

H0 CONTROVERSY & ASTROPHYSICAL BIAS

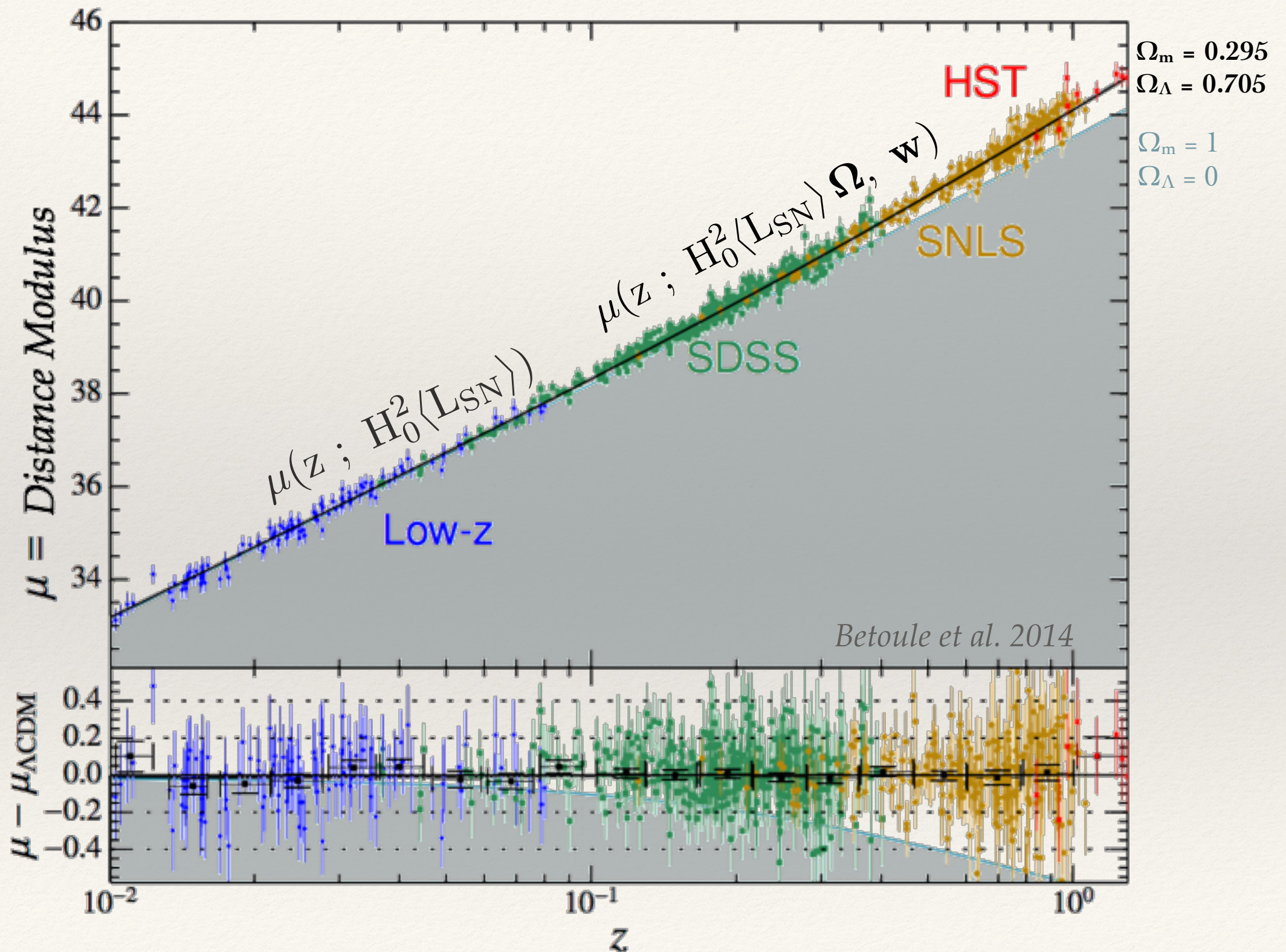
Mickael RIGAULT

m.rigault@ipnl.in2p3.fr

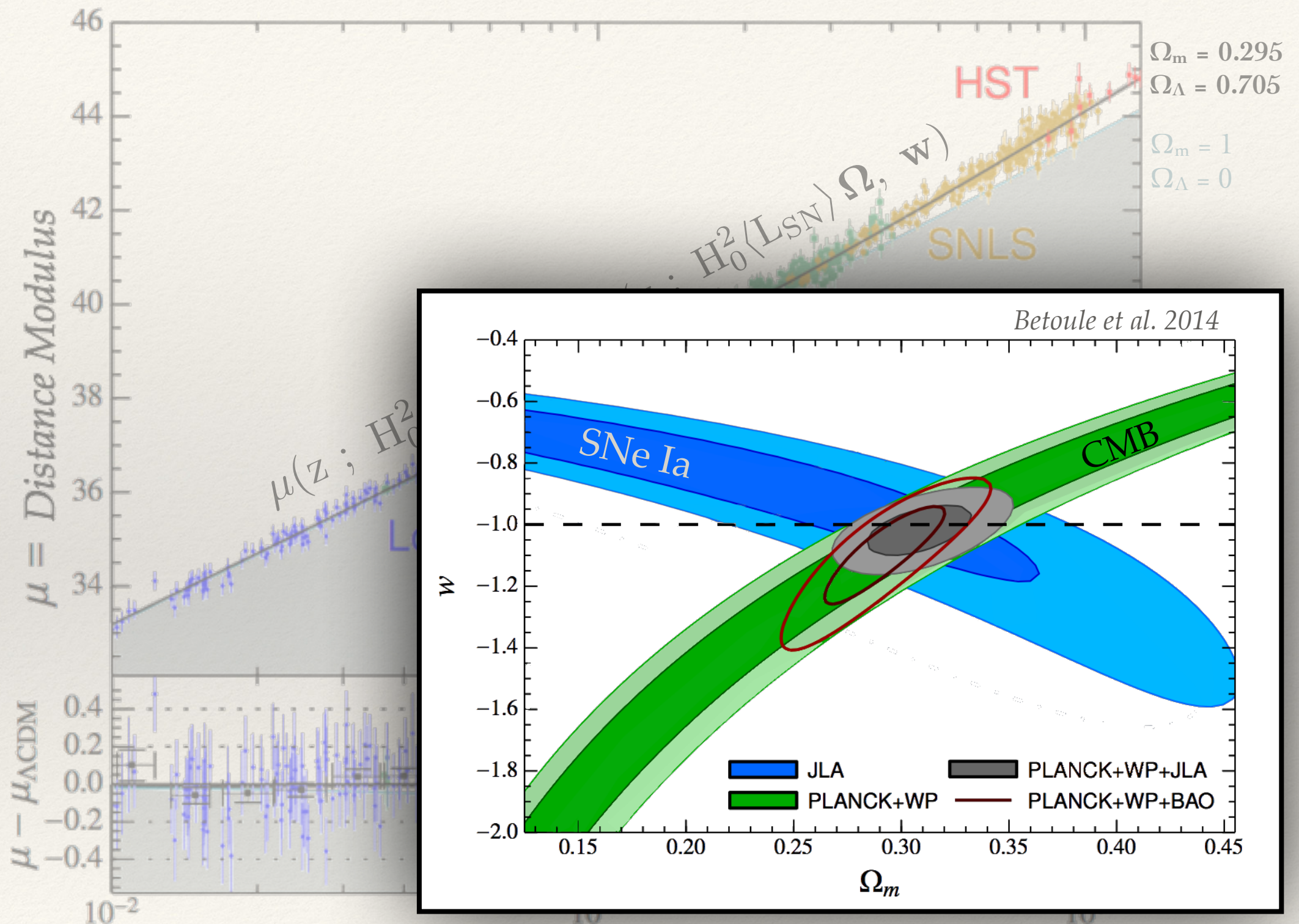
Colloque National Dark Energy 2018 | I.A.P | Paris

25th of Octobre 2018

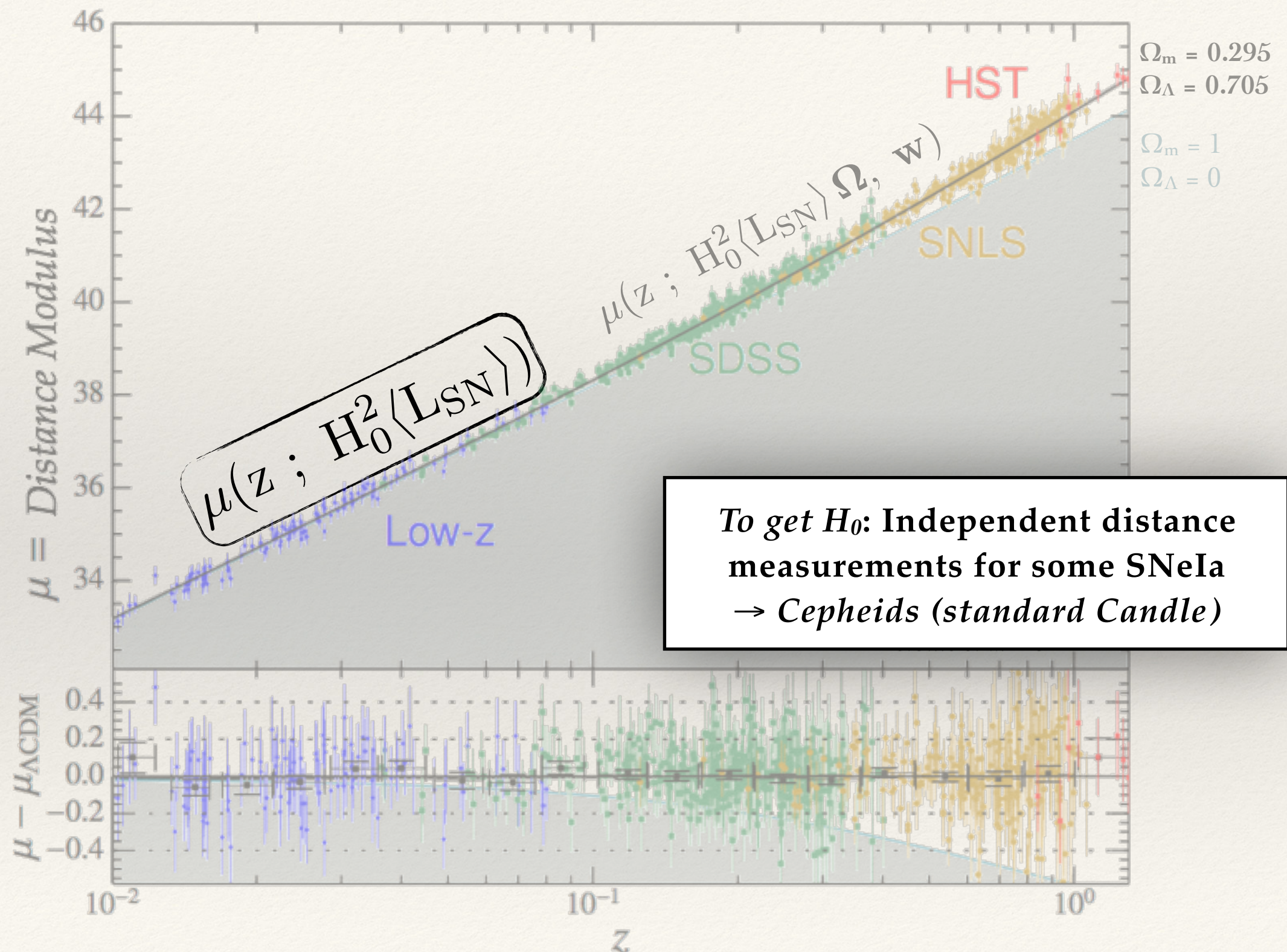
Type Ia Supernova Cosmology



Type Ia Supernova Cosmology



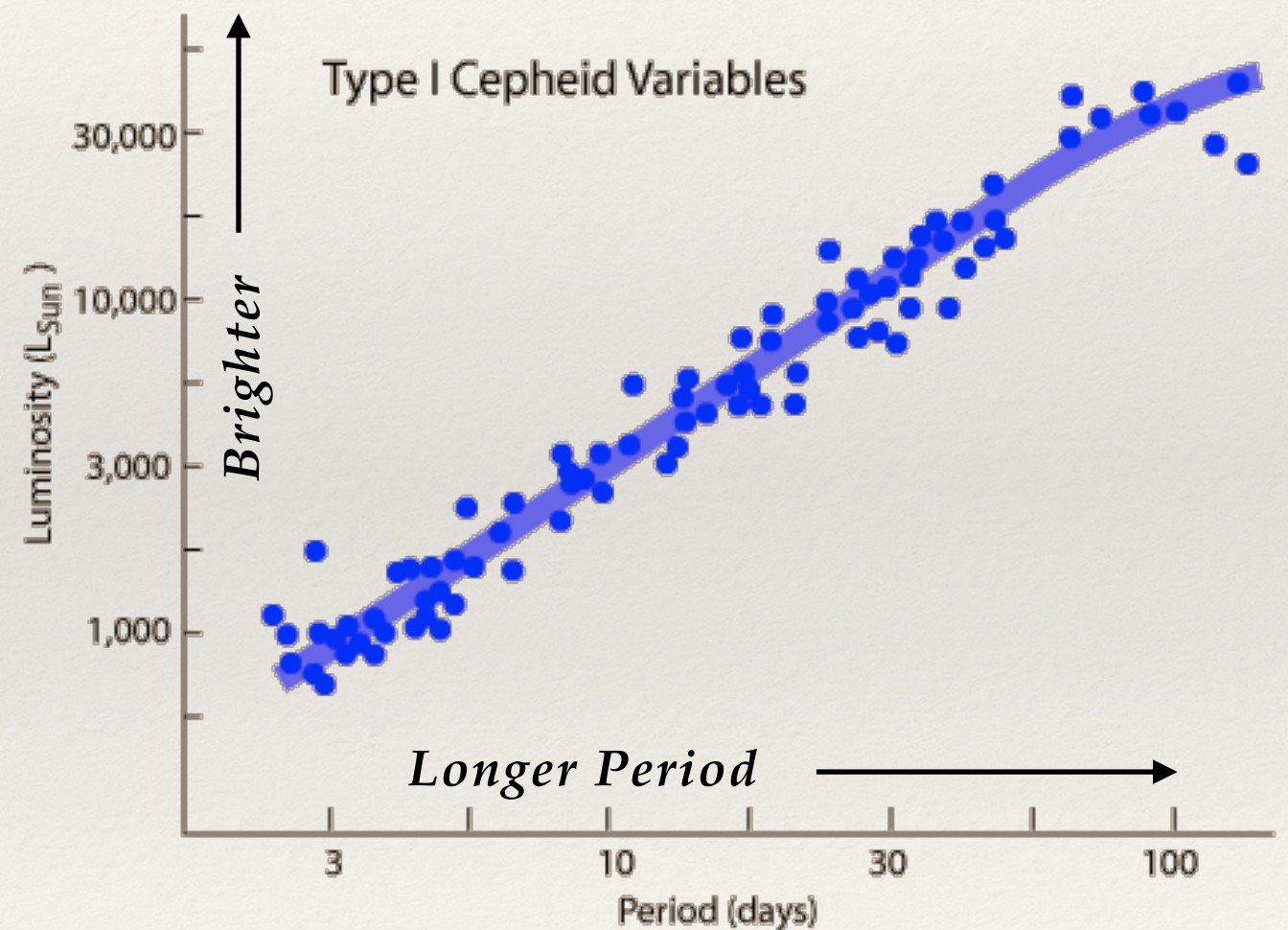
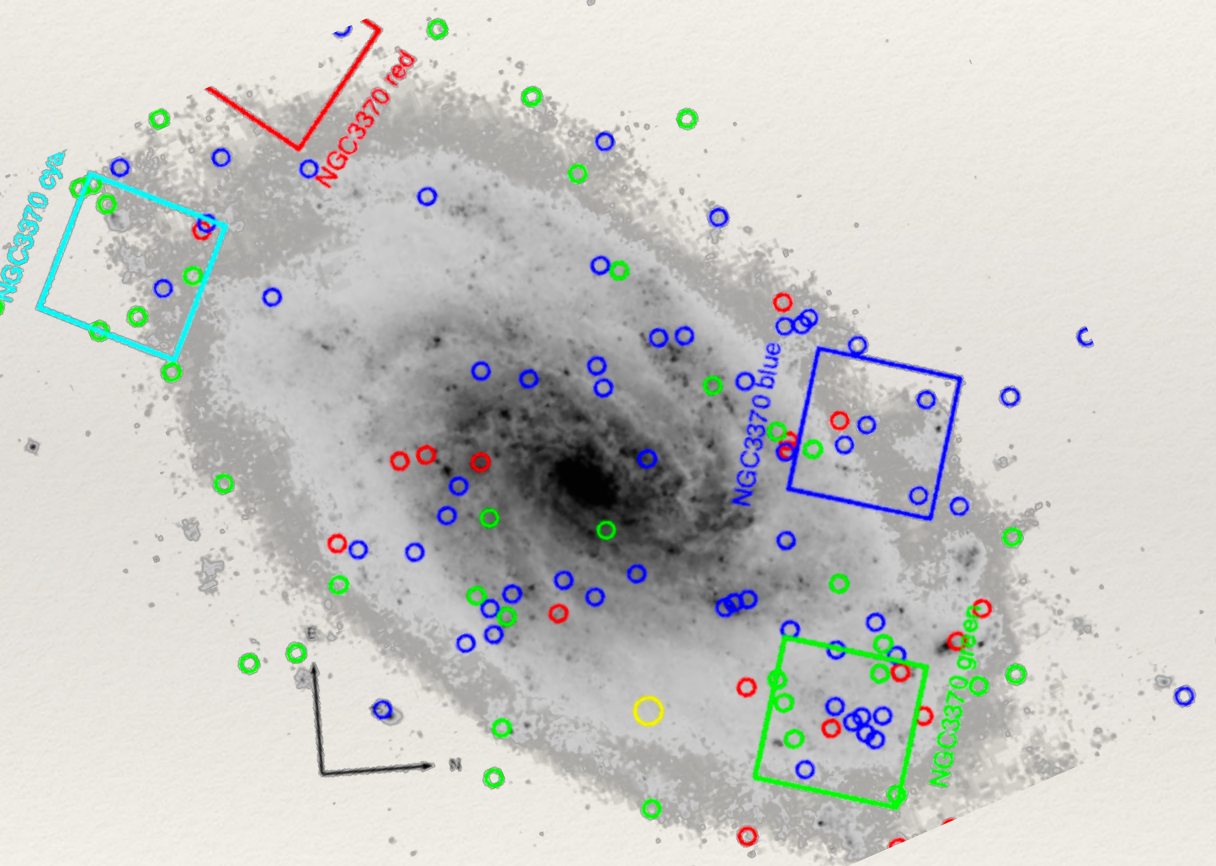
Type Ia Supernova Cosmology | H_0



The Cepheid Leavitt relation

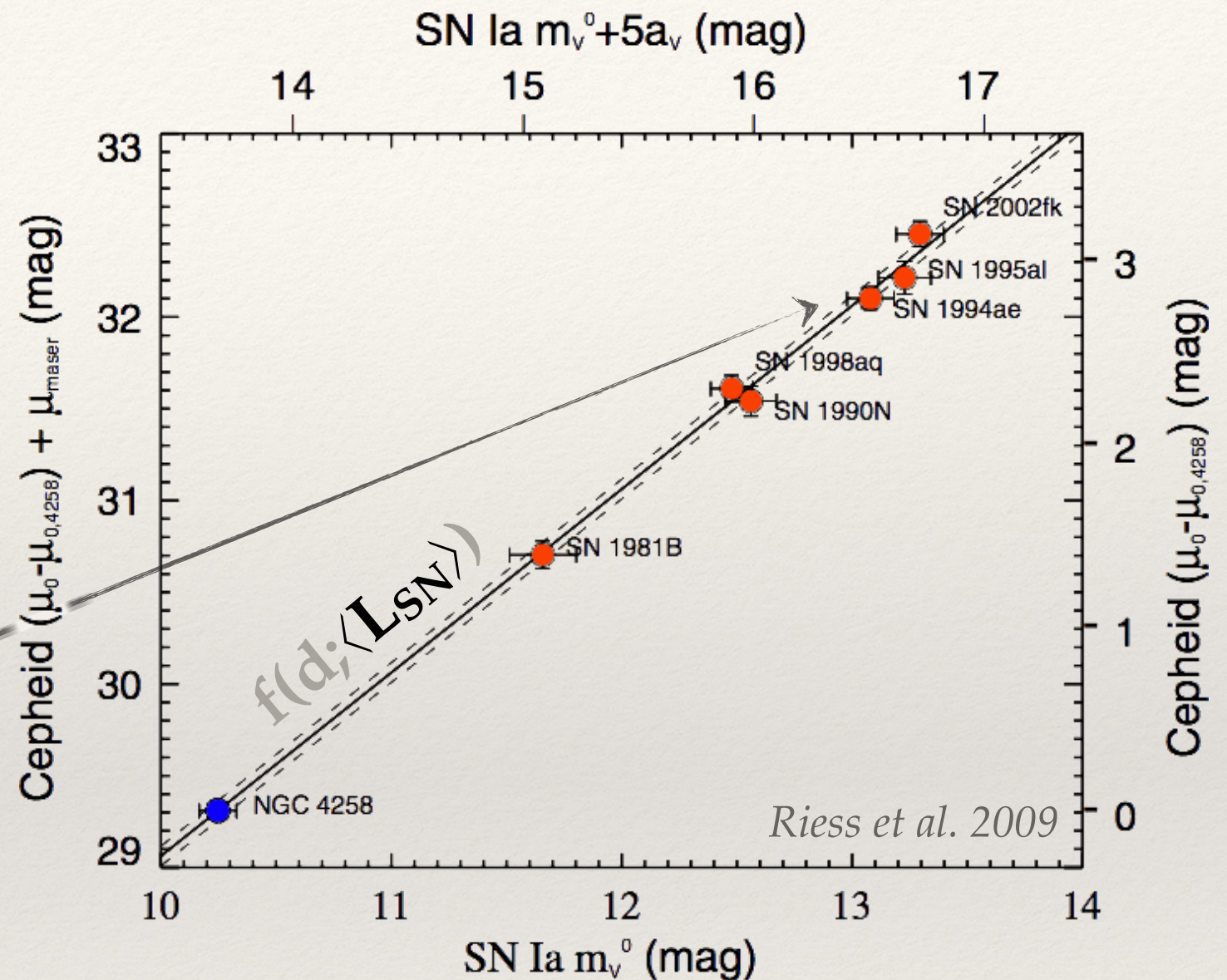
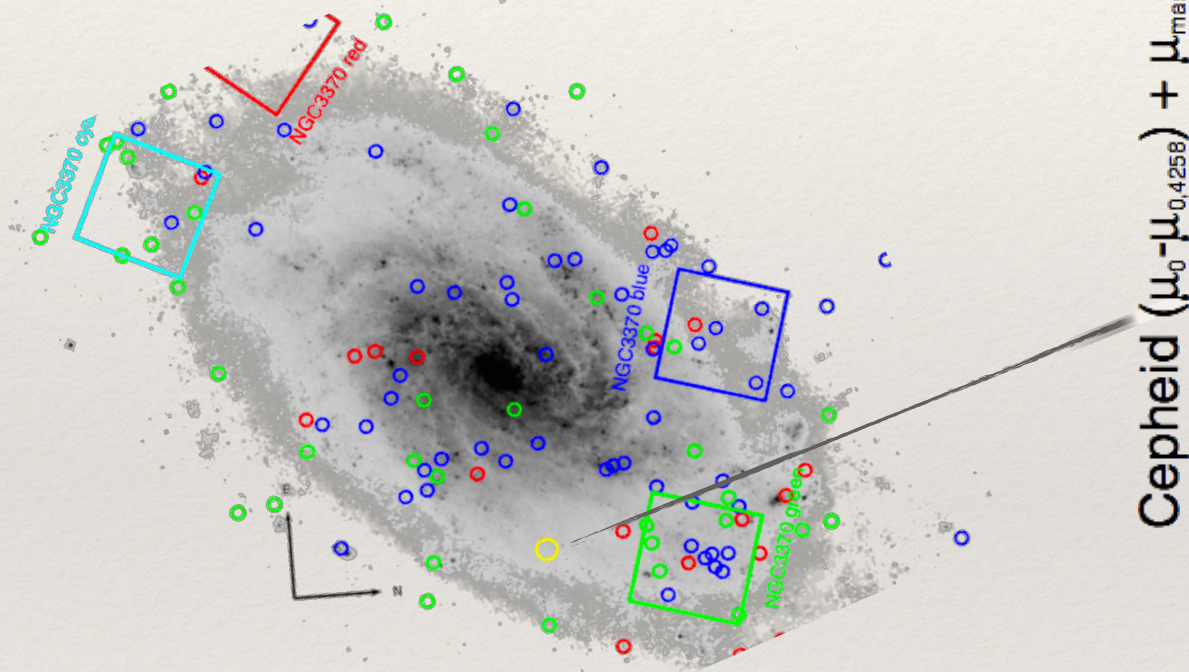
Cepheids: bright young stars with a pulsation-luminosity relation

Riess et al. 2009



Disentangle H_0 from L_{SN}

Cepheids: bright young stars with a pulsation-luminosity relation

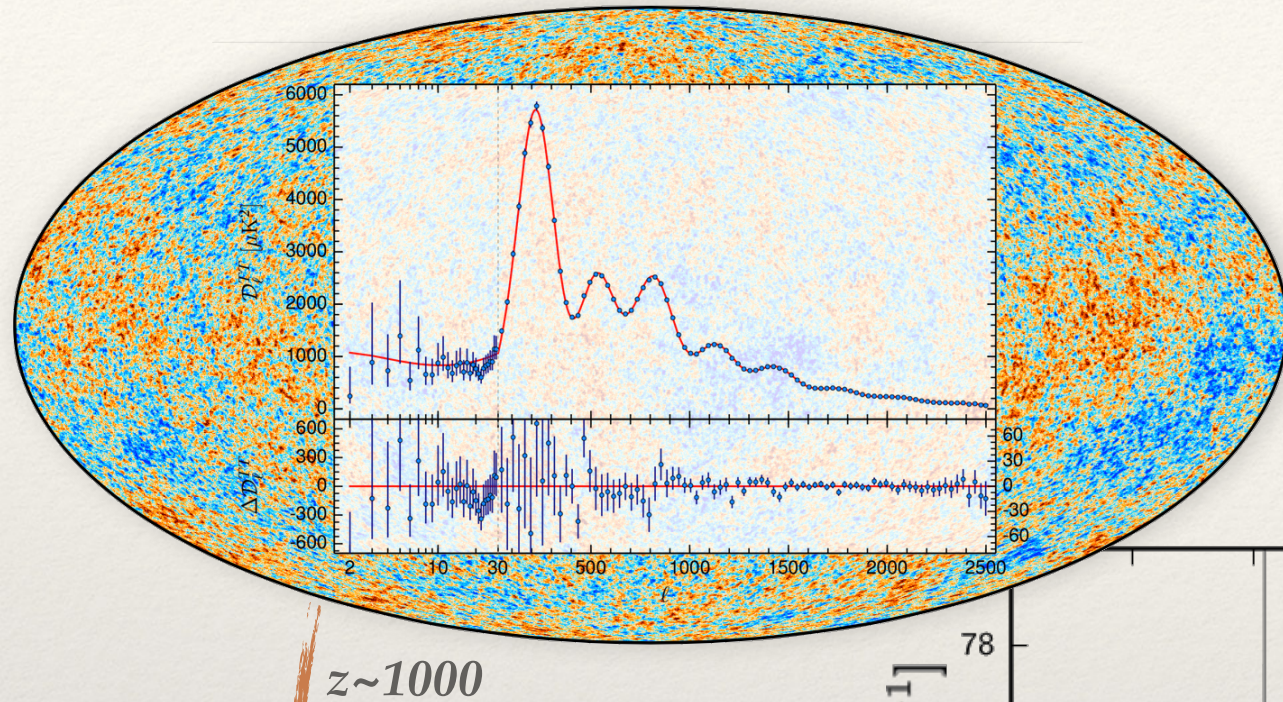


$$H_0 = 73.5 \pm 1.7 \text{ km s}^{-1} \text{ Mpc}^{-1}$$

(2.3% ; Riess et al 2016, 2018)

The Hubble Constant | *CMB*

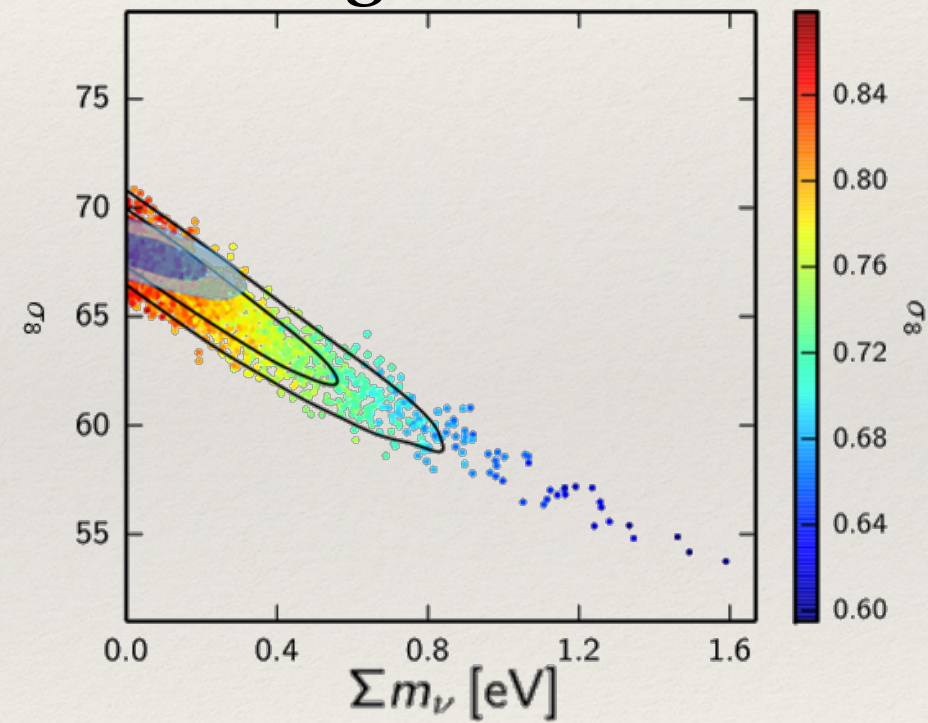
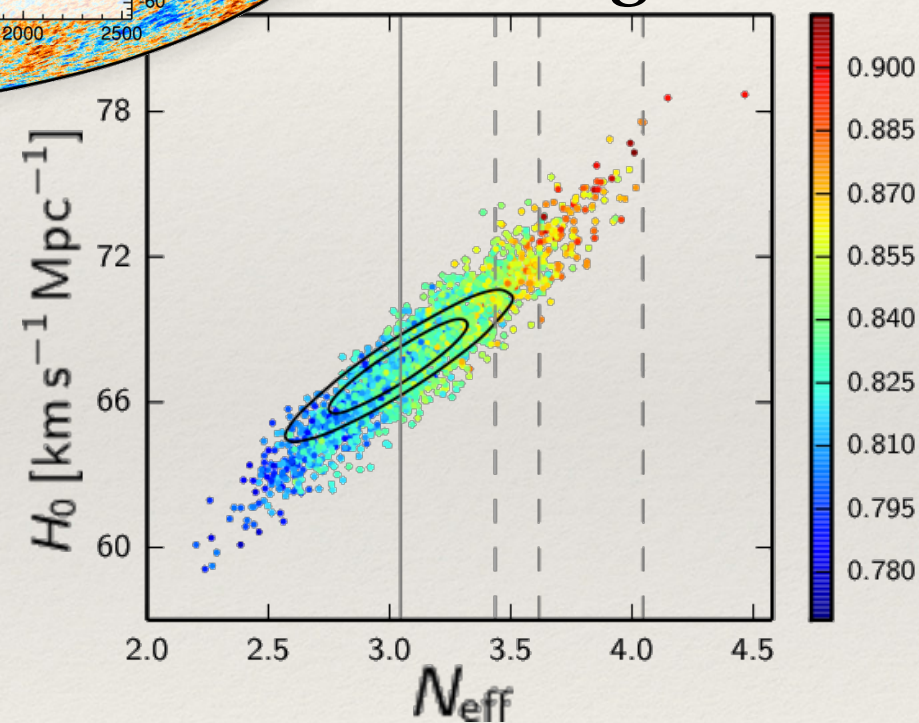
Planck 2018 results



*Test the concordance model
— Λ CDM —*

Change the model, change H_0

*THE MODEL
CONSTRAINS H_0*

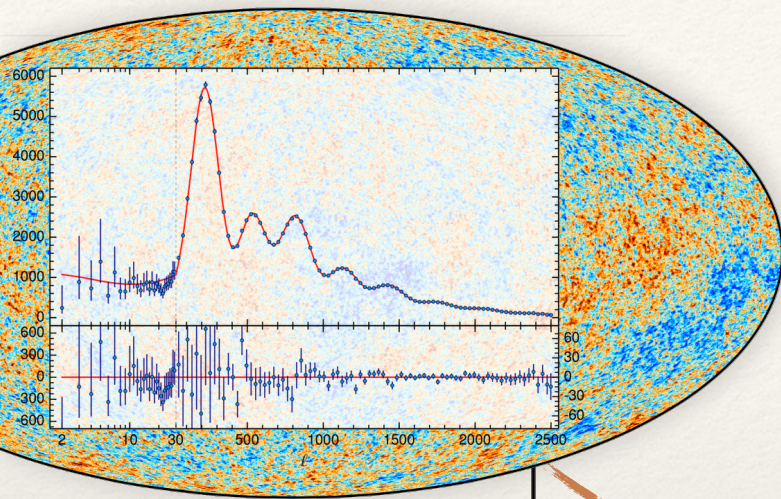


$z \sim 0$

*$H_0 = 67.4 \pm 0.5 \text{ km s}^{-1} \text{Mpc}^{-1}$
— based on Λ CDM —*

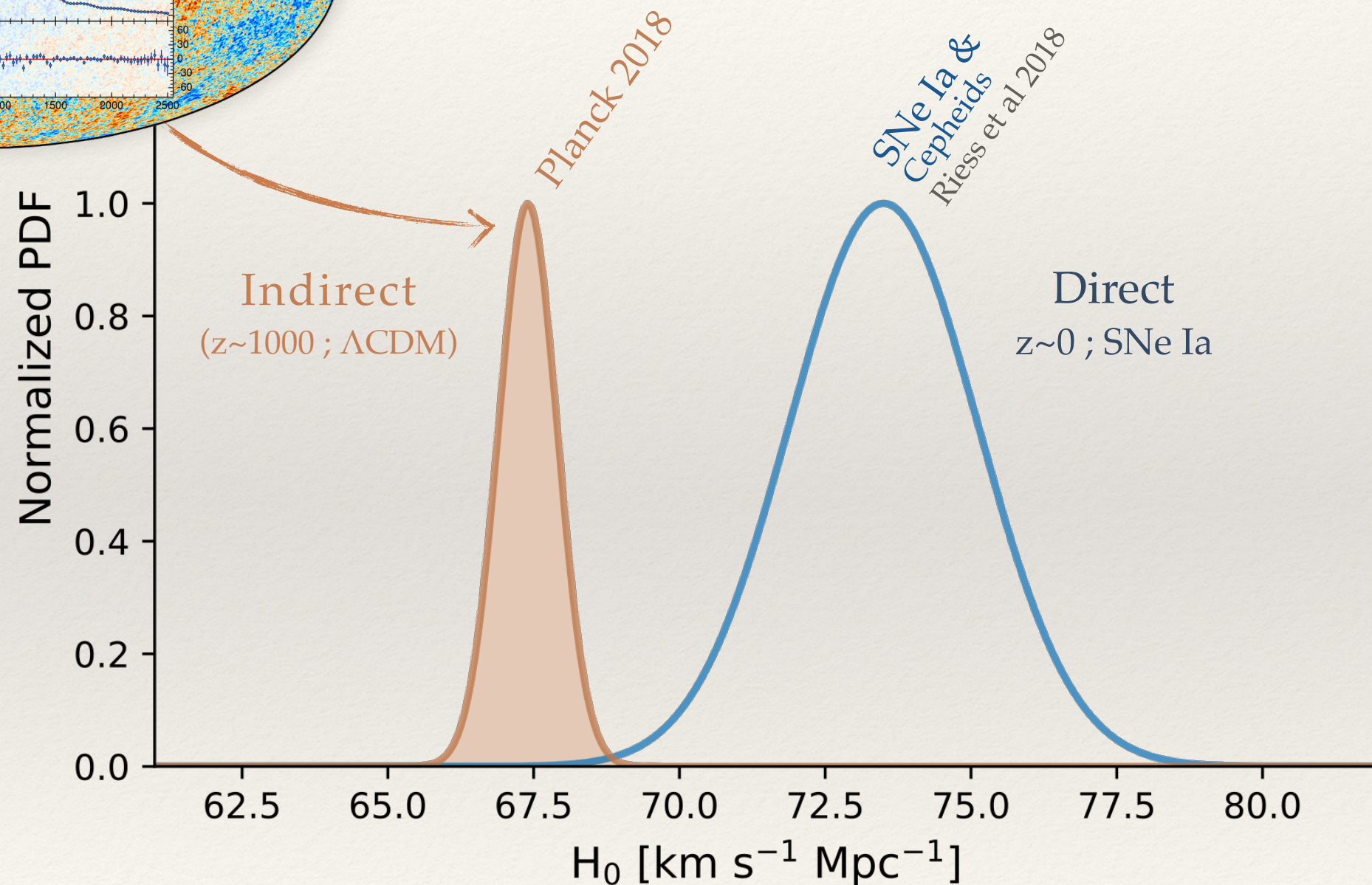
Illustrative plots from Planck 2015

Tension in the concordance model?

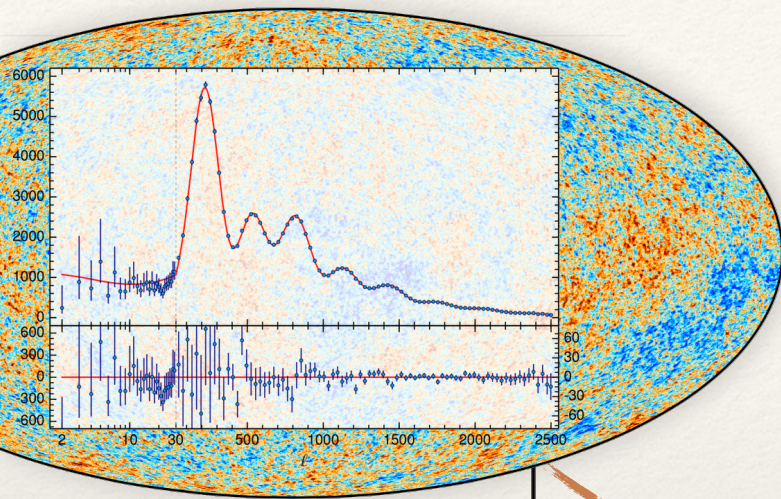


New physics or a systematic error ?

$\sim 4\sigma$

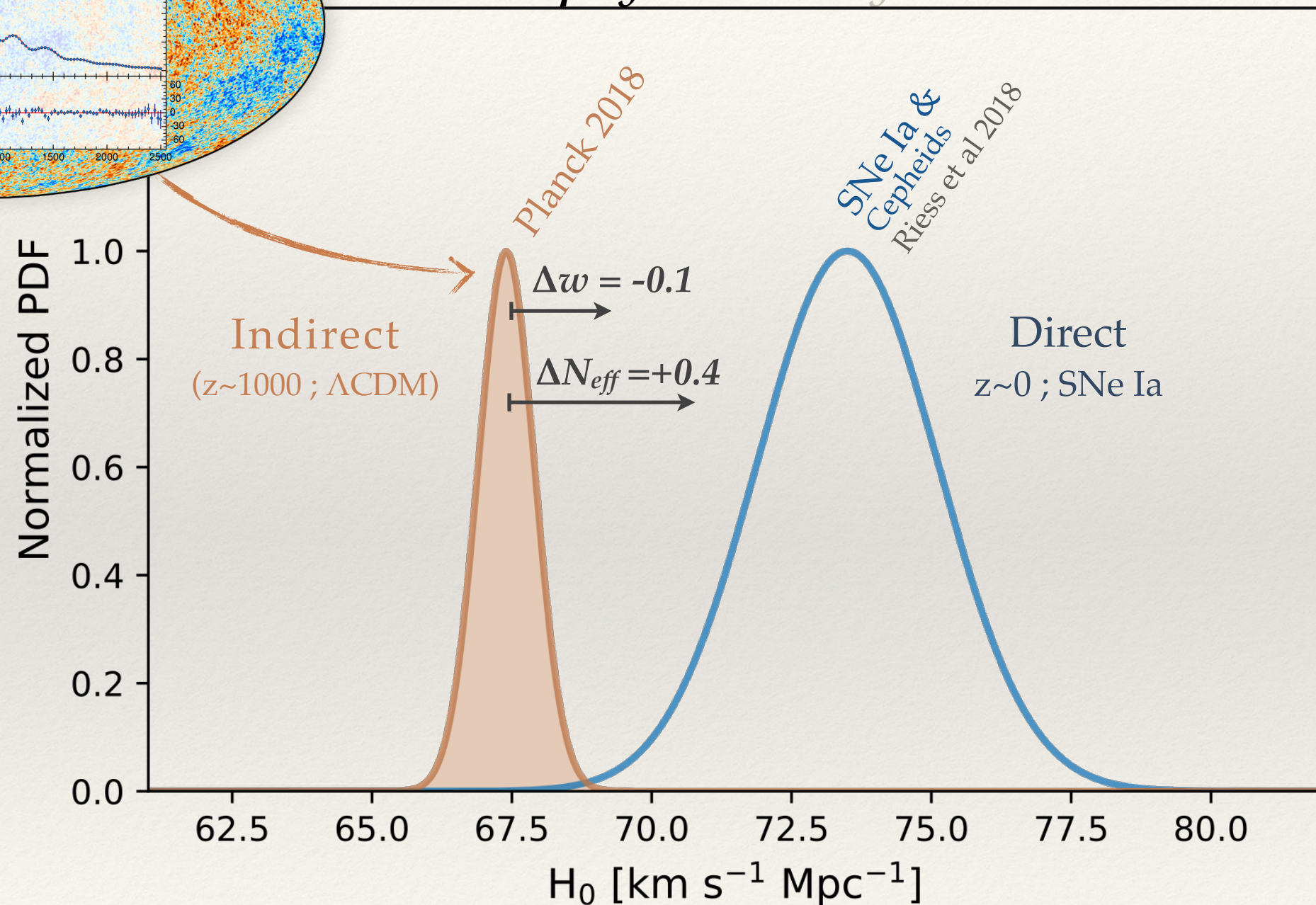


Tension in the concordance model?

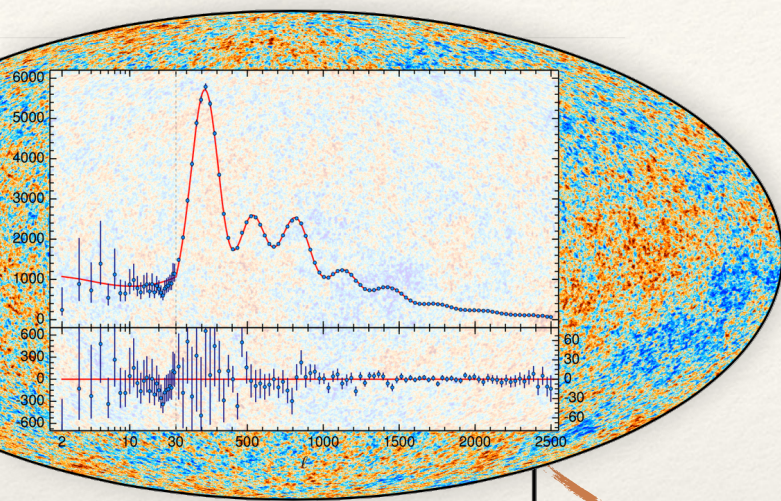


New physics or a systematic error ?

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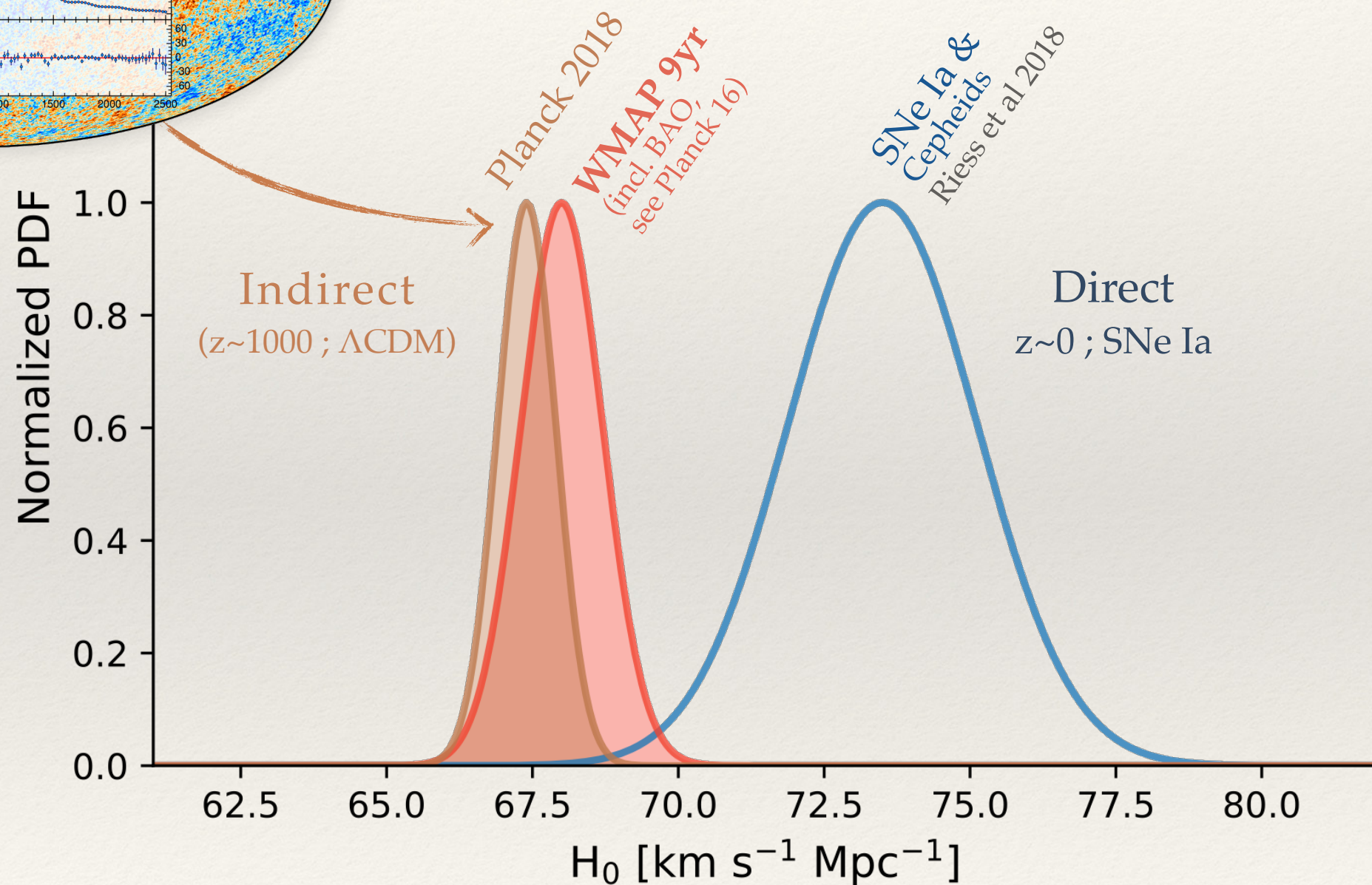


Tension in the concordance model?

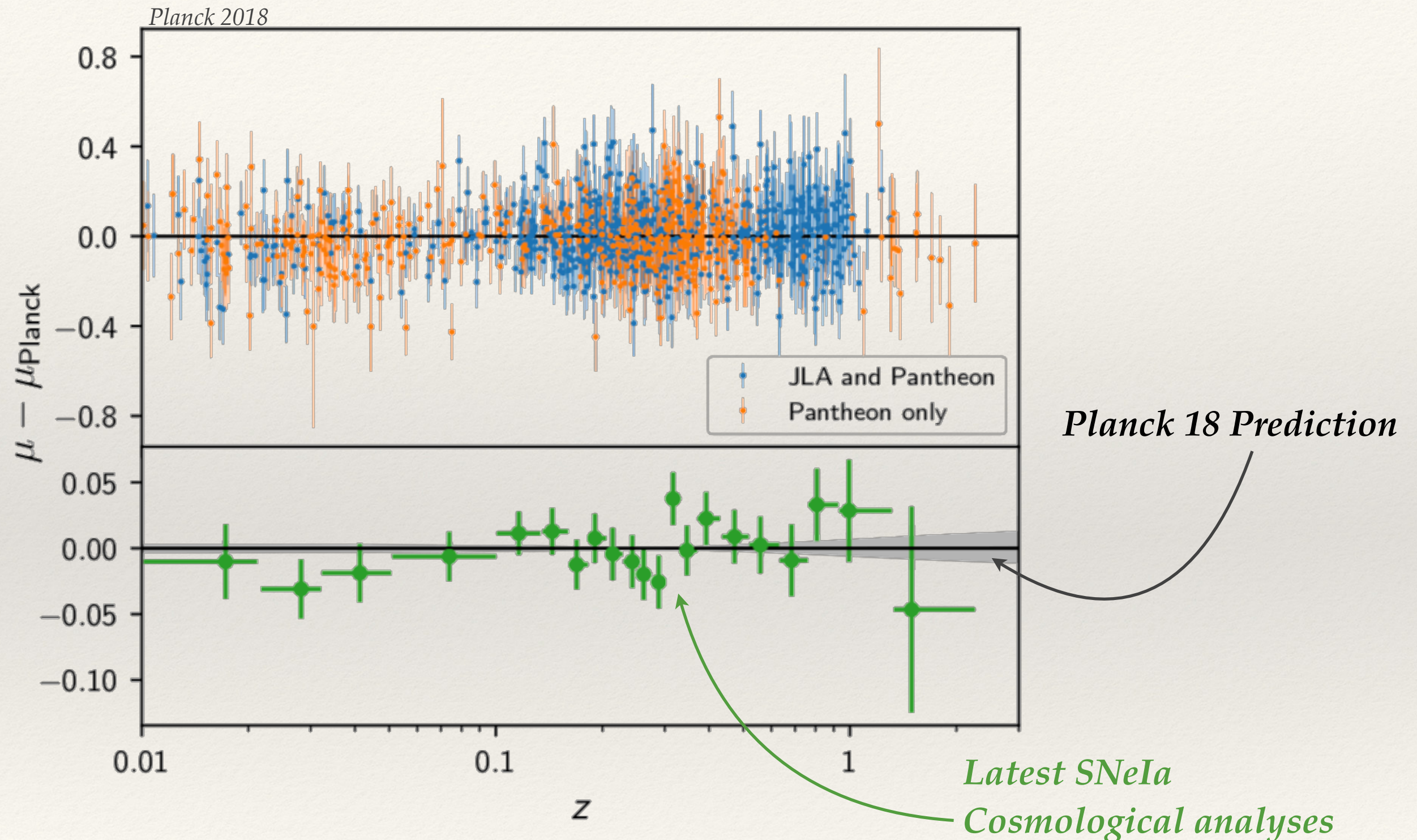


New physics or a systematic error ?

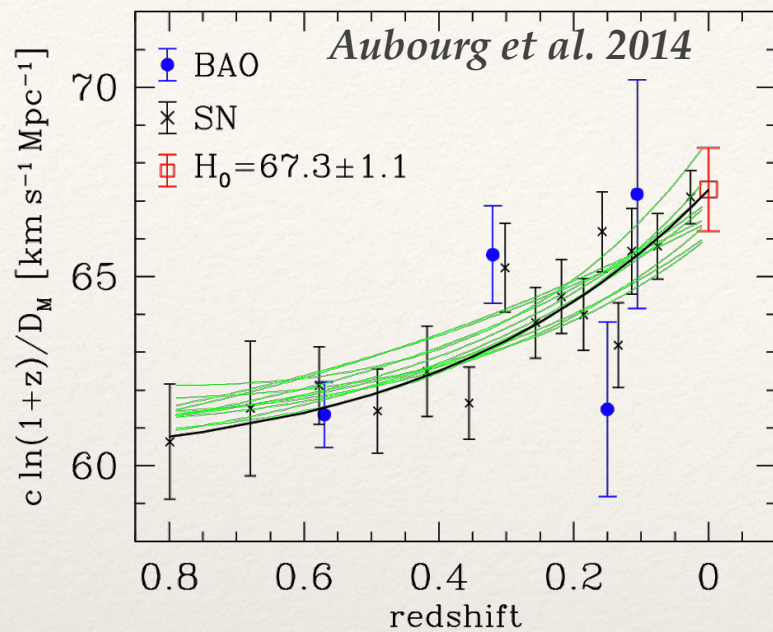
in Planck Analysis ?



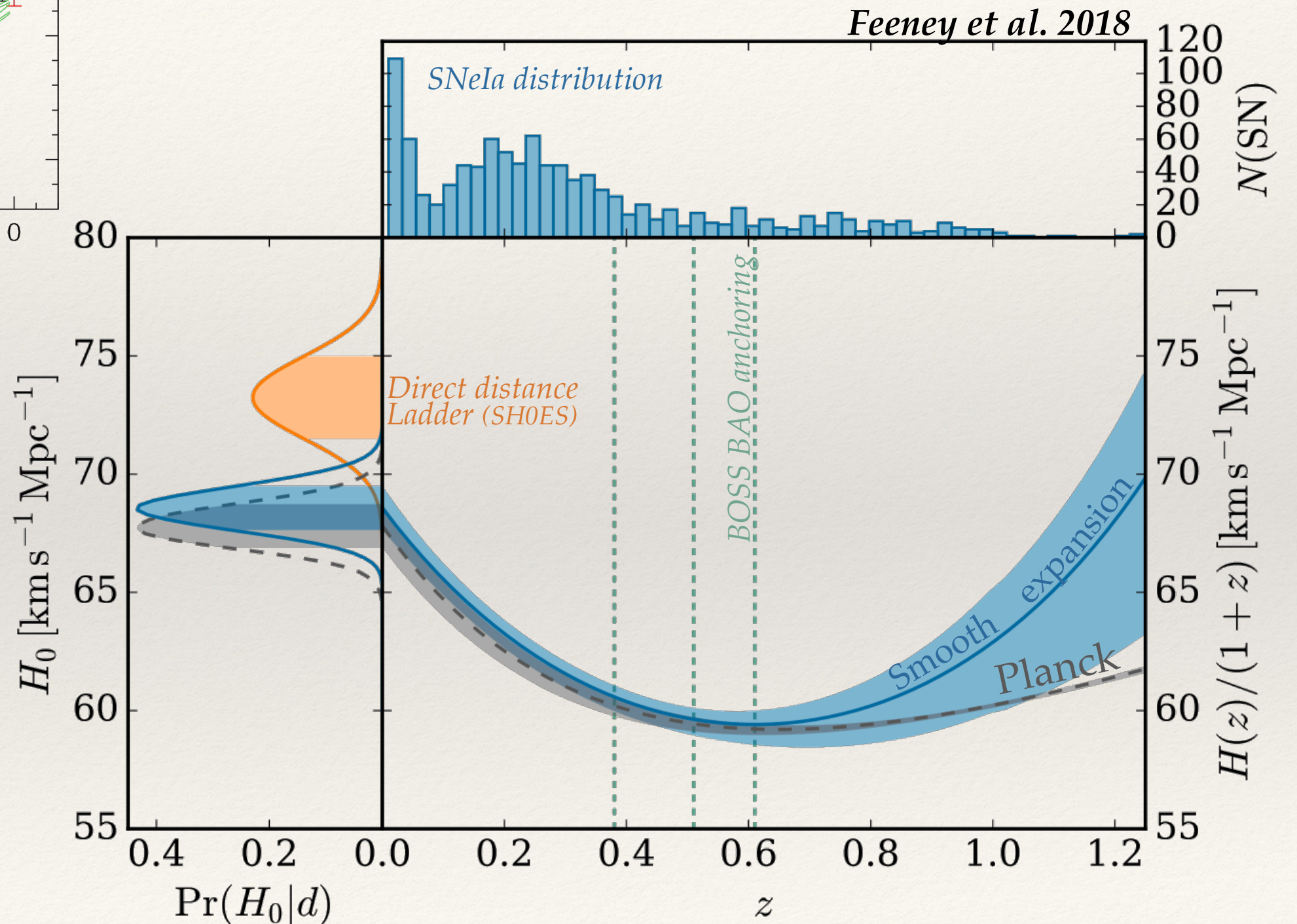
CMB and SNeIa in disagreement ?



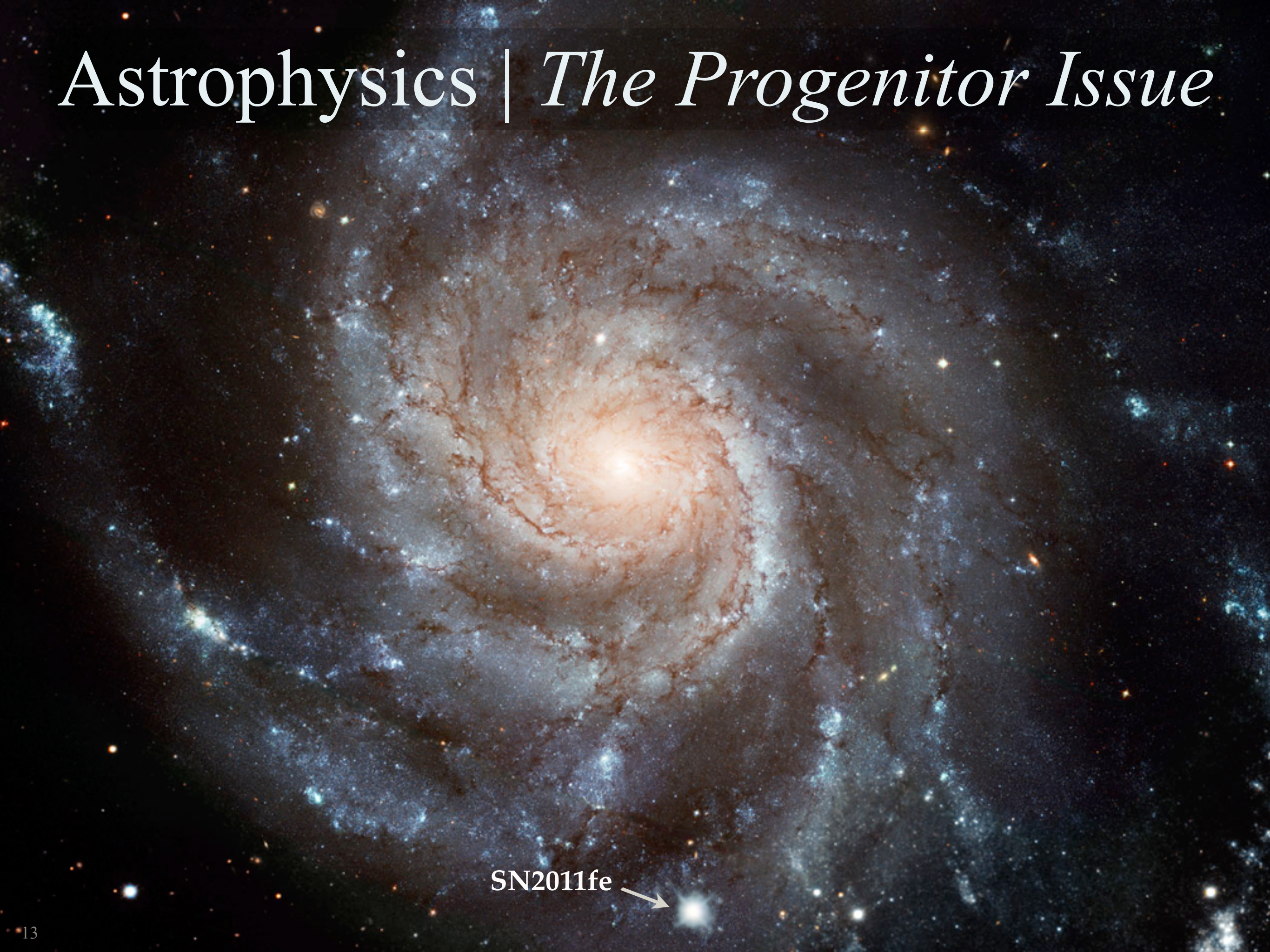
Inverse Distance Ladder



Only using r_d from CMB



Astrophysics | *The Progenitor Issue*



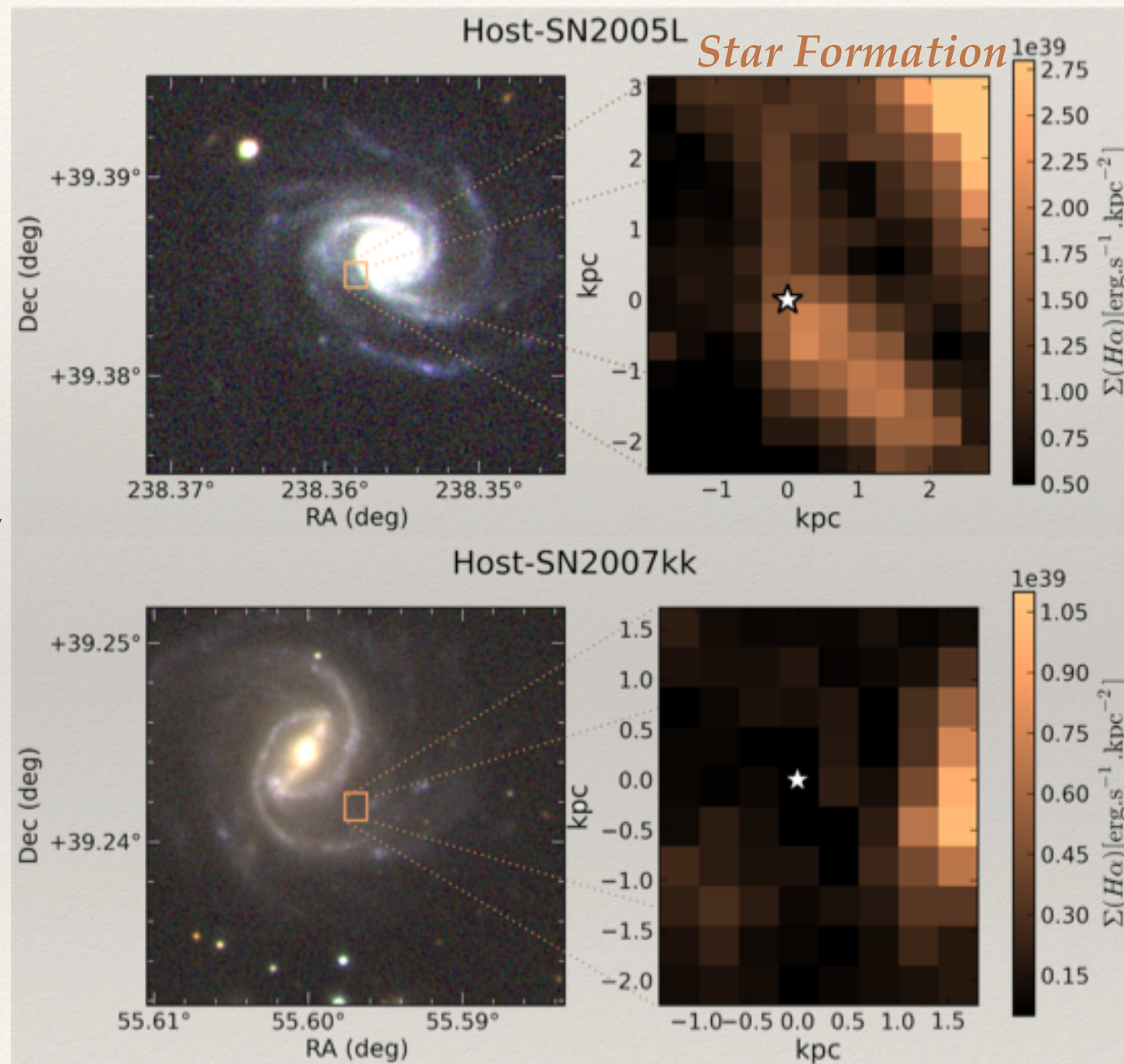
SN2011fe →

The Local Perspective

Rigault et al. 2013

GLOBAL

Spiral, Star Forming,
host galaxies



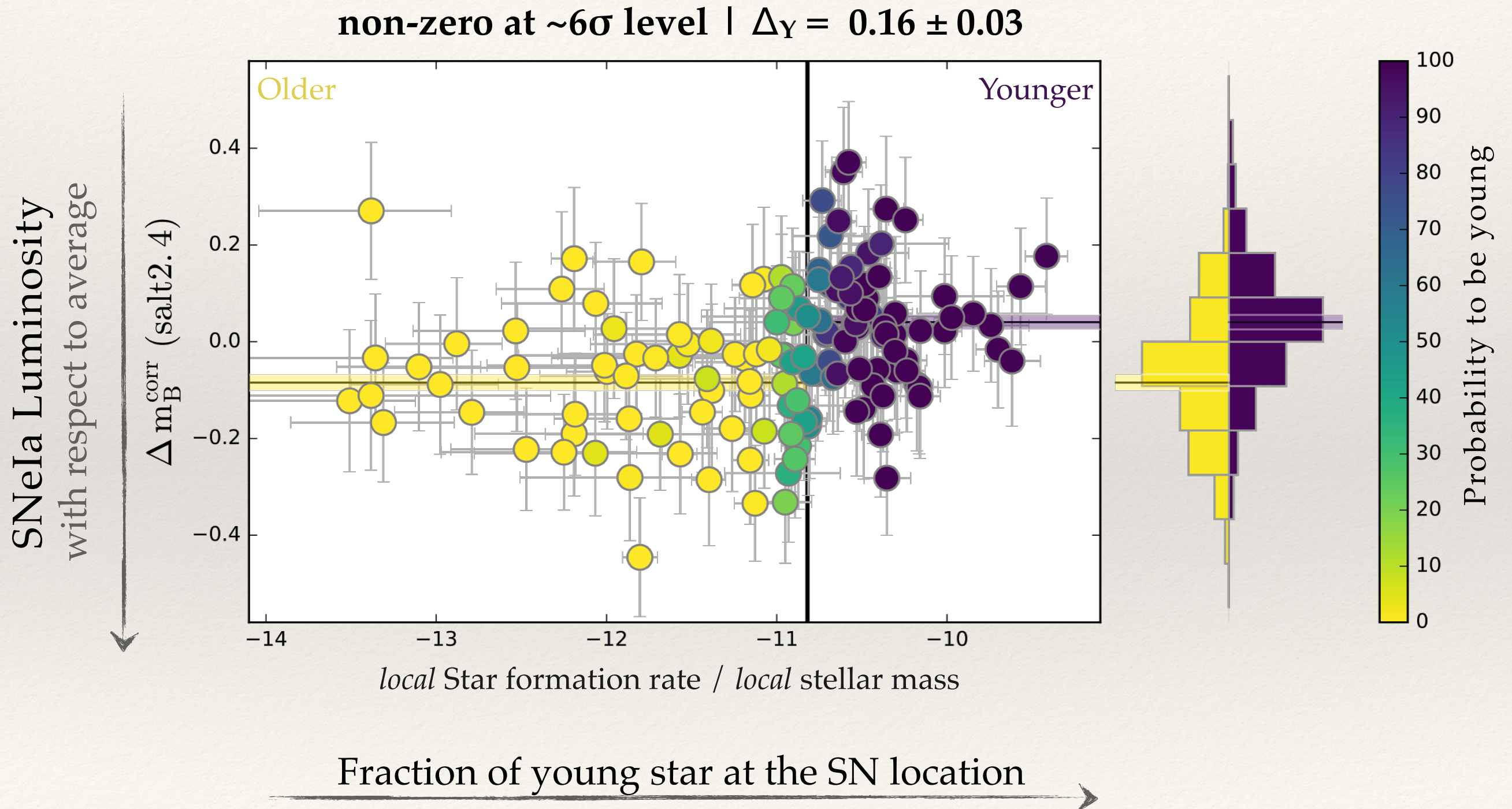
LOCAL

Star Formation
—
Young Stars

No Star Formation
—
Older Stars

The Age Step

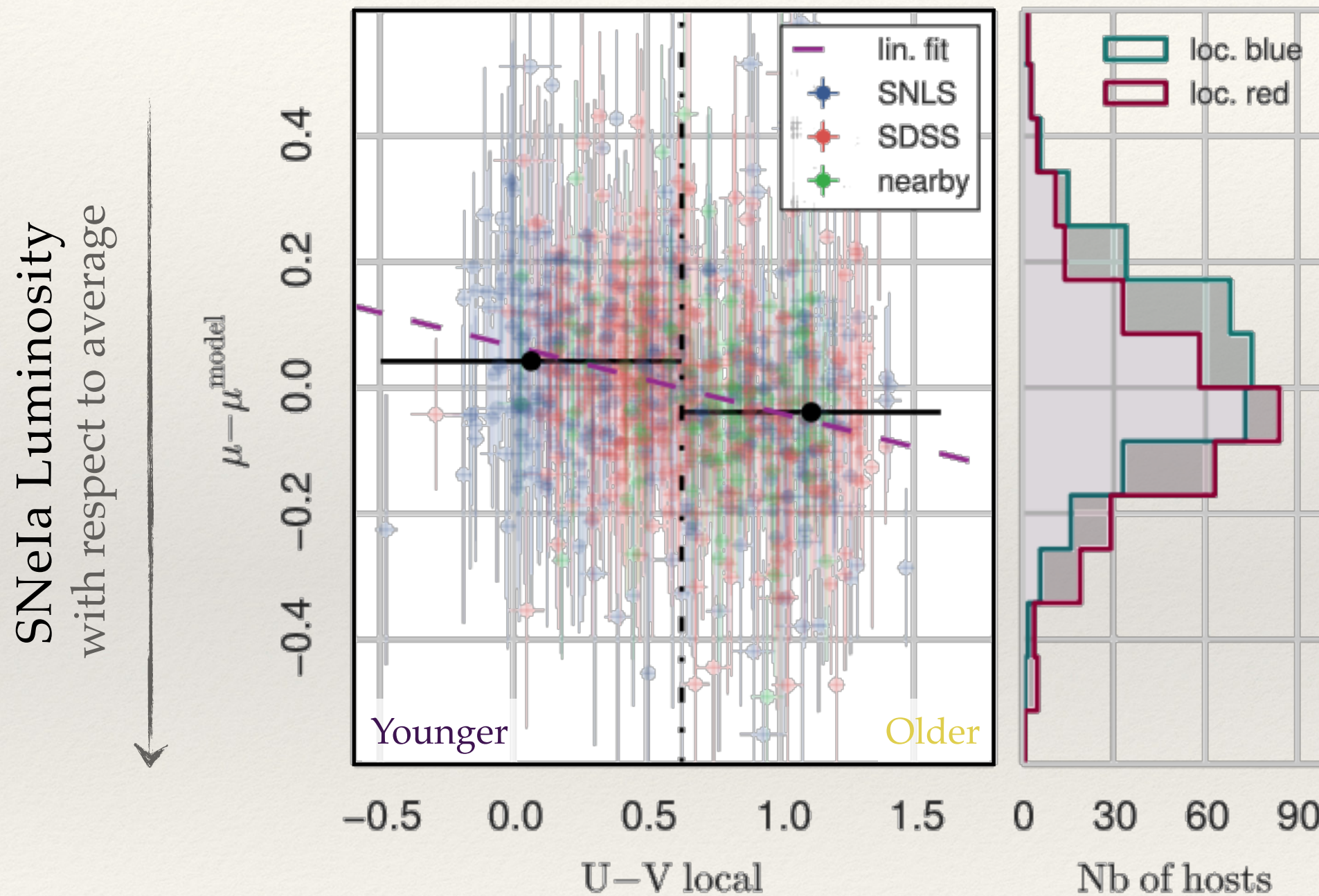
Rigault et al. 2018



The Age Step | *confirmed*

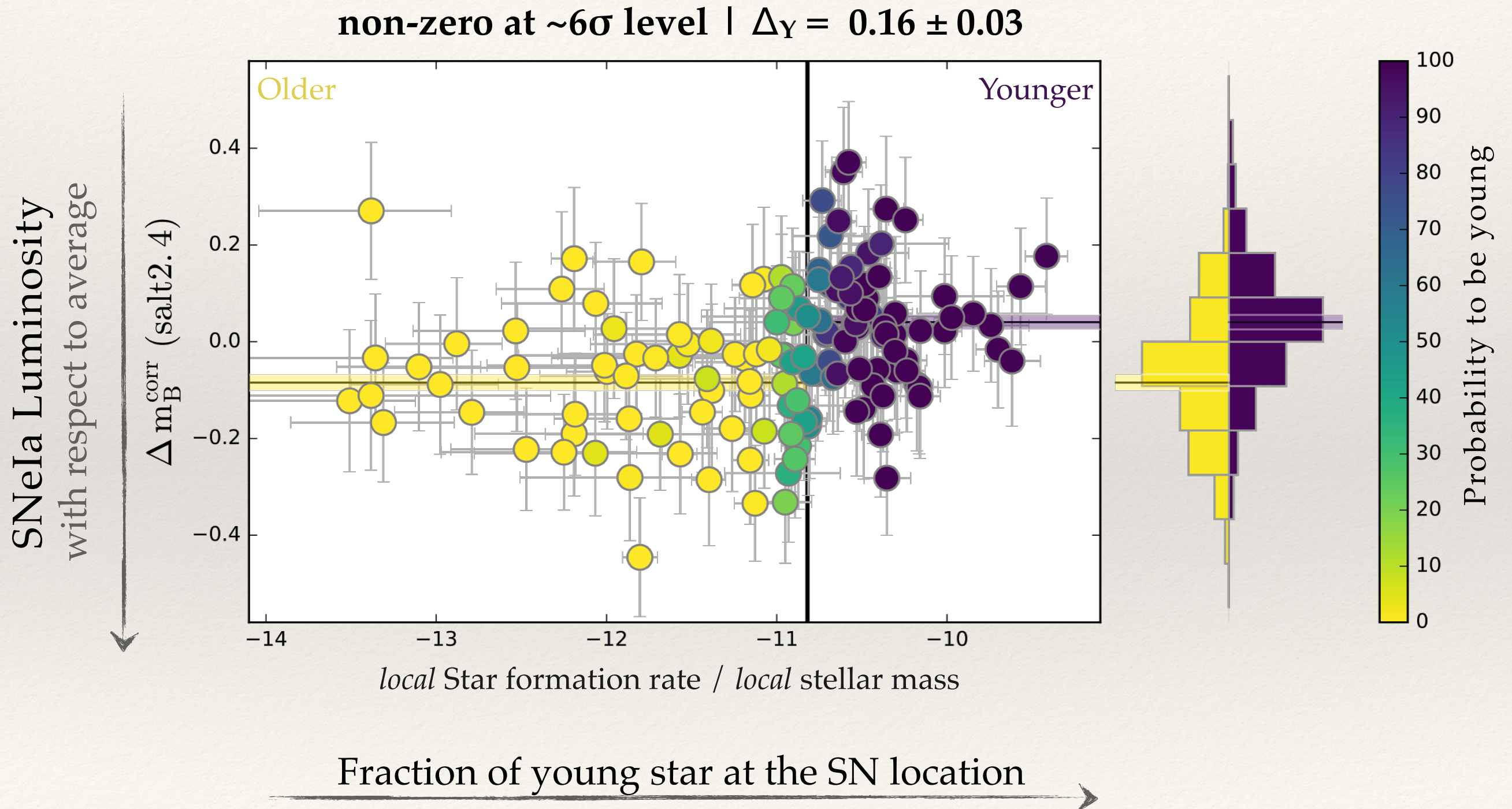
Roman et al. 2018

non-zero at $\sim 7\sigma$ level



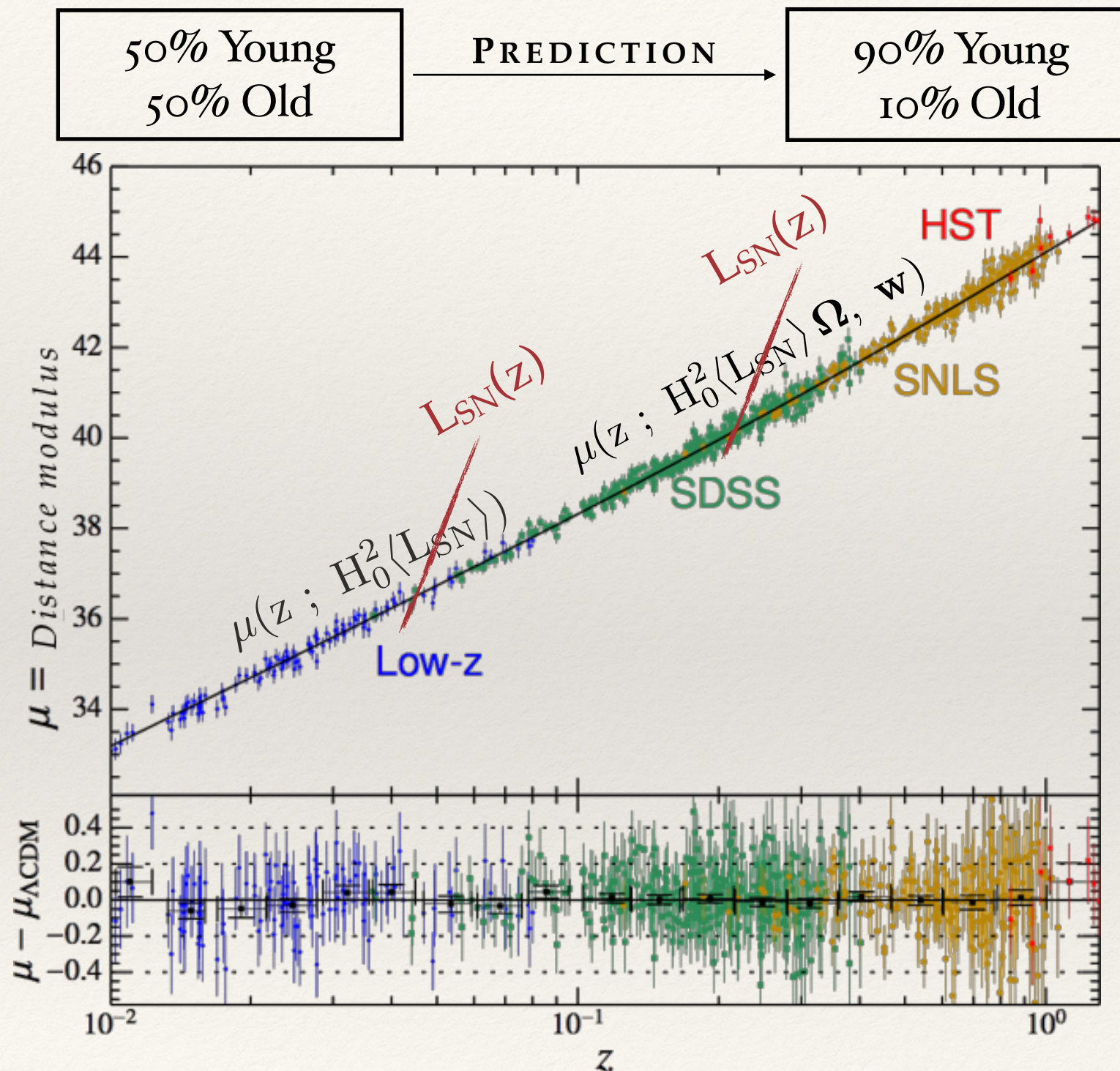
The Age Step

Rigault et al. 2018

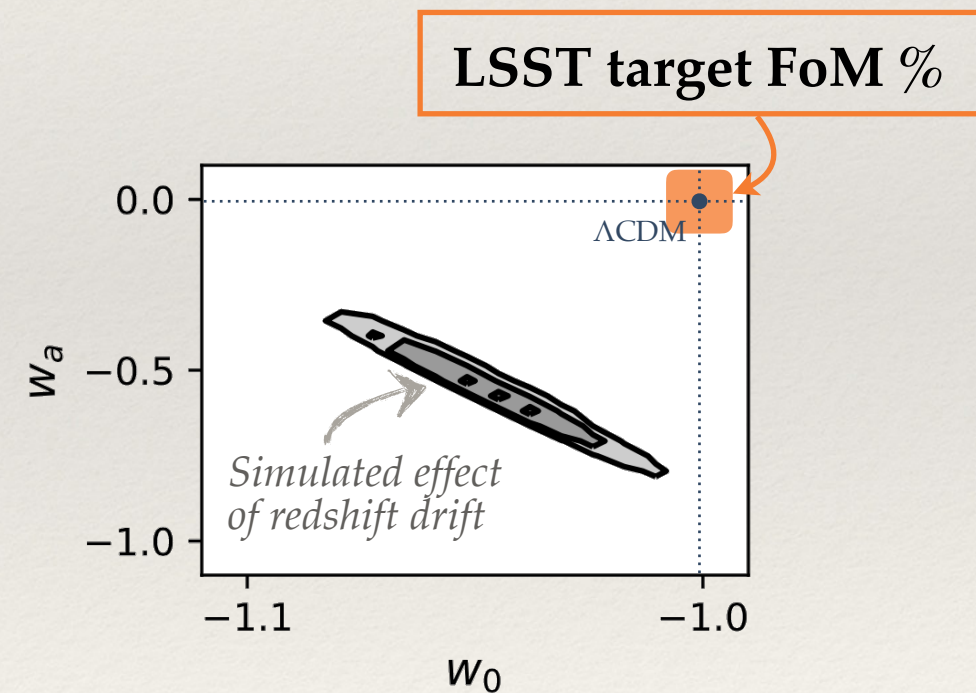


Impact on derivation of Dark Energy properties

Rigault et al. 2013, 2018

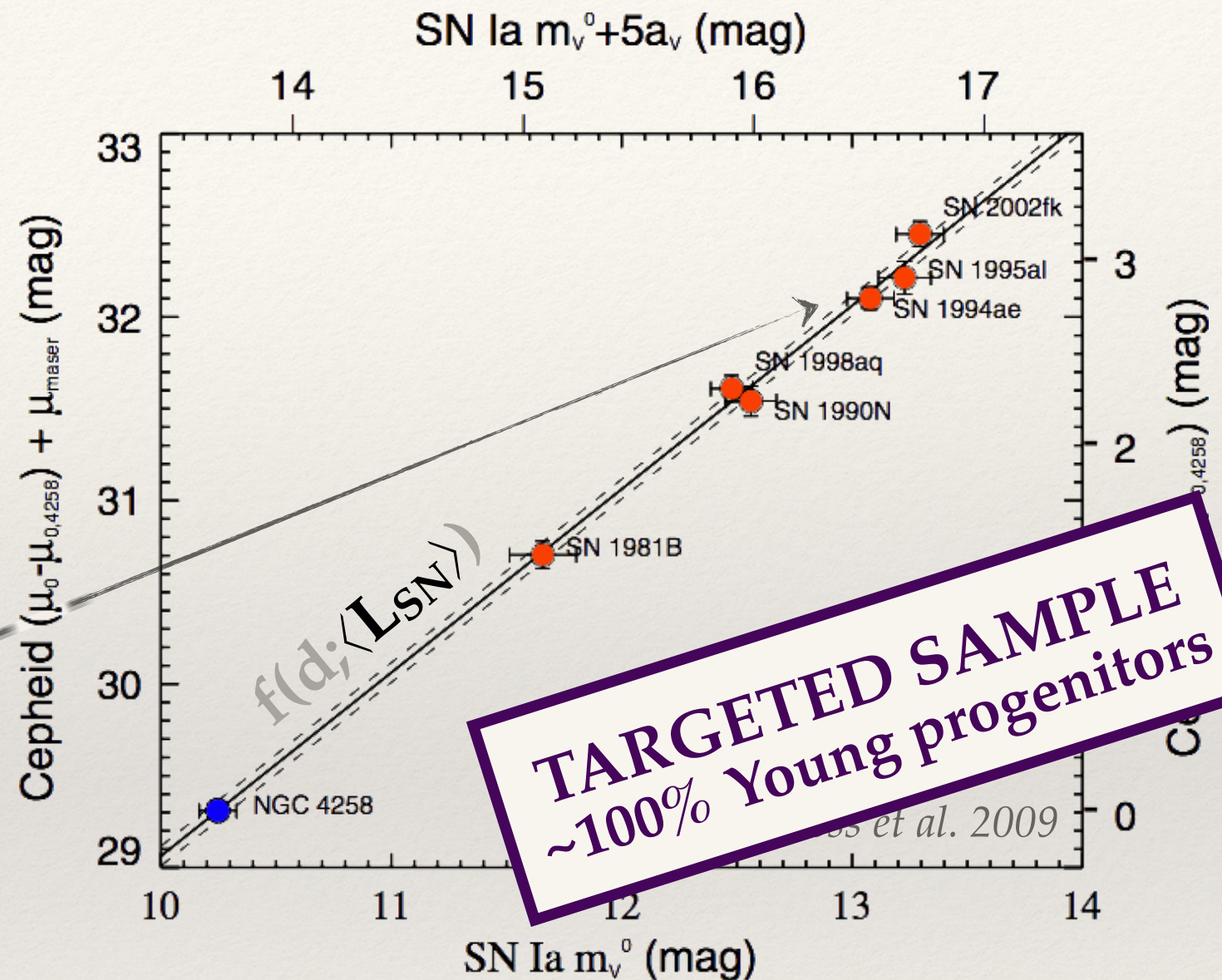
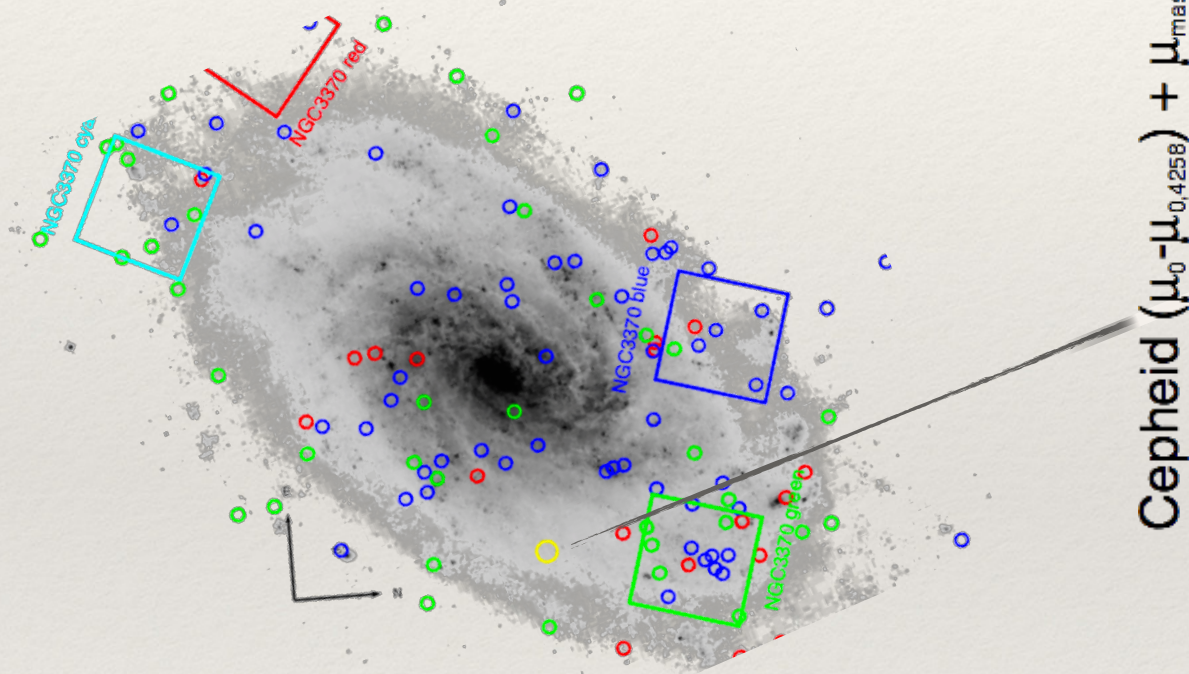


*Galaxies are more star forming
at higher redshift*



Disentangle H_0 from L_{SN}

Cepheids: bright young stars with a pulsation-luminosity relation

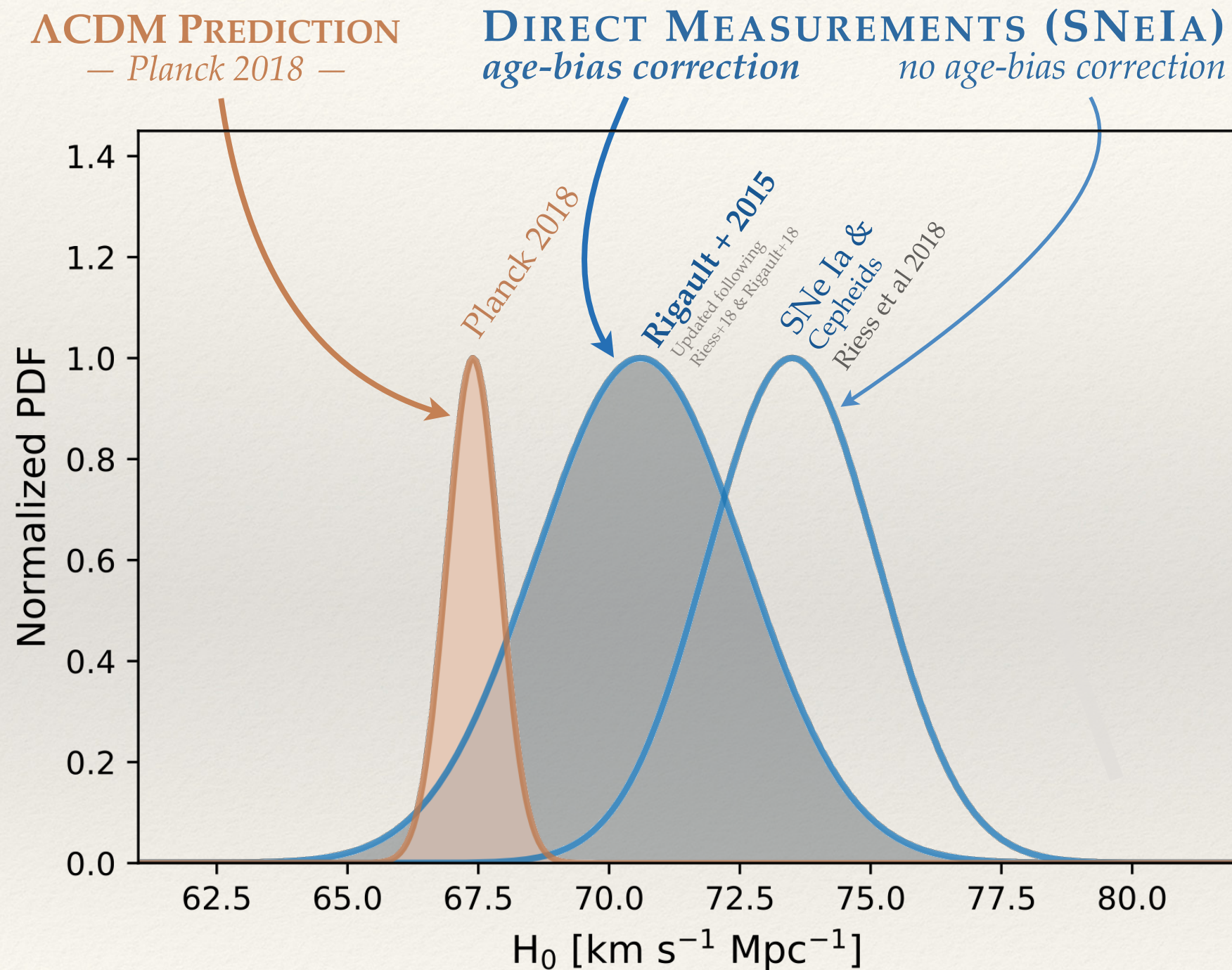


$$H_0 = 73.5 \pm 1.7 \text{ km s}^{-1} \text{ Mpc}^{-1}$$

(2.3% ; Riess et al 2016, 2018)

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

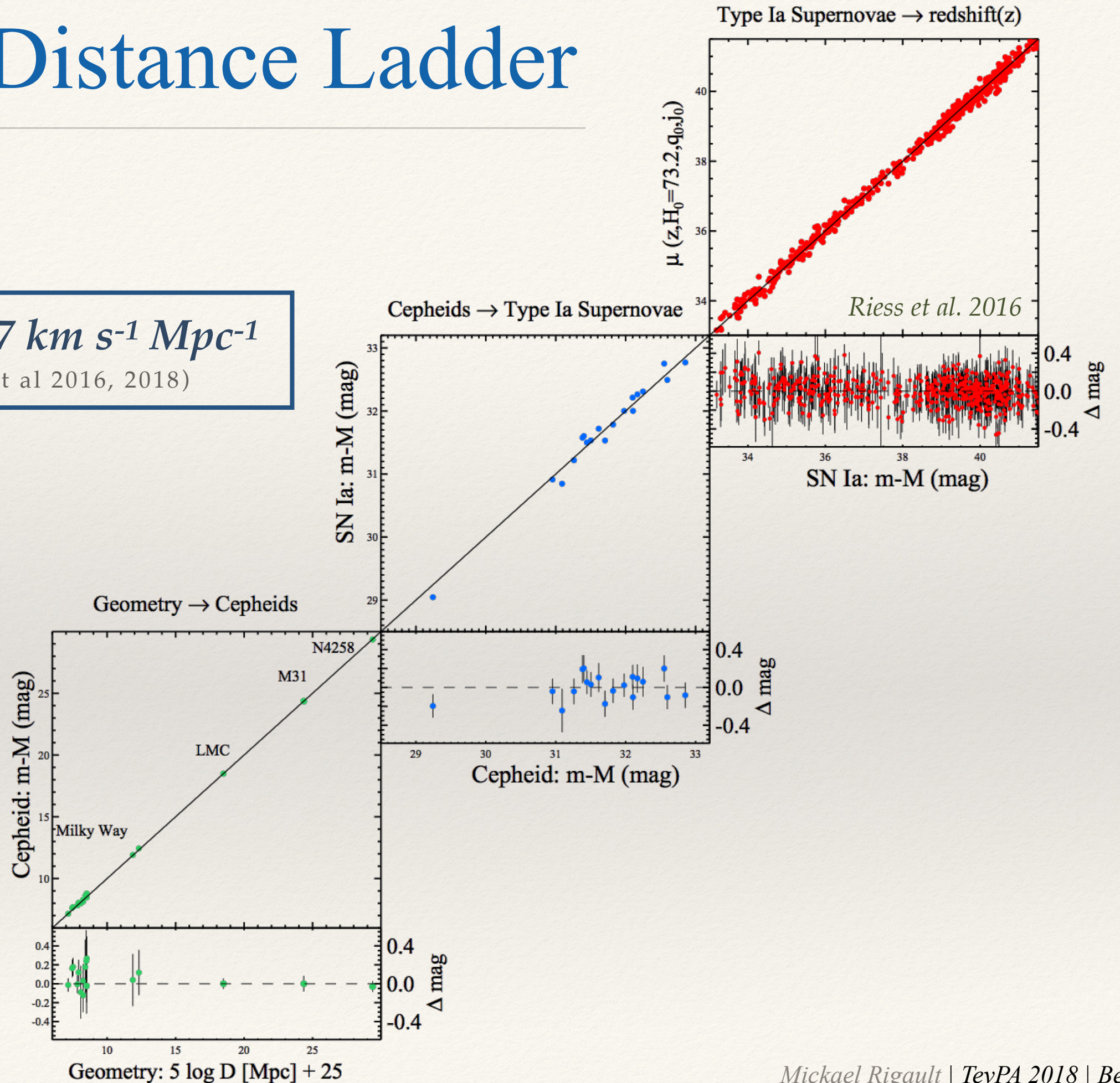
To be confirmed using Riess's SNeIa

« Back up. »

Direct Distance Ladder

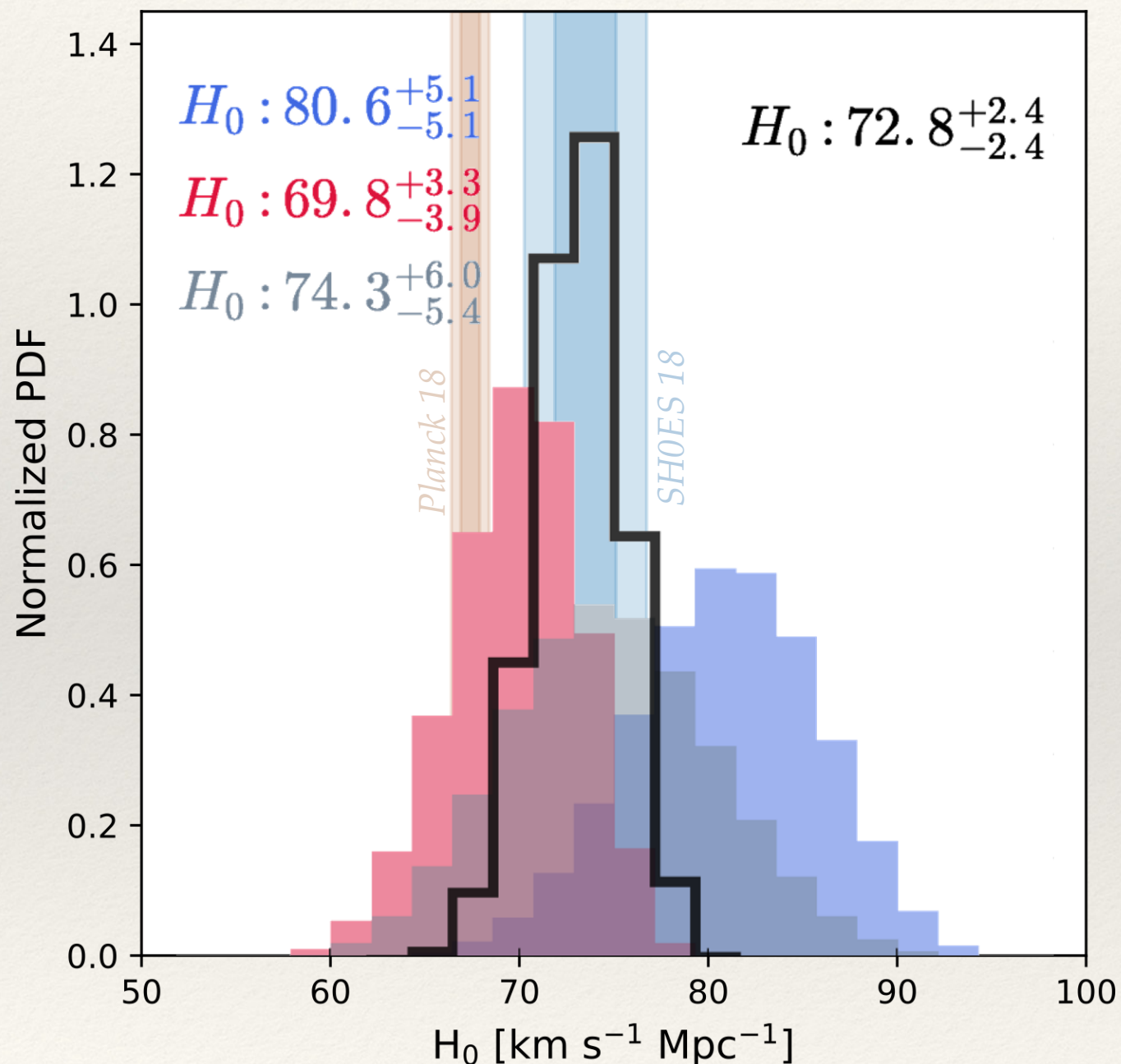
$$H_0 = 73.5 \pm 1.7 \text{ km s}^{-1} \text{ Mpc}^{-1}$$

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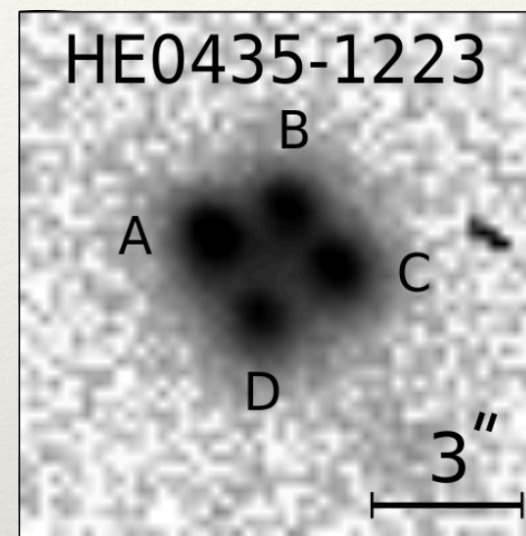


Tension in the concordance model?

New physics or a systematic error ?

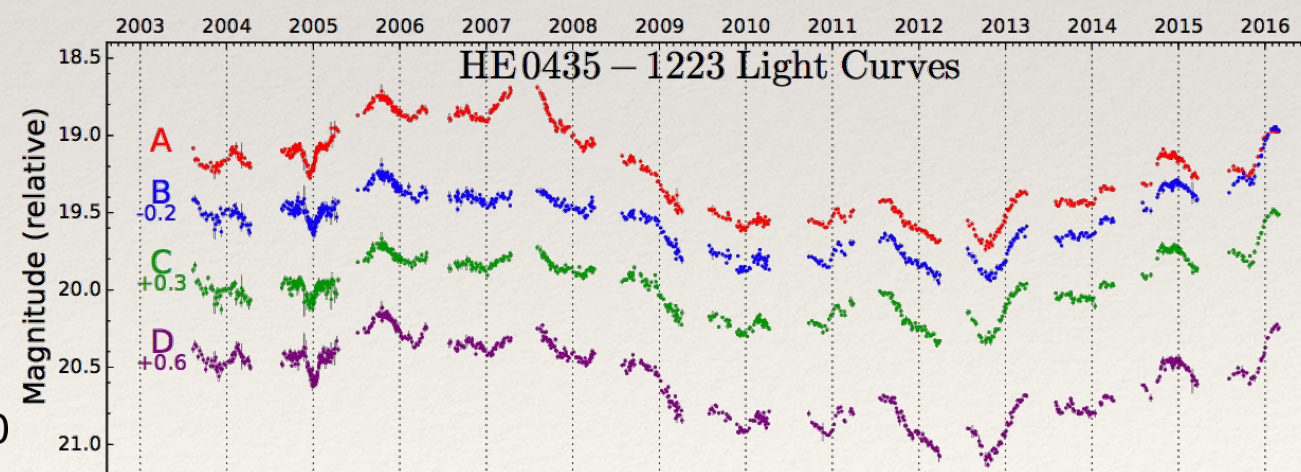


in SH0ES
Analysis ?

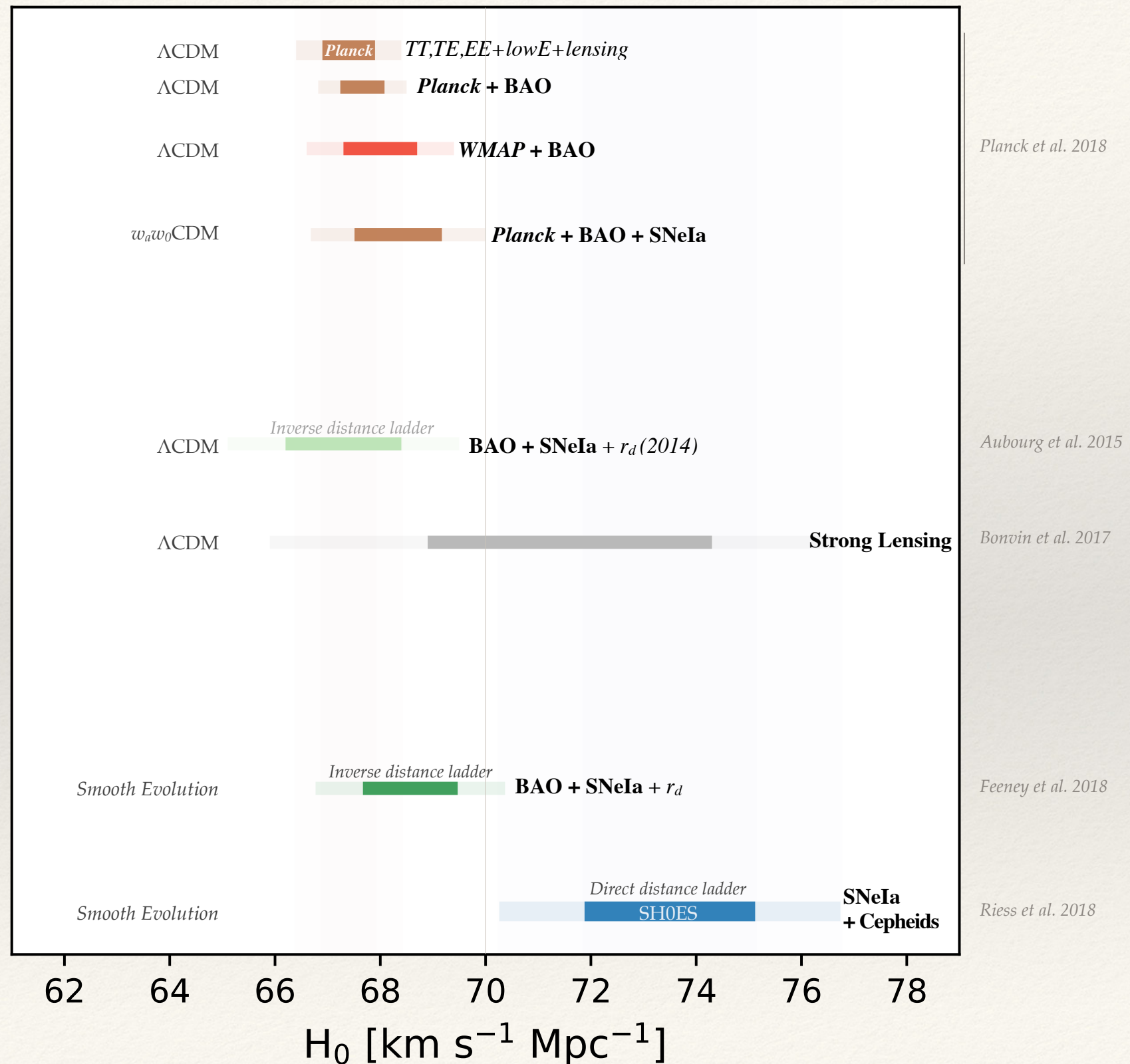


Strong Lensing
 $\Delta t \rightarrow H_0$
(assuming cosmo)

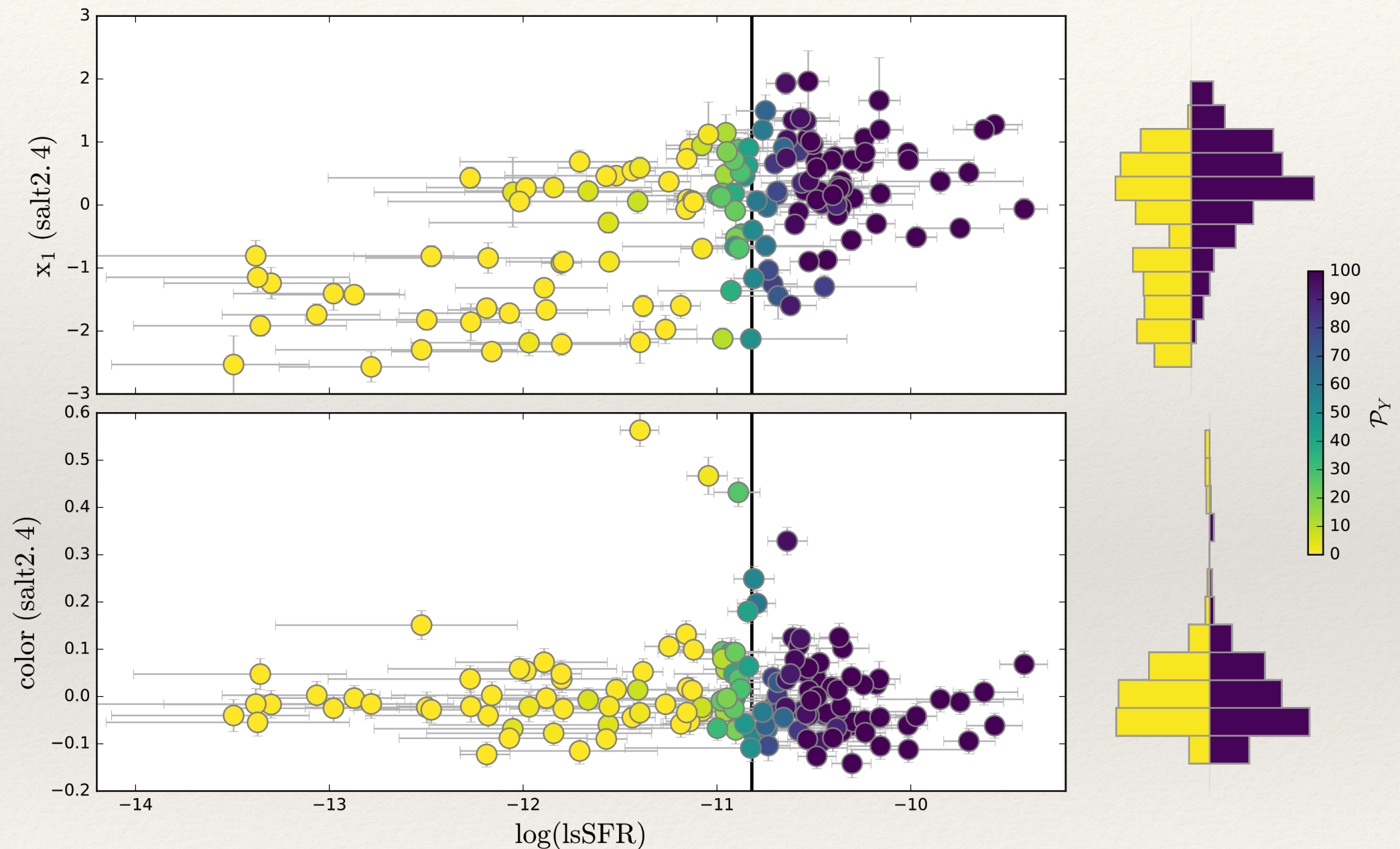
Bonvin et al. 2017



H₀ Controversy



LightCurve parameters and progenitor age

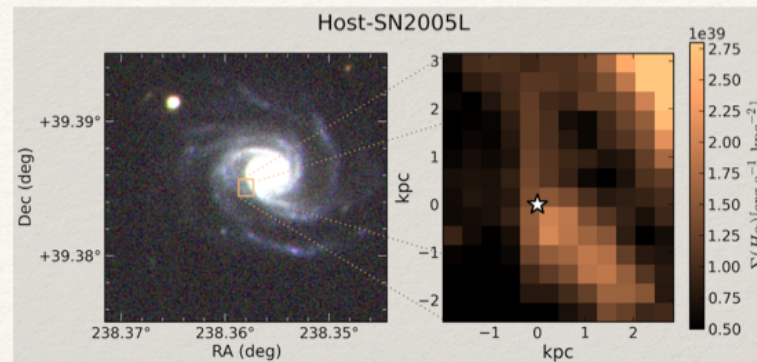


Fraction of young star at the SN location

Local specific Star Formation Rate (LsSFR)

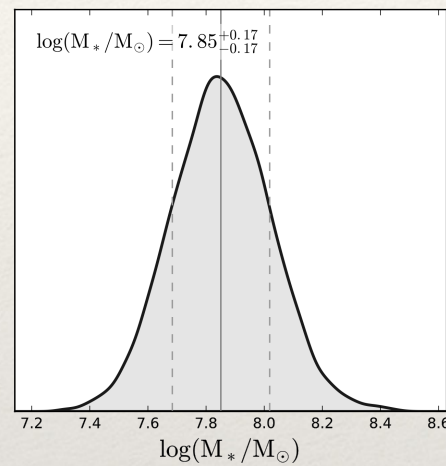
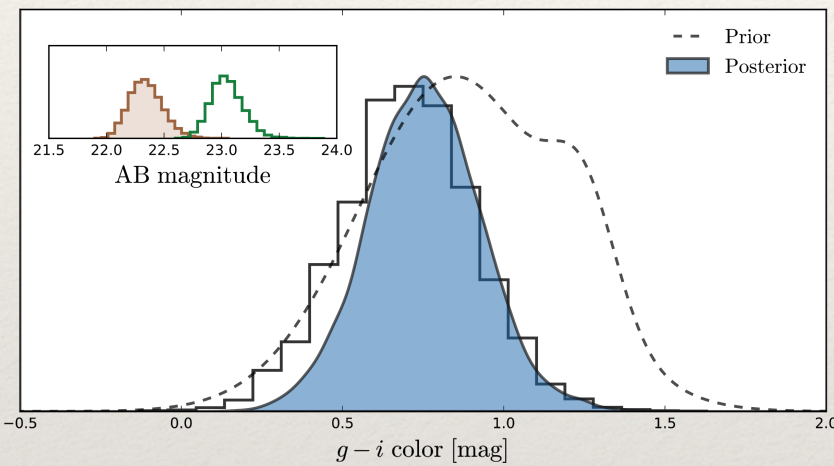
Rigault et al. 2018, (2013)

Local mass
from g and i photometry



Local SFR
from $H\alpha$ spectroscopy

Derivation of the Local Stellar Mass: SNF20060912 - 004



$$\text{LsSFR} = \text{LSFR} / \text{LMass}$$

