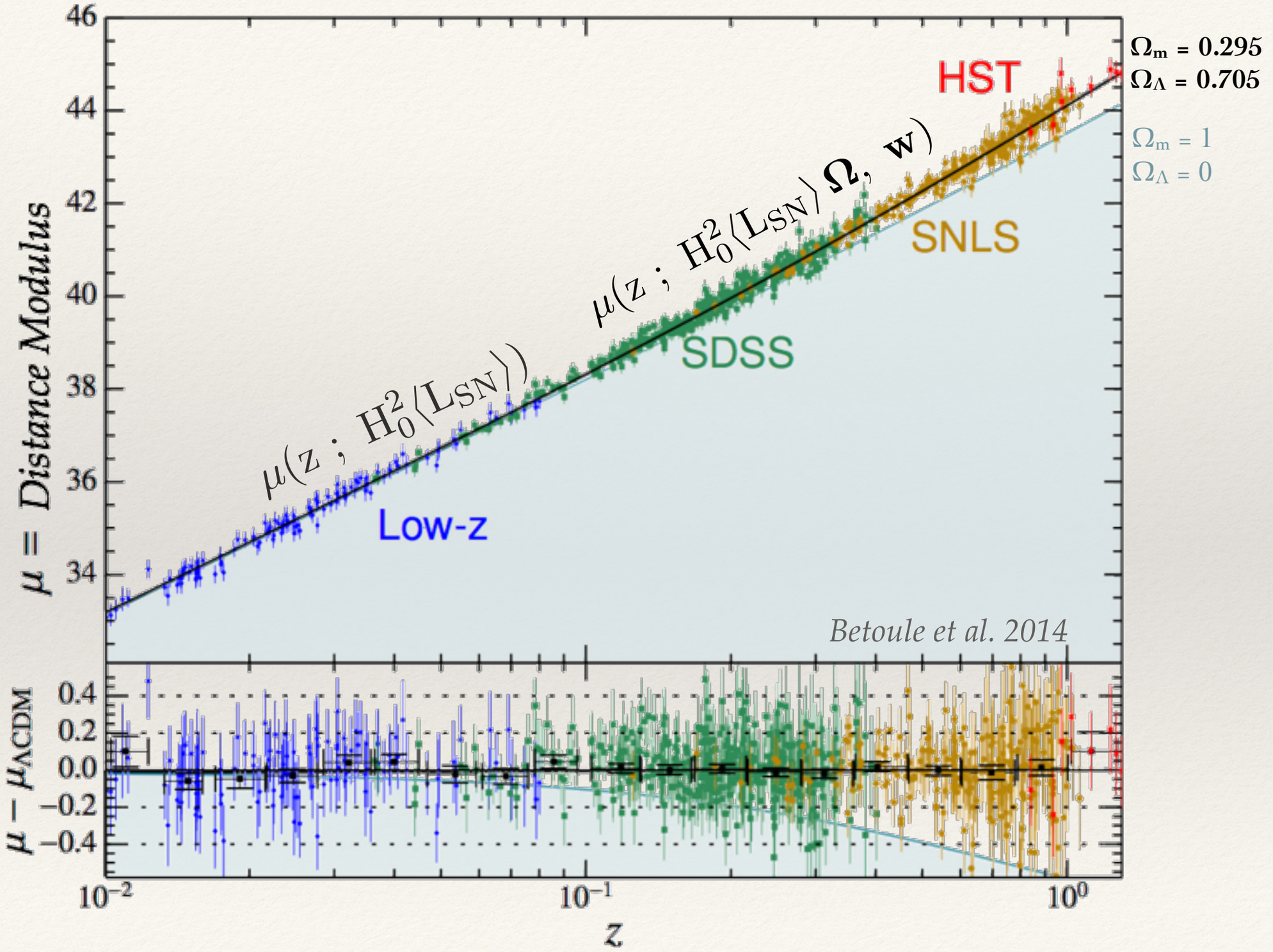
Type Ia Supernova Cosmology



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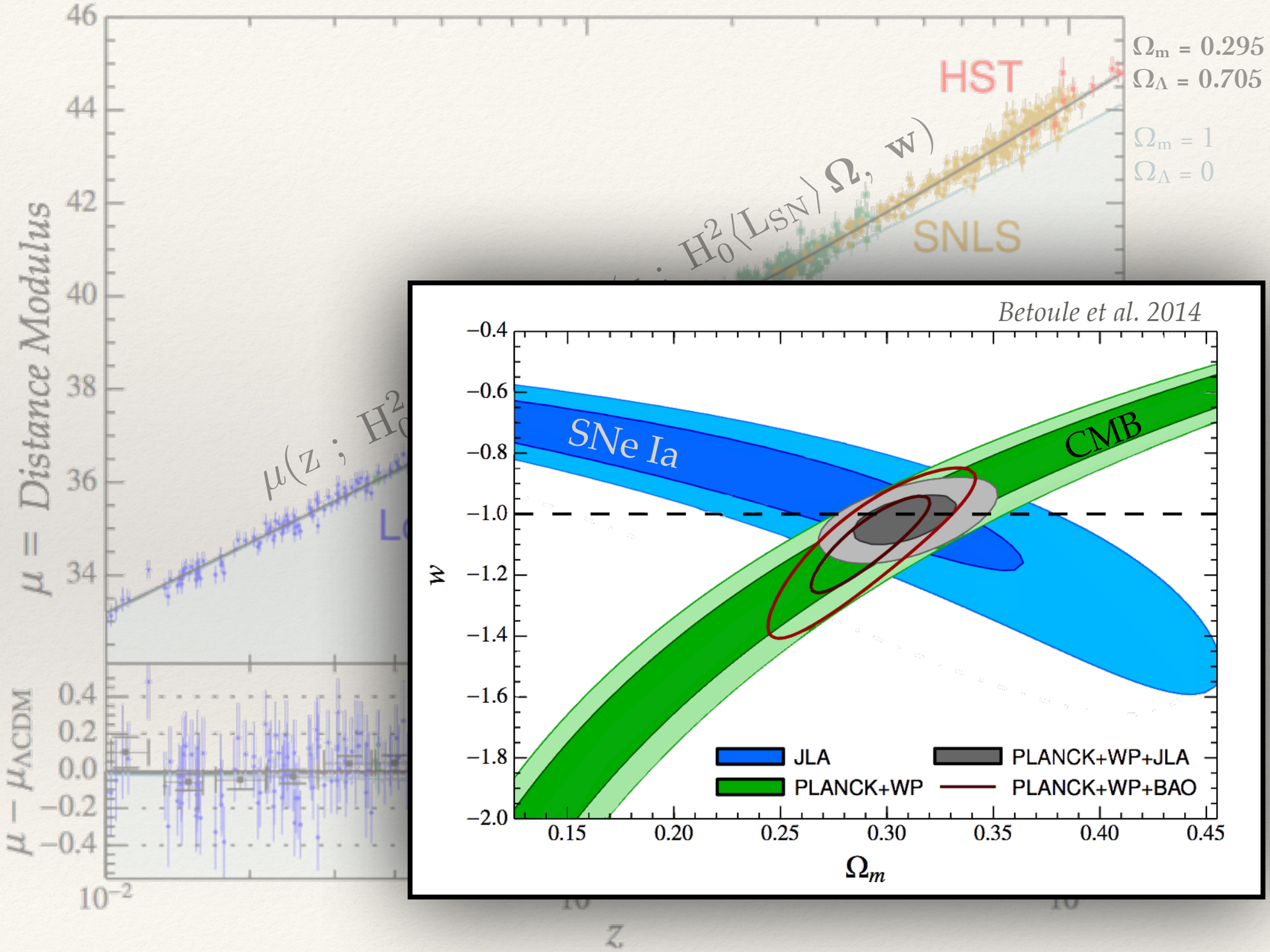
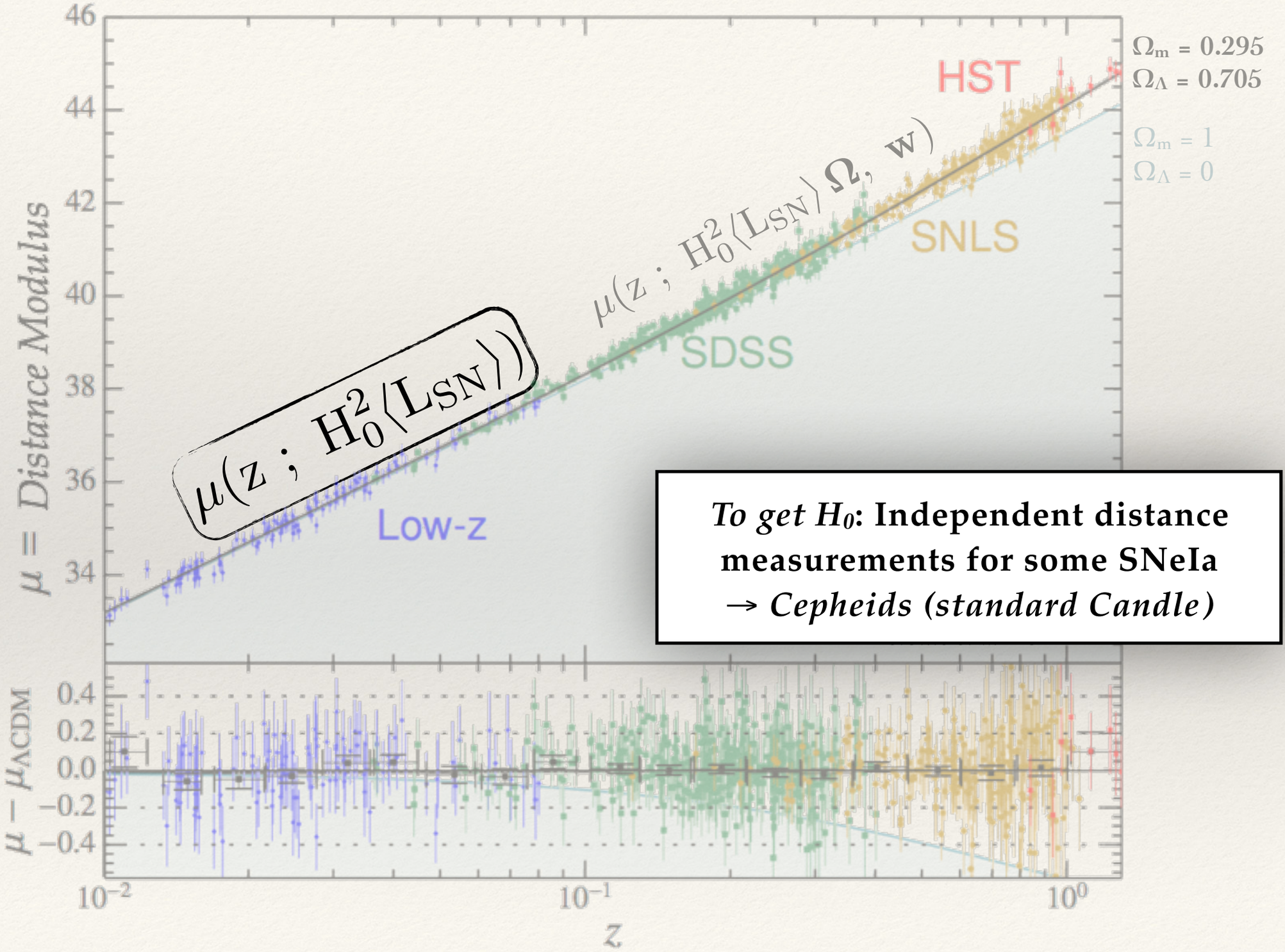


Type Ia Supernova Cosmology | H_0

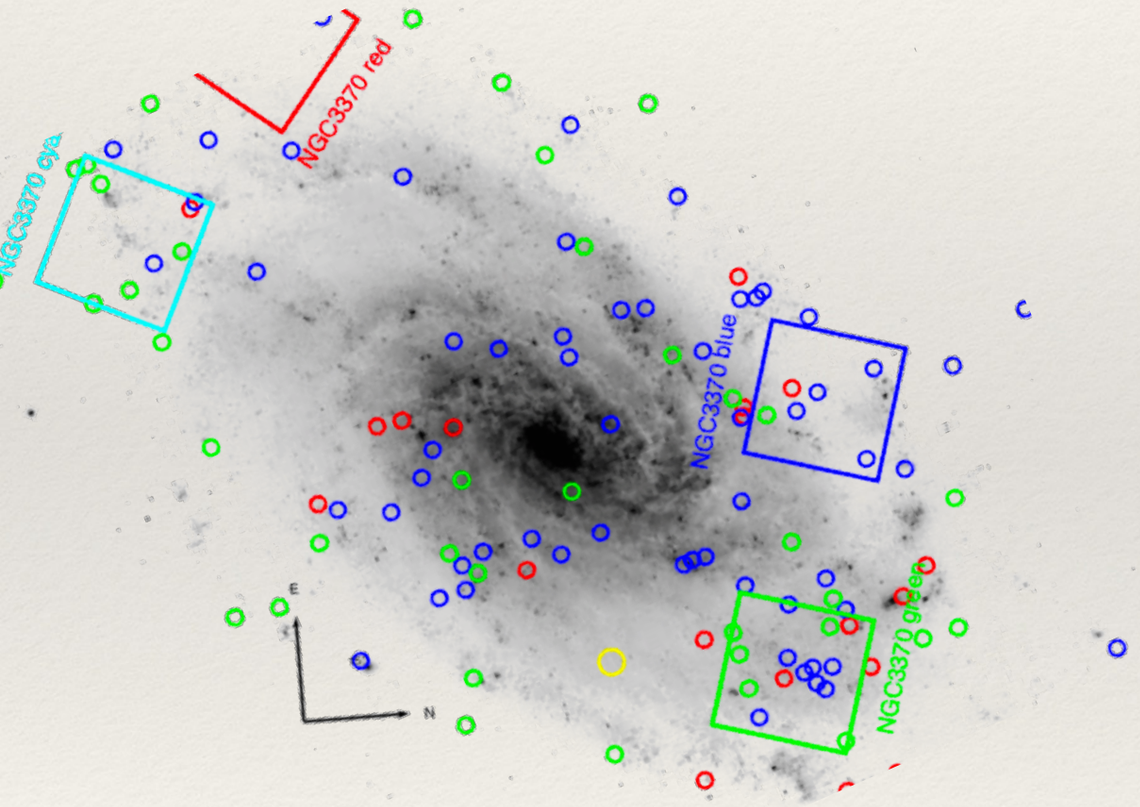


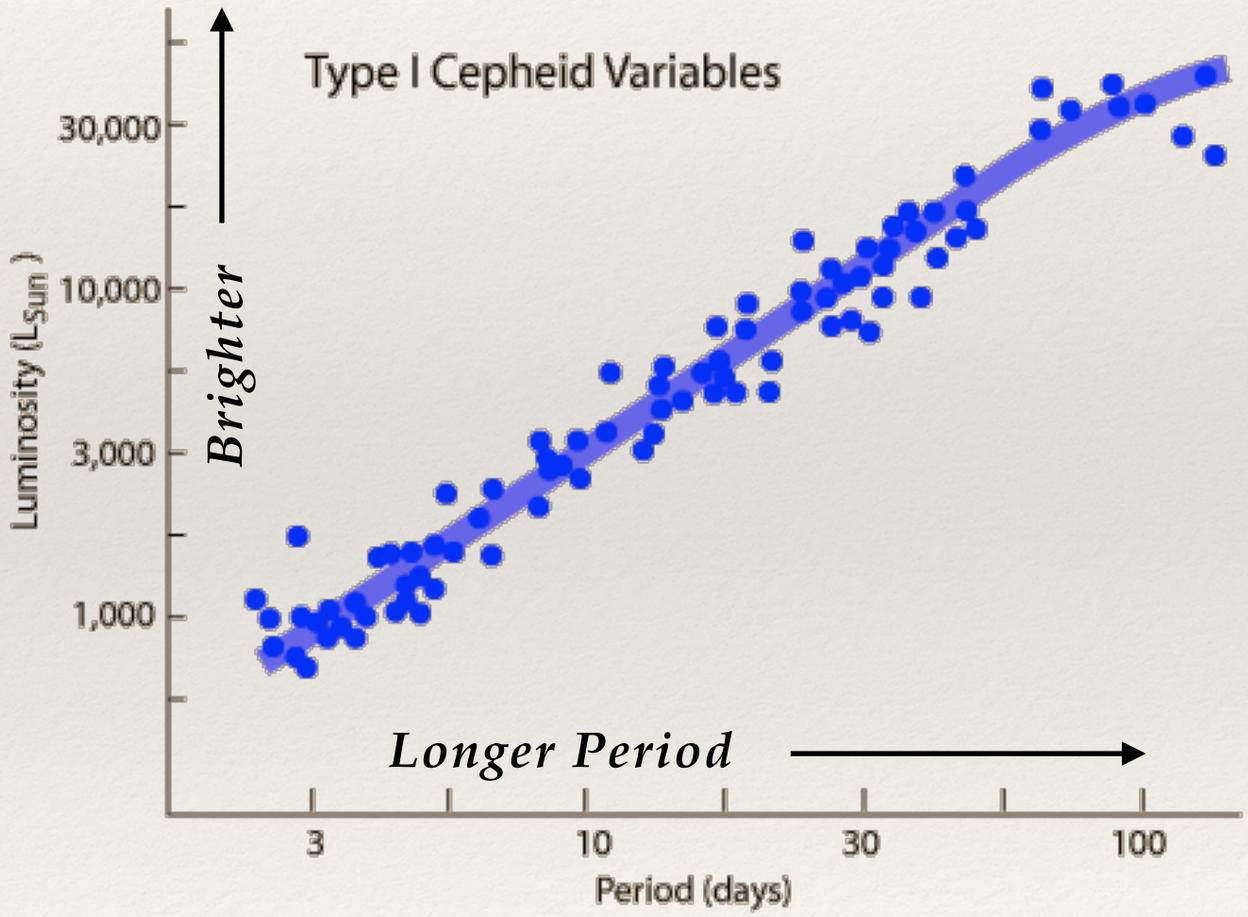
***To get H_0*: Independent distance measurements for some SNeIa**
→ *Cepheids (standard Candle)*

The Cepheid Leavitt relation

Cepheids: *bright young stars with a* ***pulsation-luminosity*** *relation*

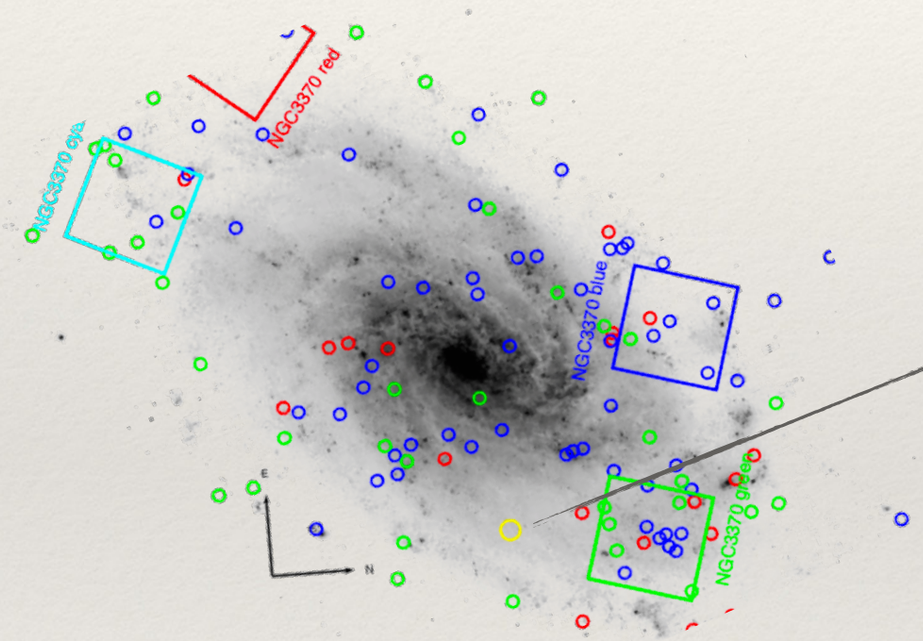
Riess et al. 2009

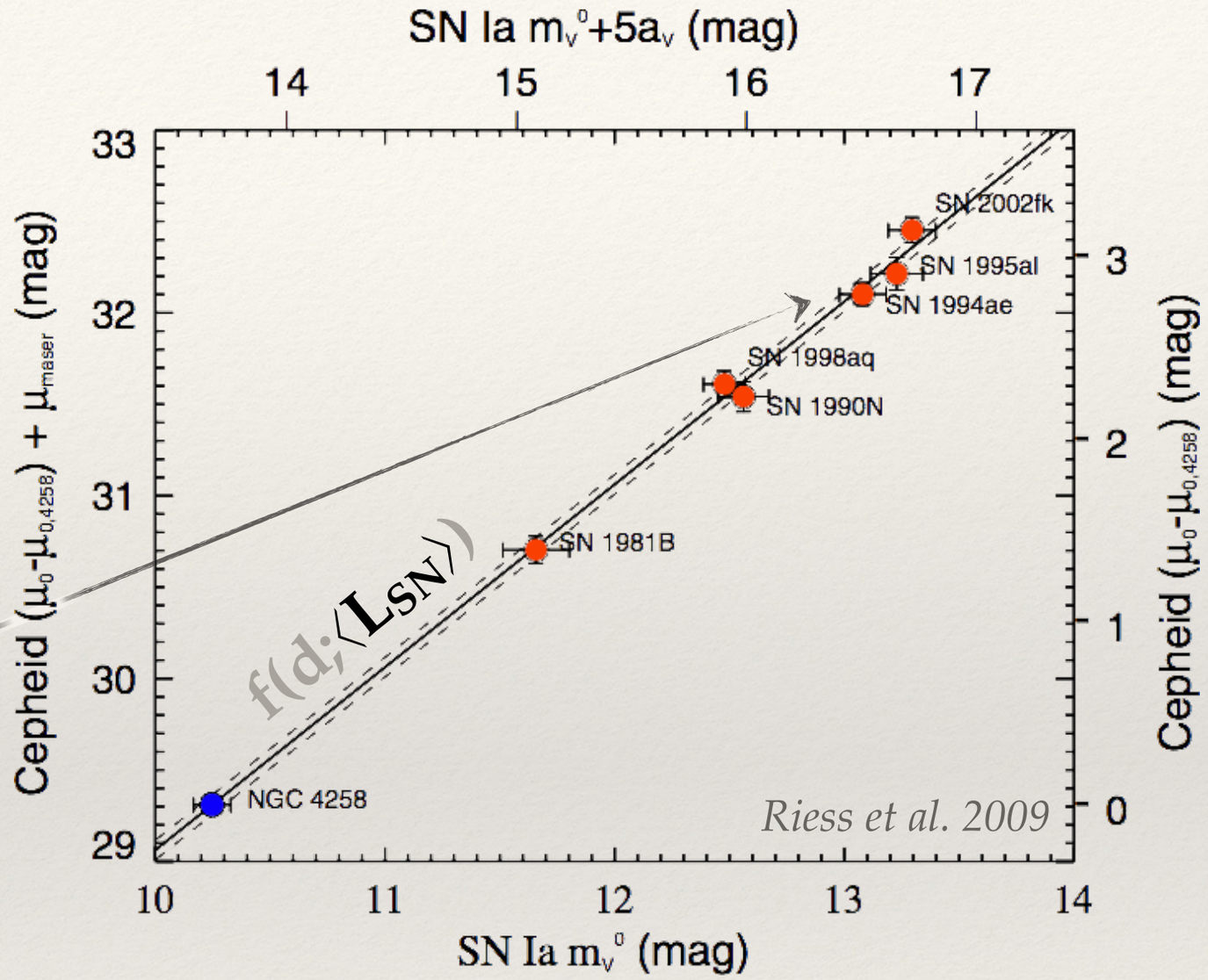




Disentangle H_0 from L_{SN}

Cepheids: *bright young stars with a* ***pulsation-luminosity*** *relation*





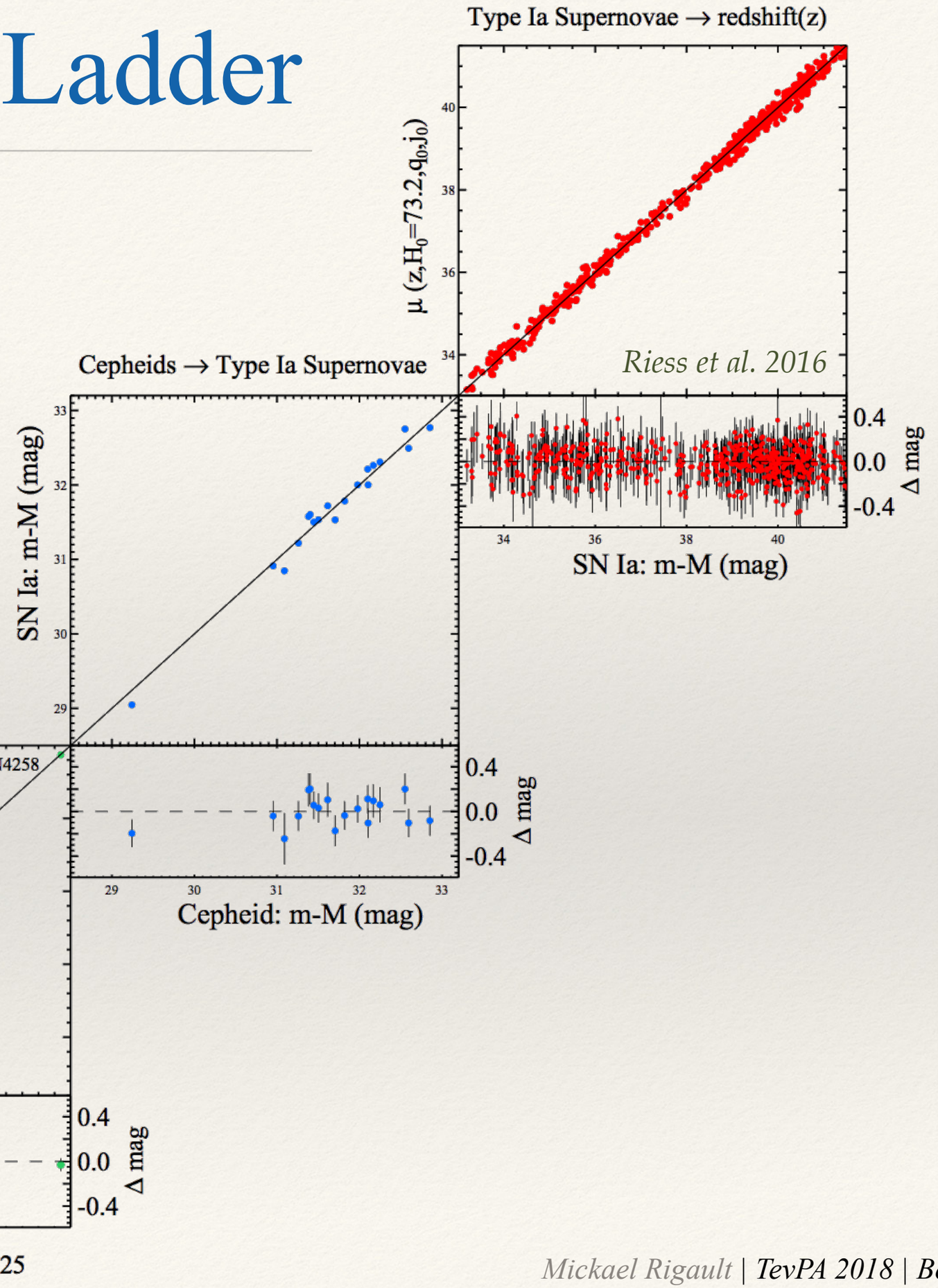
$$H_0 = 73.5 \pm 1.7 \text{ km s}^{-1} \text{ Mpc}^{-1}$$

(2.3% ; Riess et al 2016, 2018)

Direct Distance Ladder

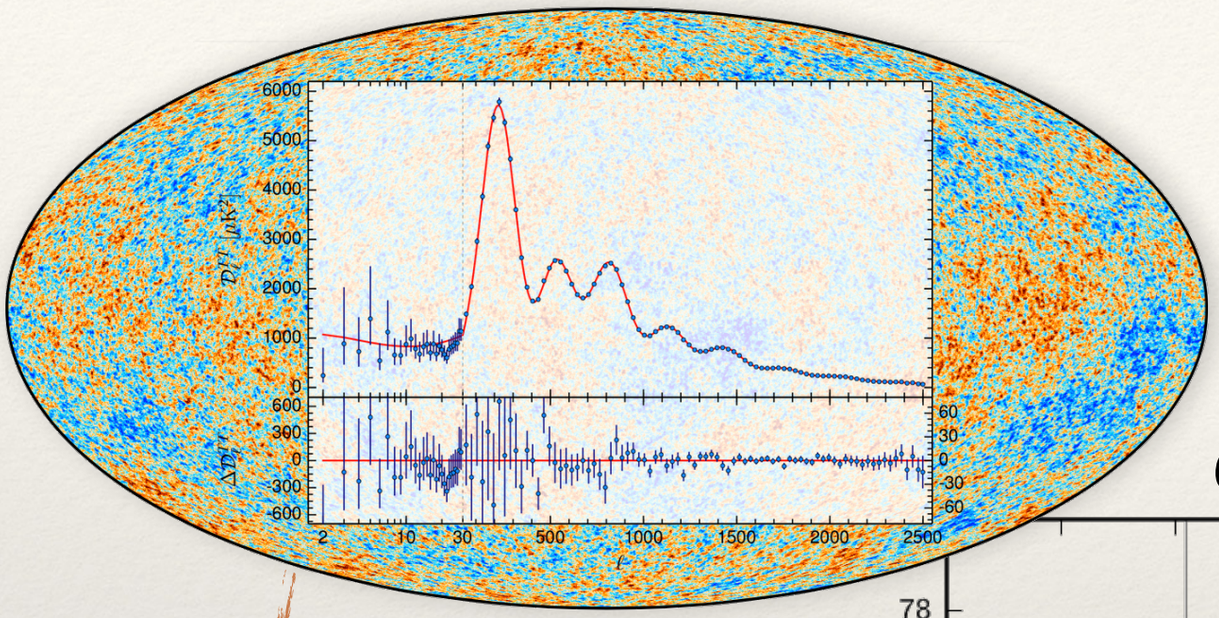
$$H_0 = 73.5 \pm 1.7 \text{ km s}^{-1} \text{ Mpc}^{-1}$$

(2.3% ; Riess et al 2016, 2018)



The Hubble Constant | *CMB*

Planck 2018 results



z~1000

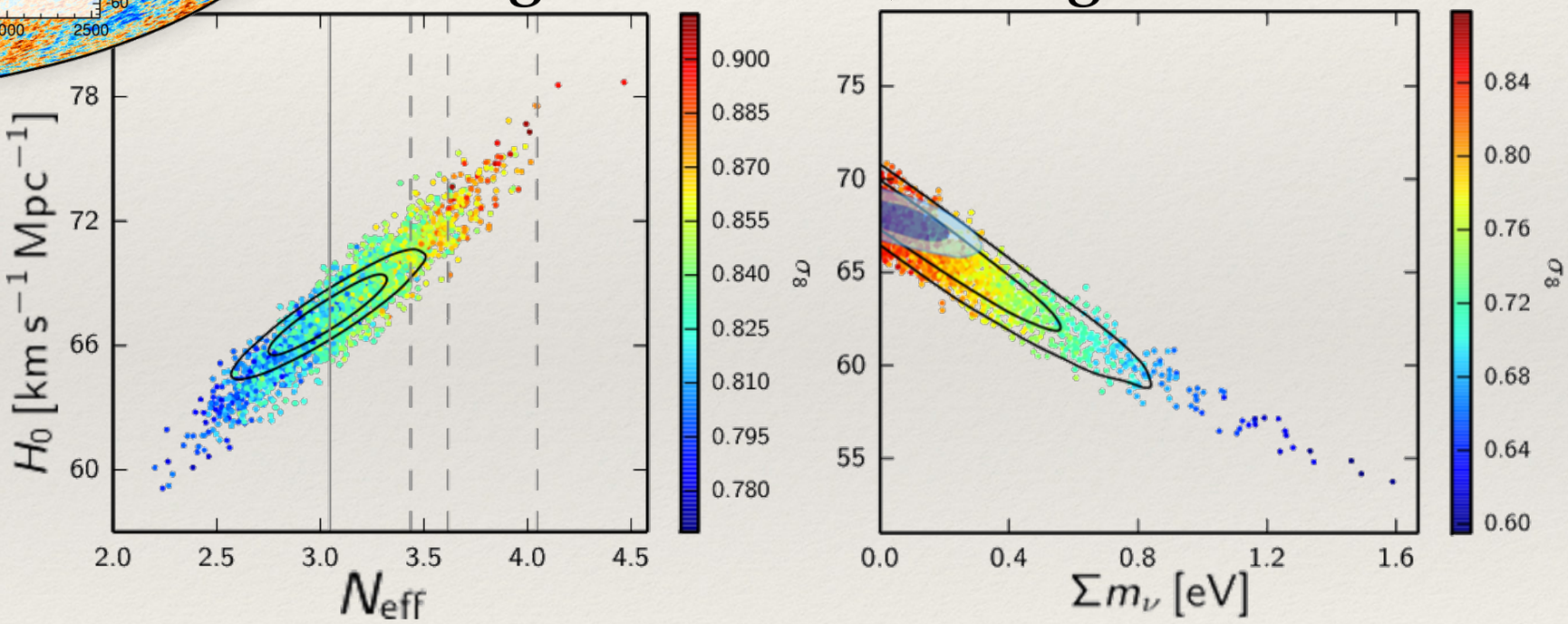
THE MODEL CONTRAINS H_0

z~0

Test the concordance model

— ΛCDM —

Change the model, change H_0



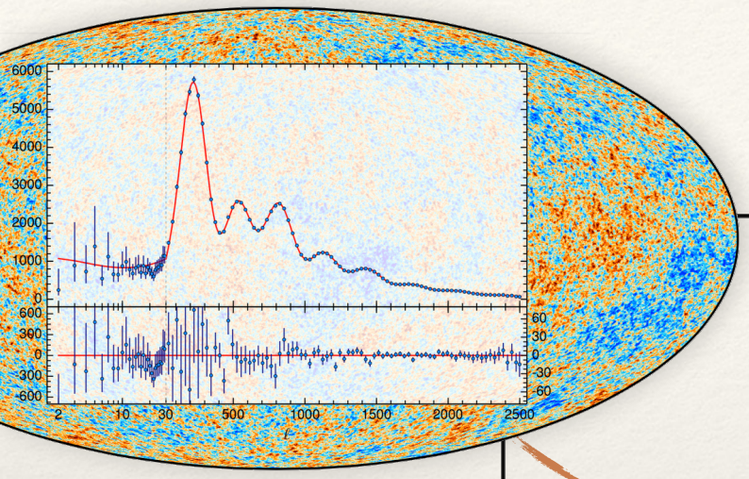
$H_0 = 67.4 \pm 0.5$ km s^{-1} Mpc^{-1}

— based on ΛCDM —

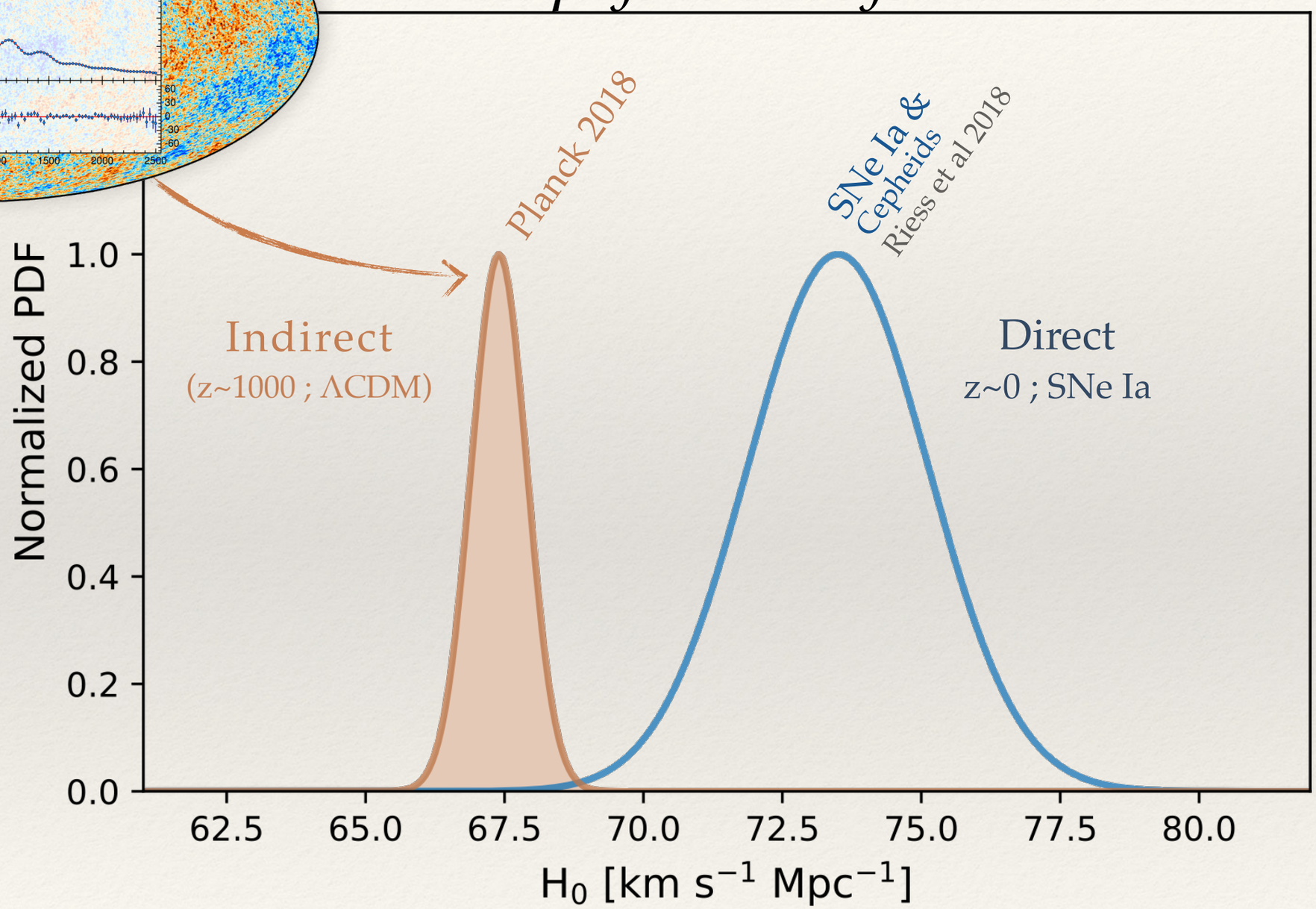
Illustrative plots from Planck 2015

Tension in the concordance model?

~4σ



New physics or a systematic error ?



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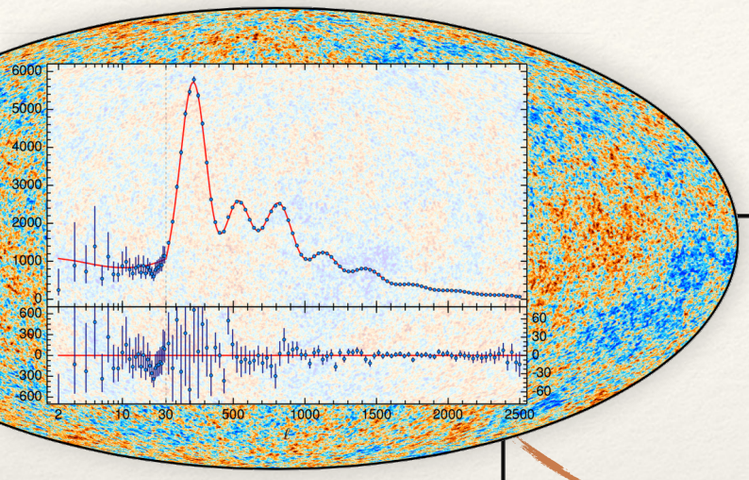
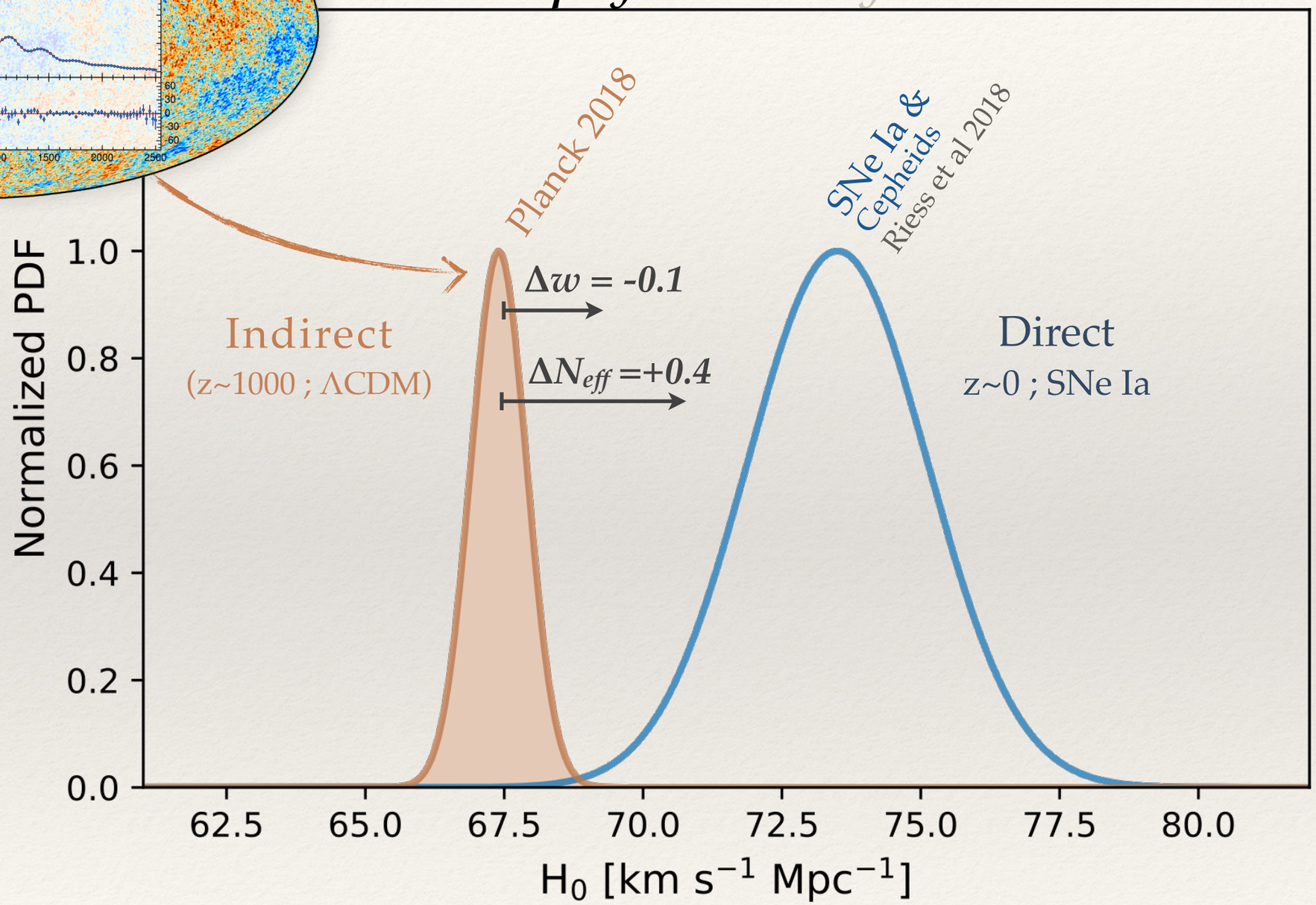
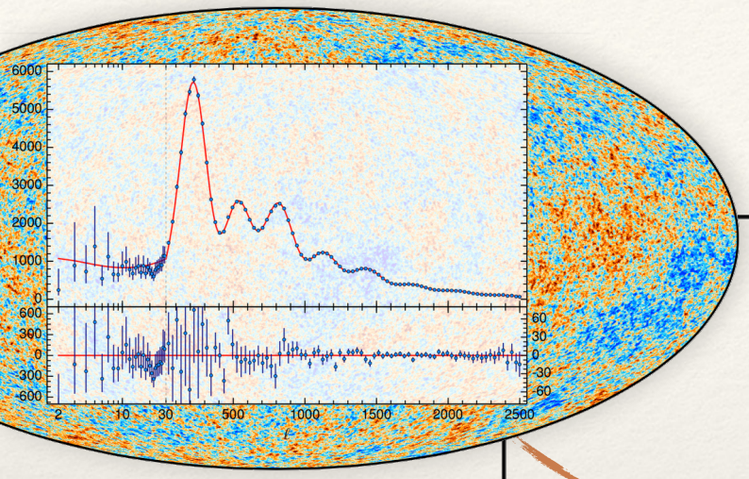


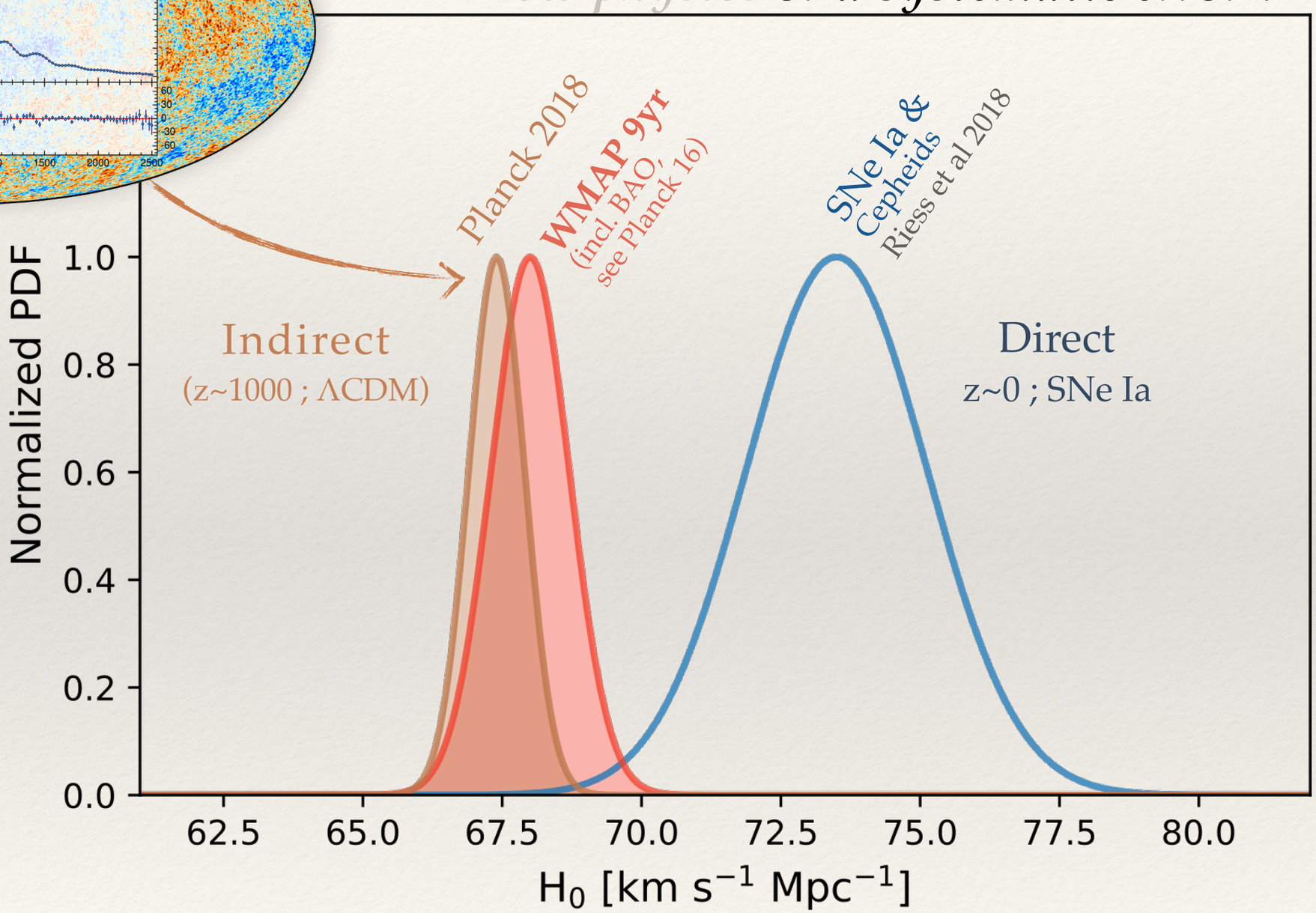


Tension in the concordance model?

New physics ***or a systematic error ?***

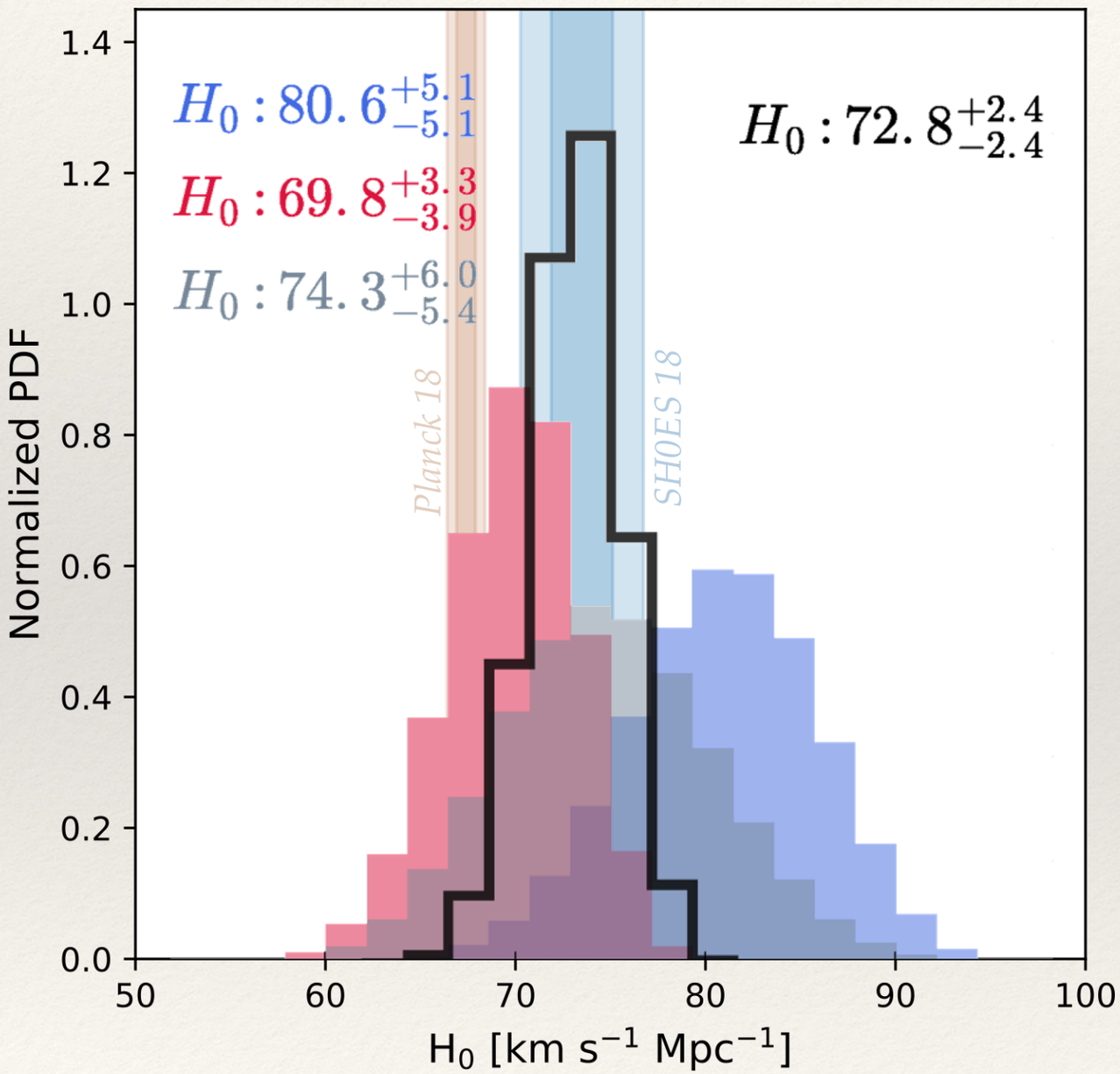
in Planck Analysis ?



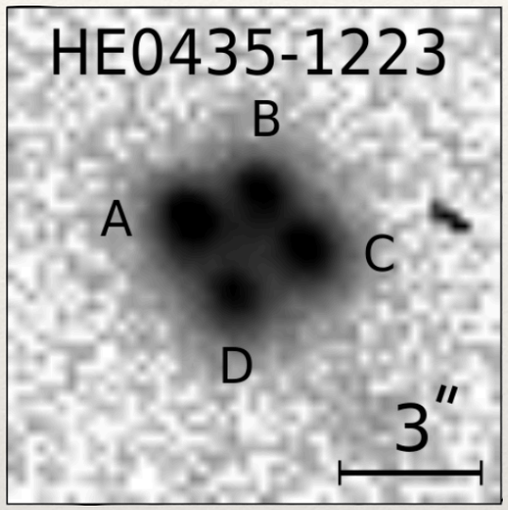


Tension in the concordance model?

New physics ***or a systematic error ?***



in SH0ES Analysis ?

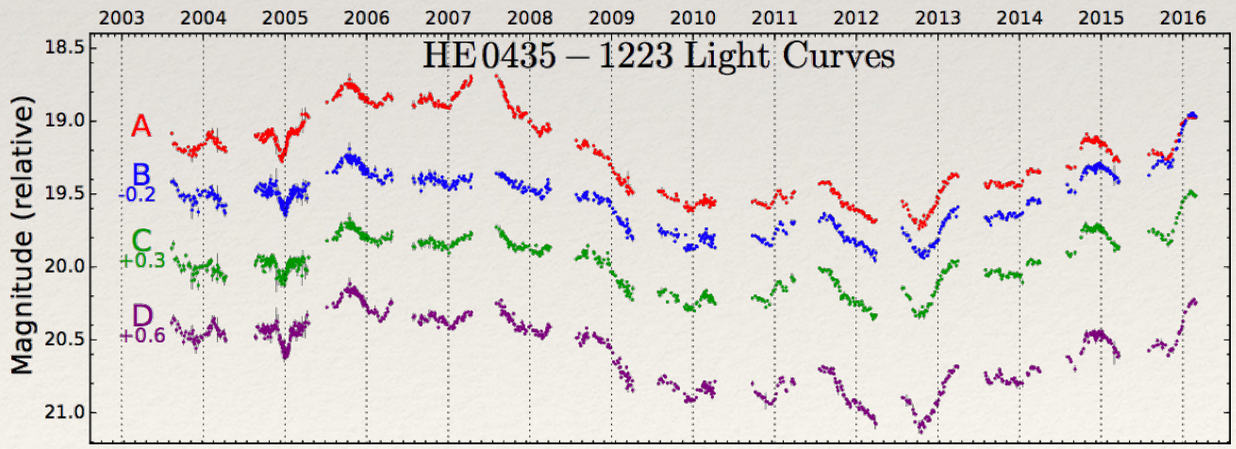


Strong Lensing

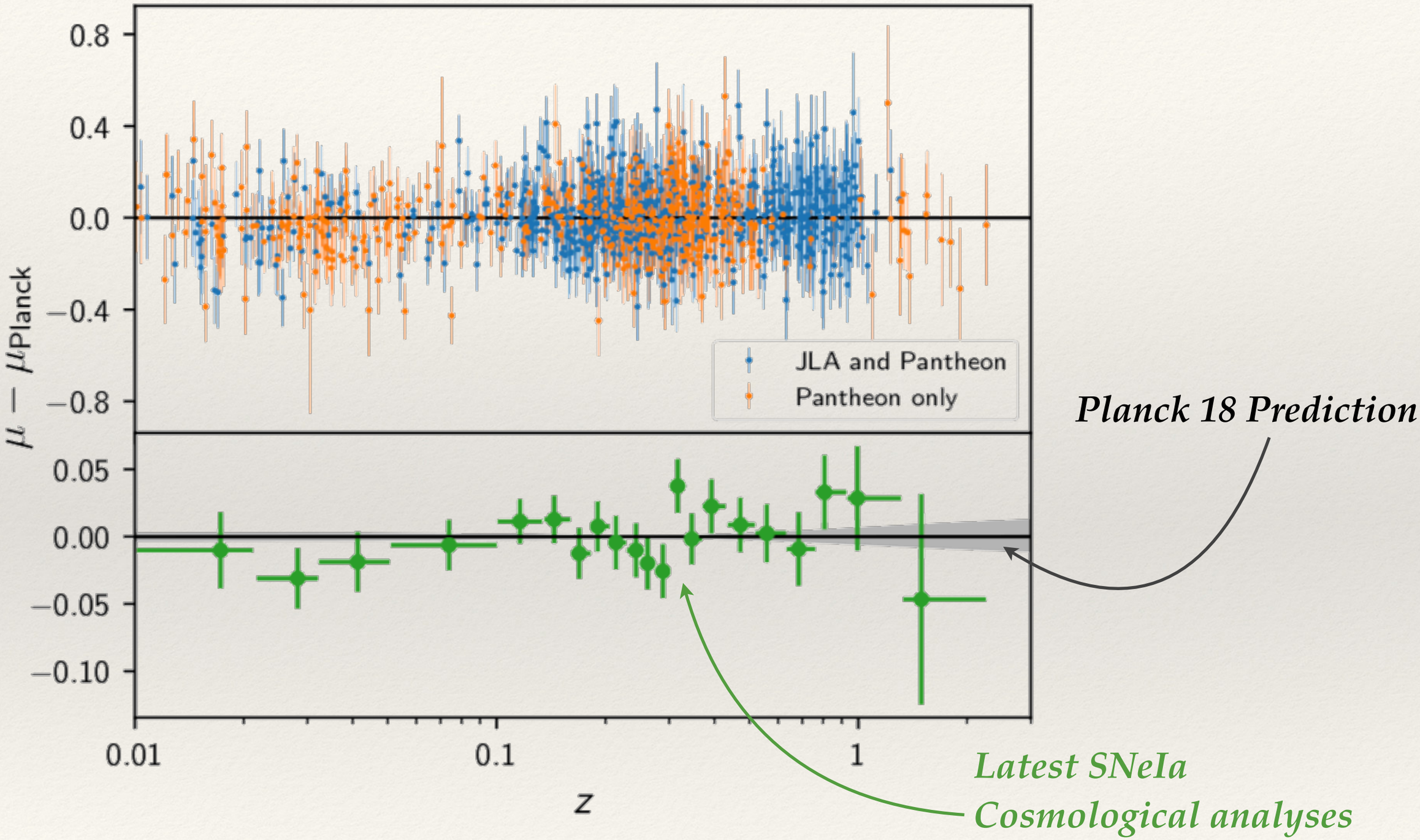
$\Delta t \rightarrow H_0$

(assuming cosmo)

Bonvin et al. 2017

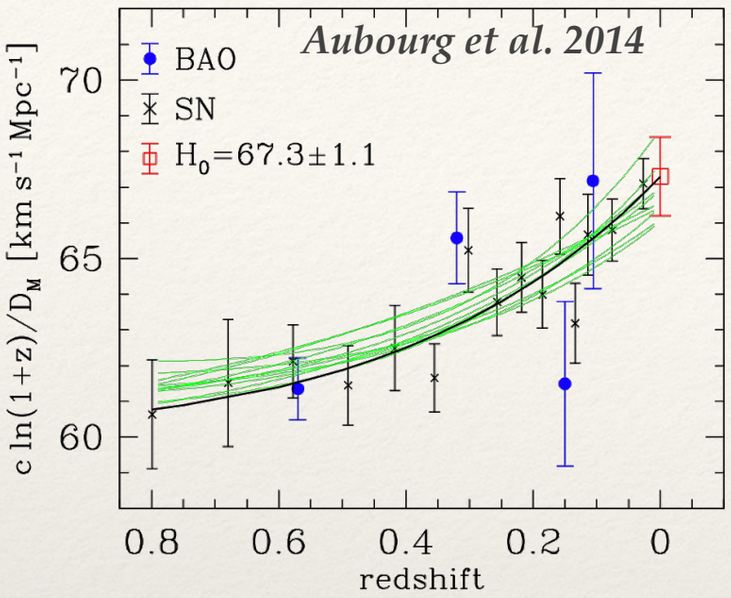


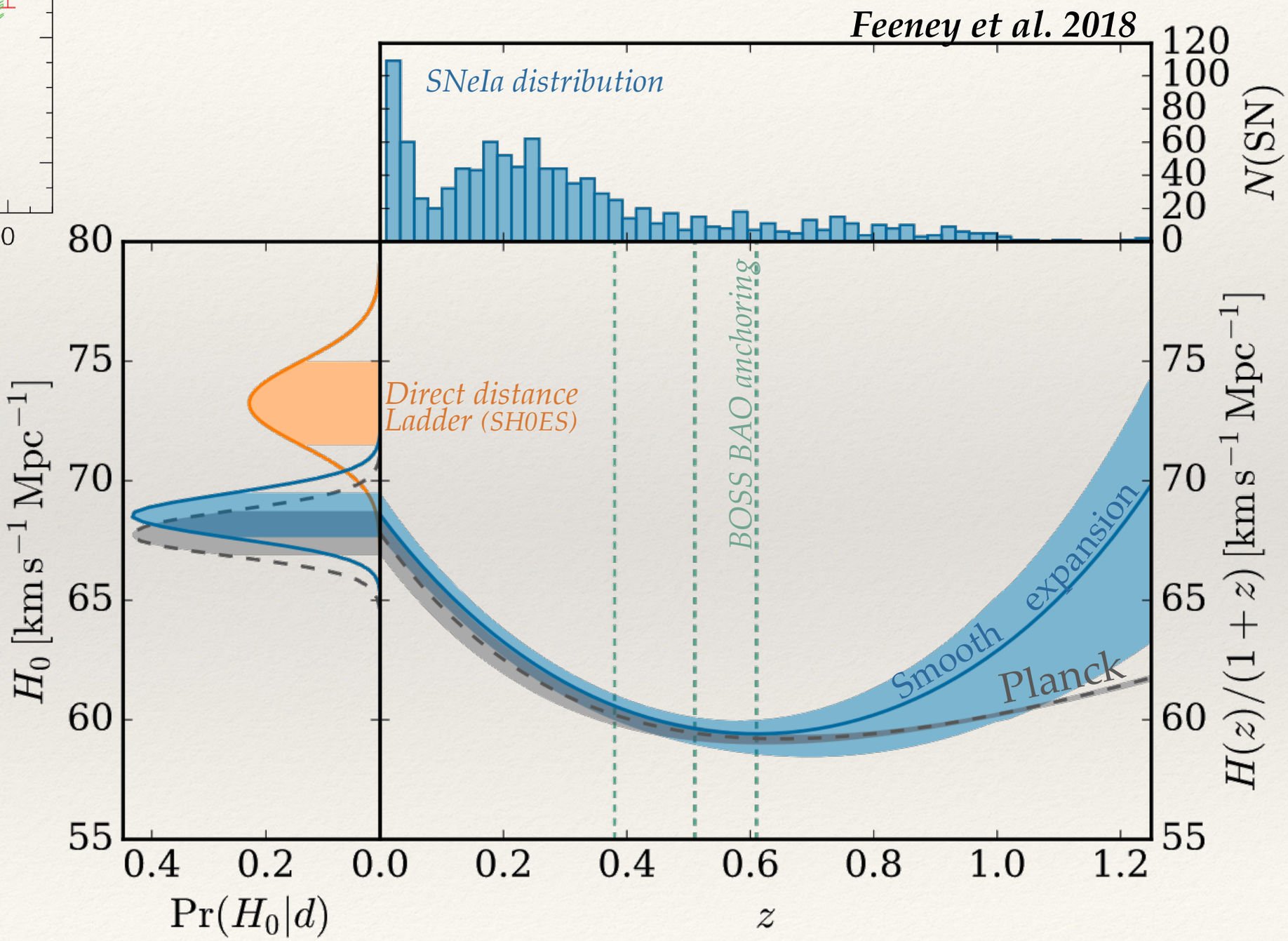
CMB and SNeIa in disagreement ?



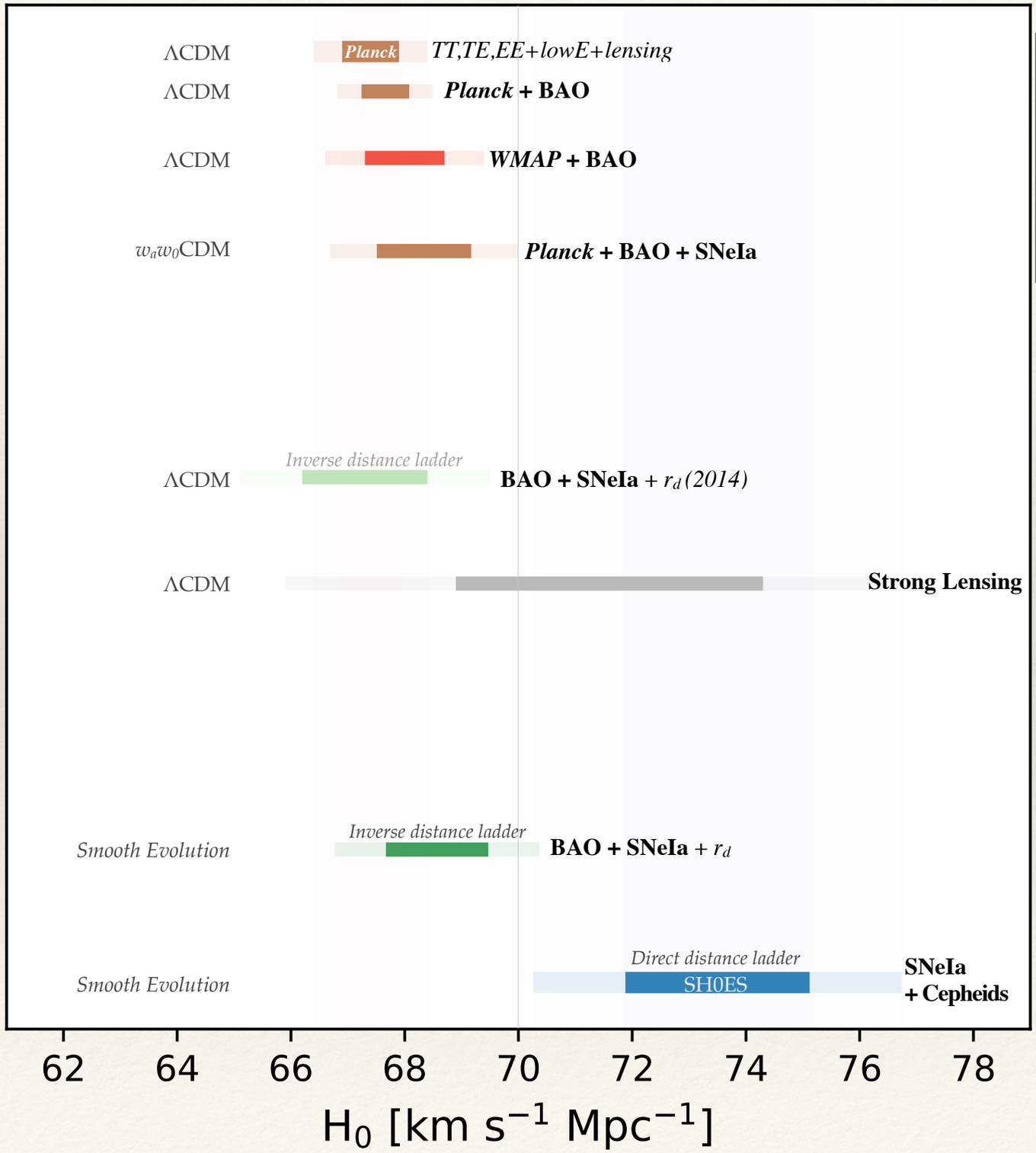
Inverse Distance Ladder

Only using r_d from CMB





H_0 Controversy



Planck et al. 2018

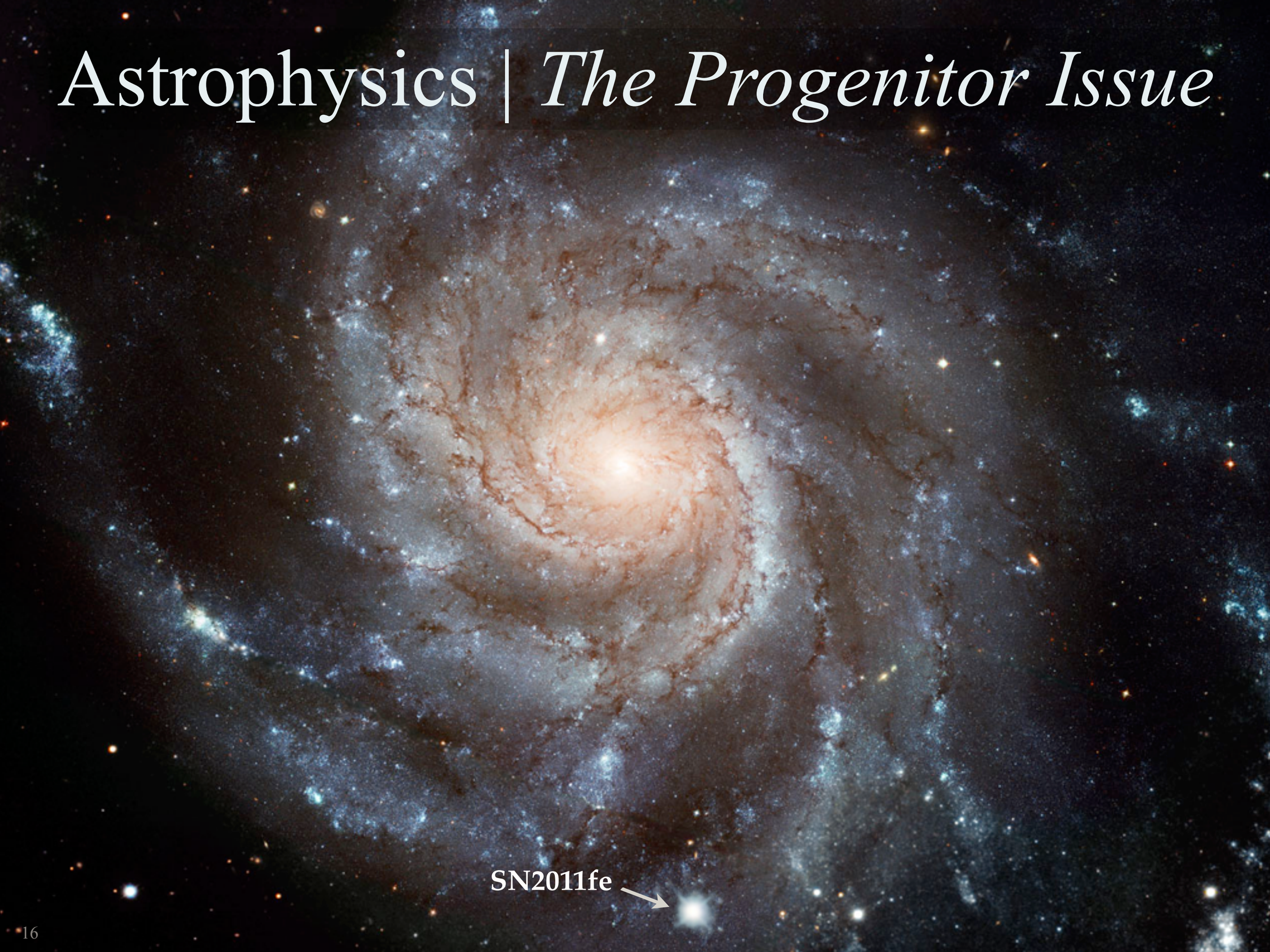
Aubourg et al. 2015

Bonvin et al. 2017

Feeney et al. 2018

Riess et al. 2018

Astrophysics | *The Progenitor Issue*

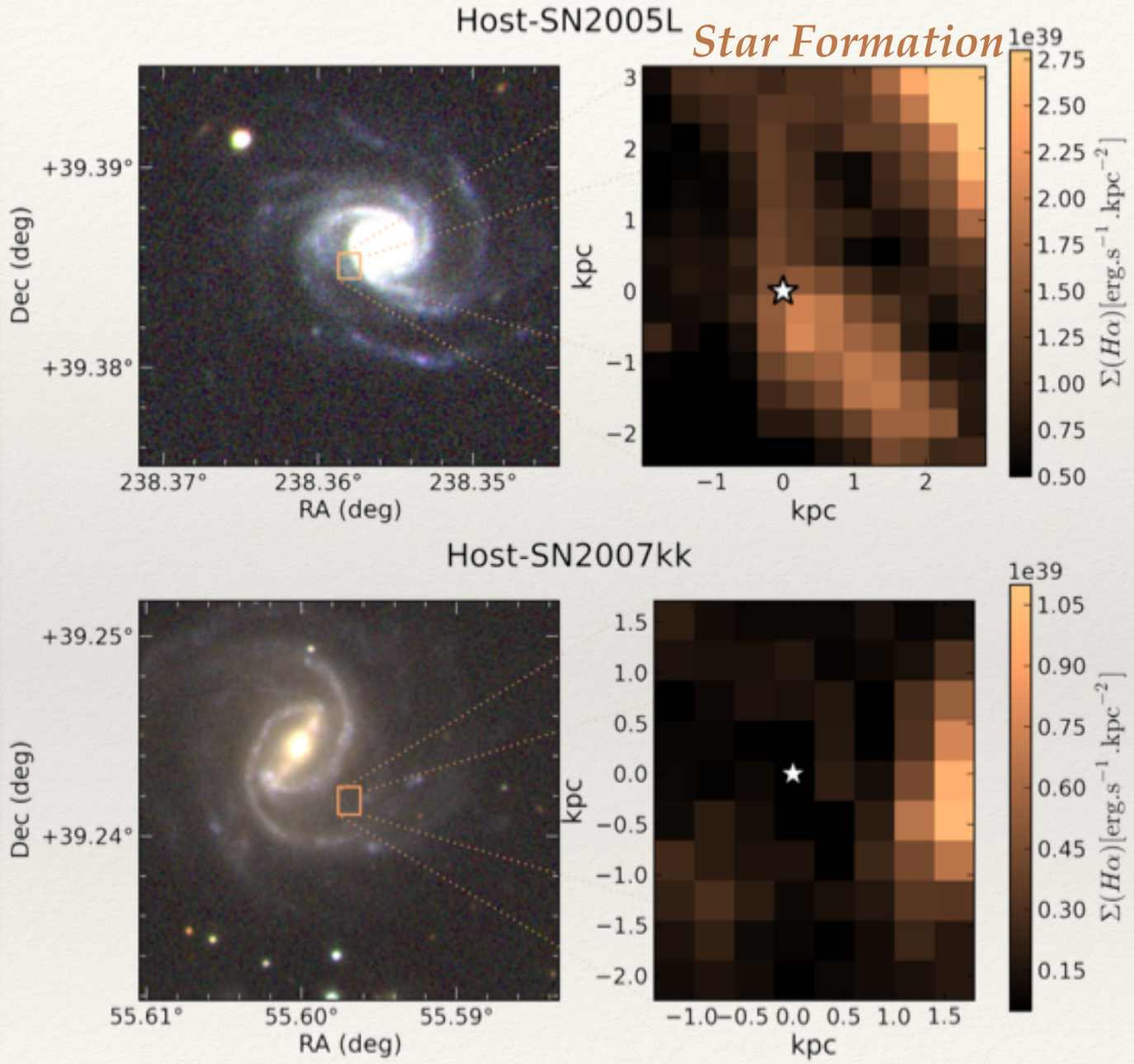


The Local Perspective

Rigault et al. 2013

Global

Spiral, Star Forming, host galaxies



Local

Star Formation

—

Young Stars

No Star Formation

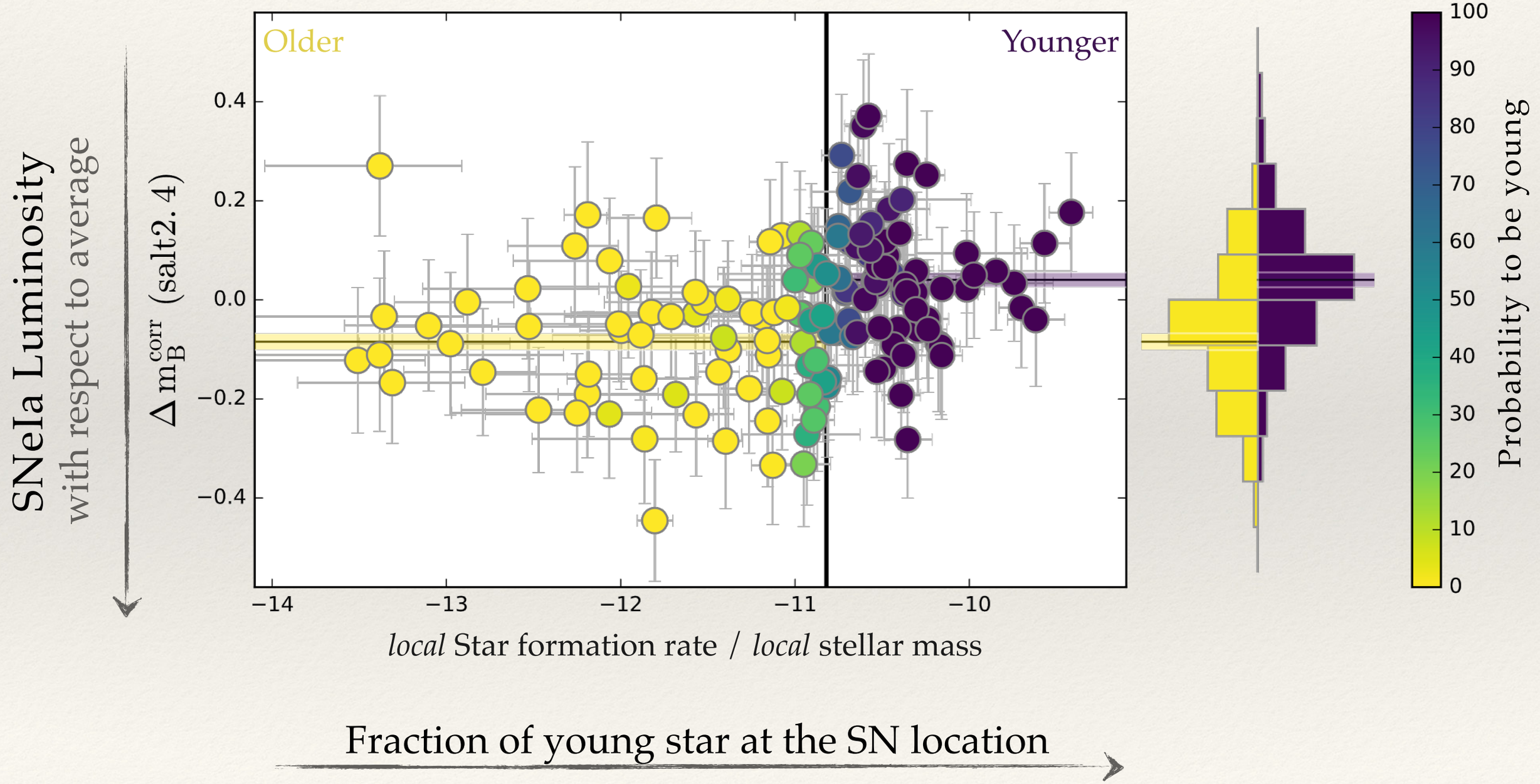
—

Older Stars

The Age Step

Rigault et al. 2018

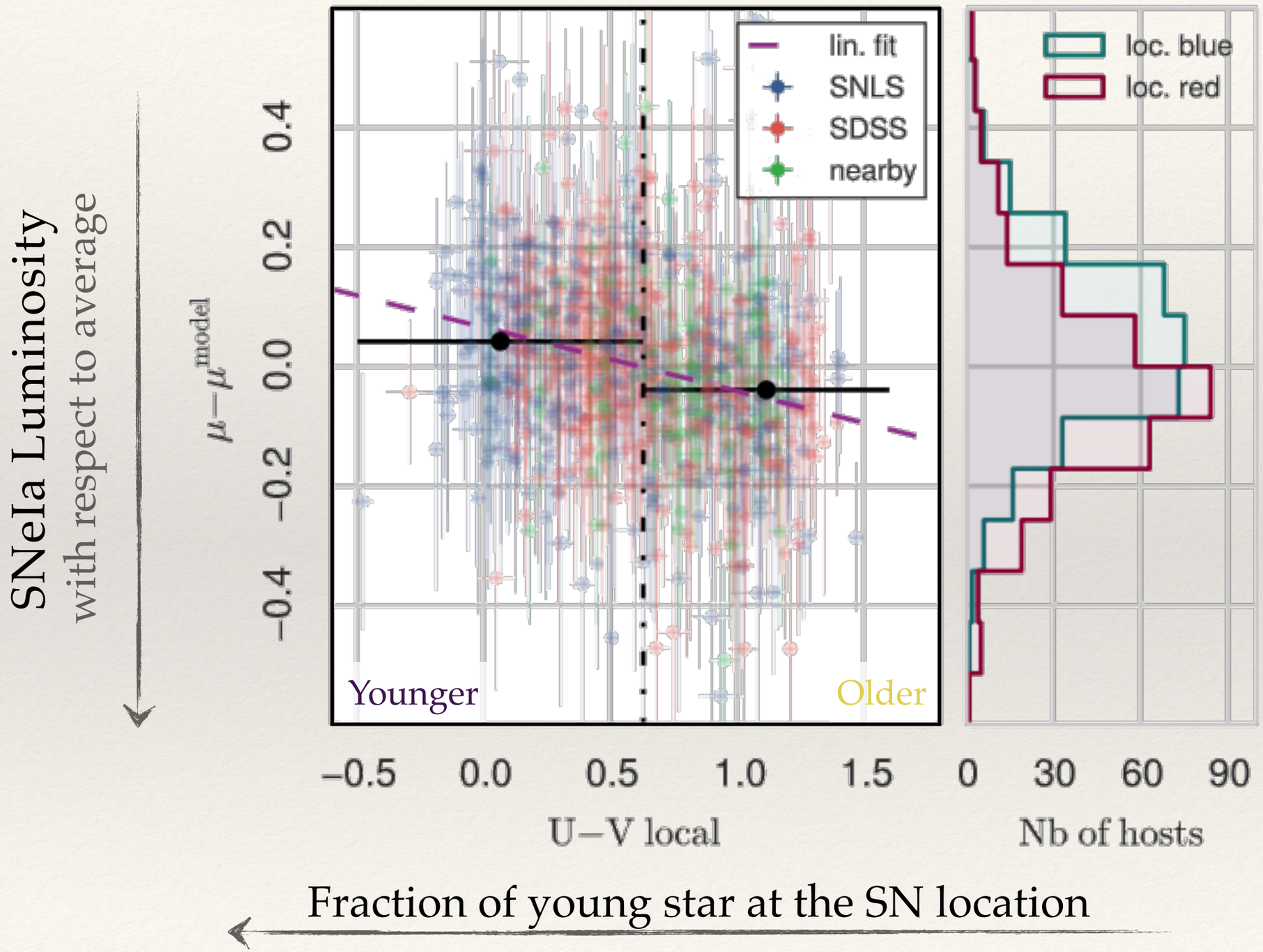
non-zero at ~6σ level | $\Delta_Y = 0.16 \pm 0.03$



The Age Step | *confirmed*

Roman et al. 2017

non-zero at ~7σ level



The Age Step

Rigault et al. 2018

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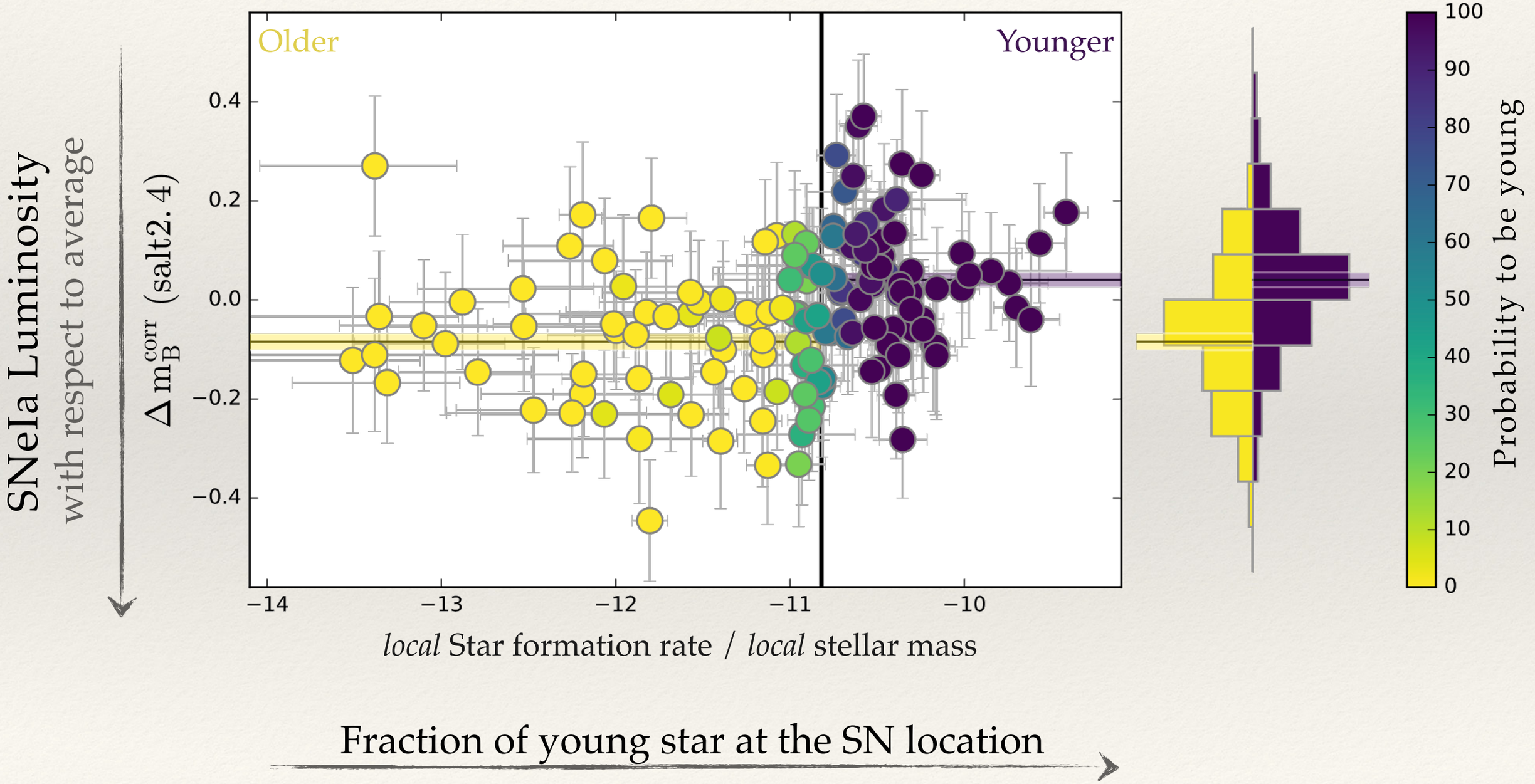
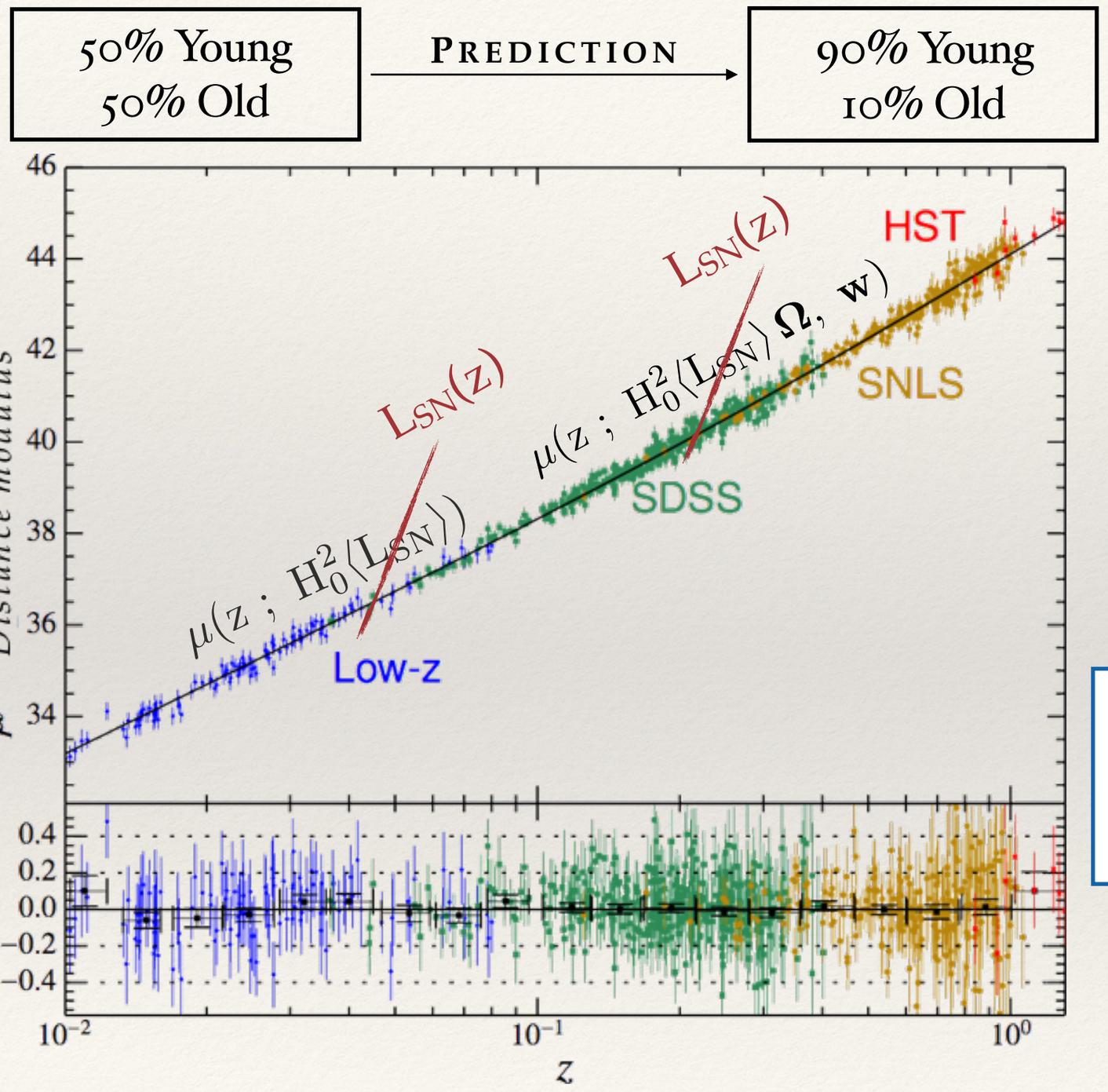


Impact on derivation of Dark Energy properties

Rigault et al. 2013, 2018

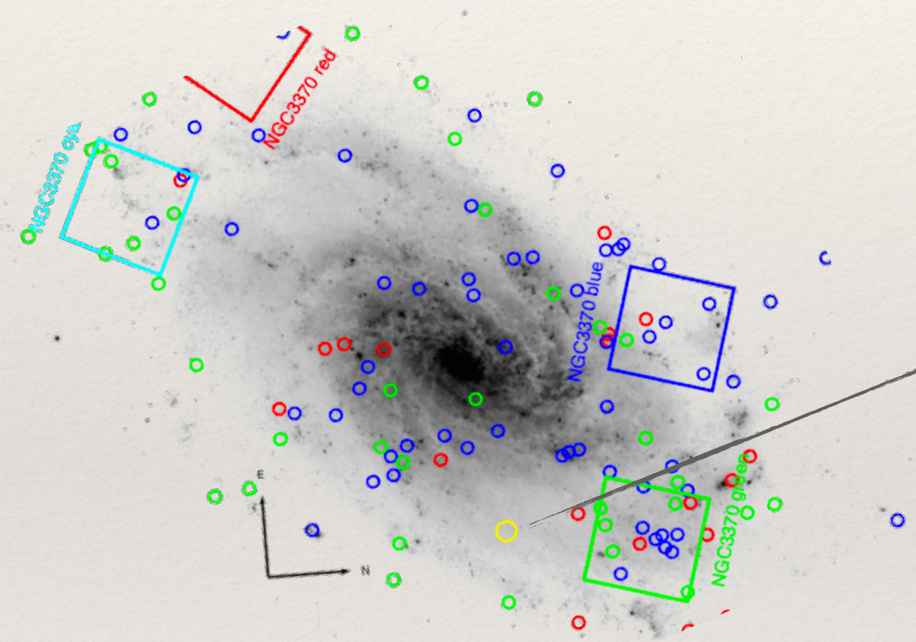


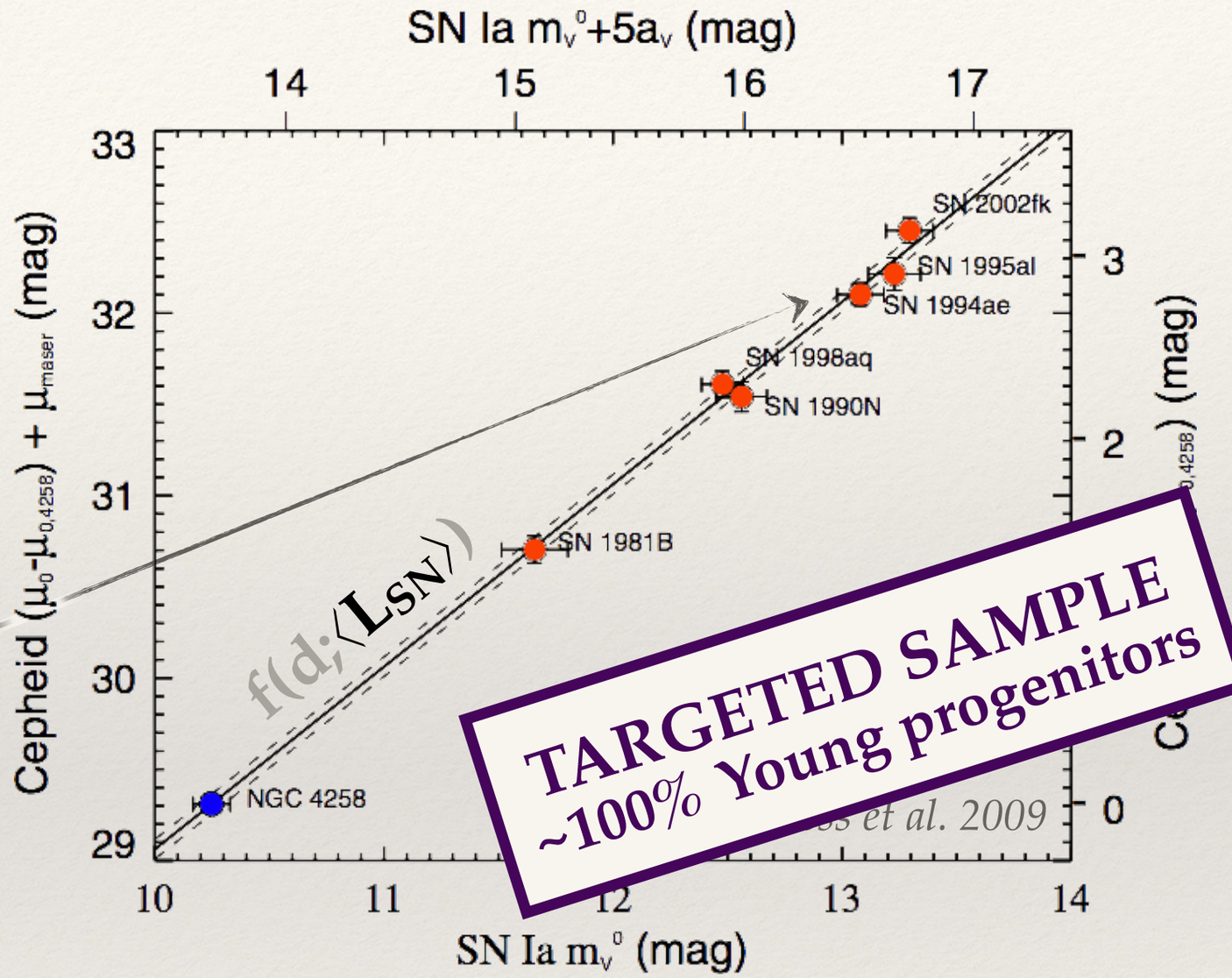
Galaxies are more star forming at higher redshift

Could significantly bias *(by a lot!)* the determination of dark energy equation of state parameters (w_0,w_a)

Disentangle H_0 from L_{SN}

***Cepheids**: bright young stars with a **pulsation-luminosity** relation*





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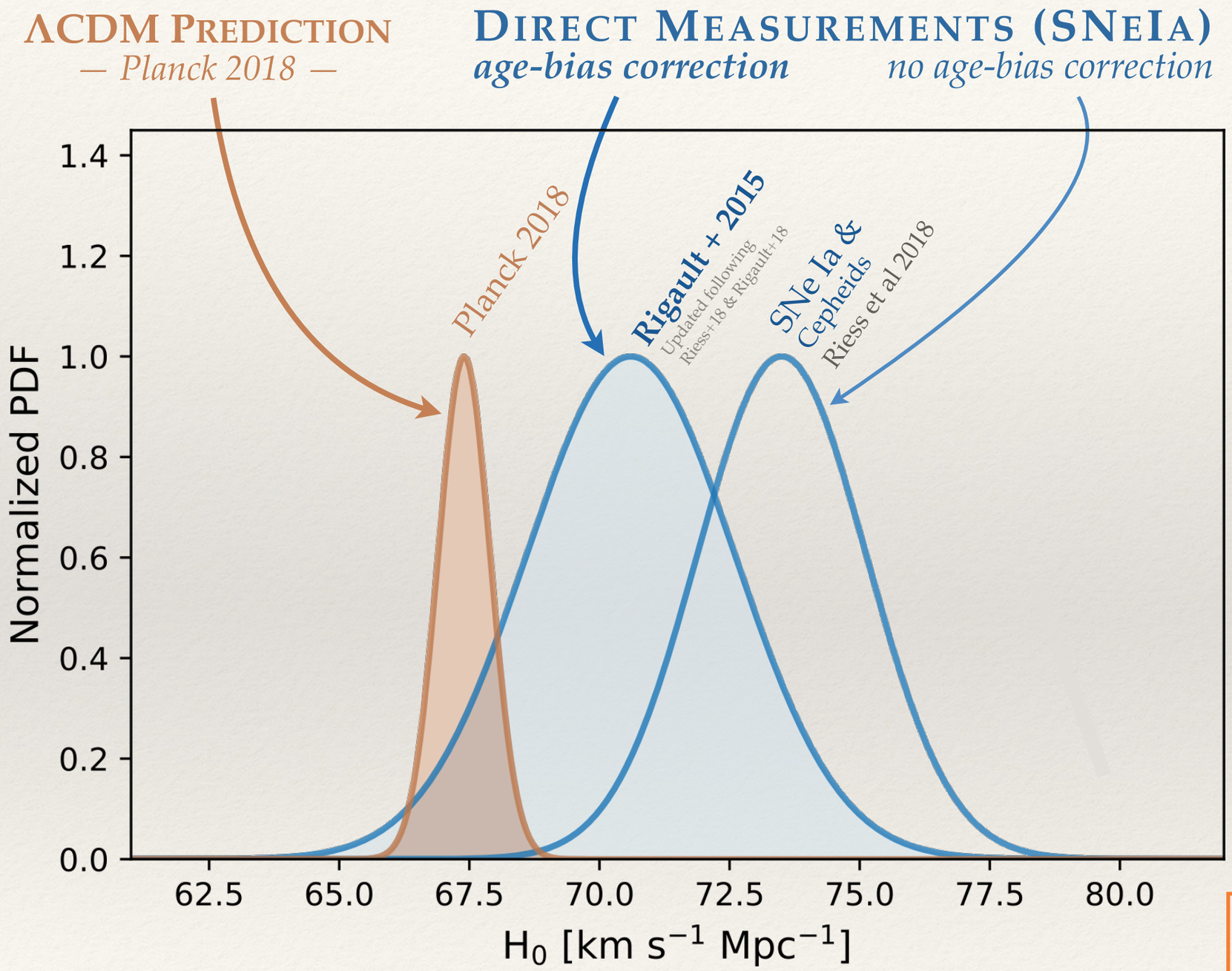
Tension in the concordance model?

Rigault et al. 2015, 2018



Astrophysical bias on H_0
Up to 3% if :

1. Different fraction of prompt
~90% in Cepheid-SN
vs. ~50% in Hubble flow-SN

2. Magnitude difference between prompts and delayed SNeIa
age step ~0.15 mag

To be confirmed using Riess's SNeIa

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