HUBBLE CONSTANT

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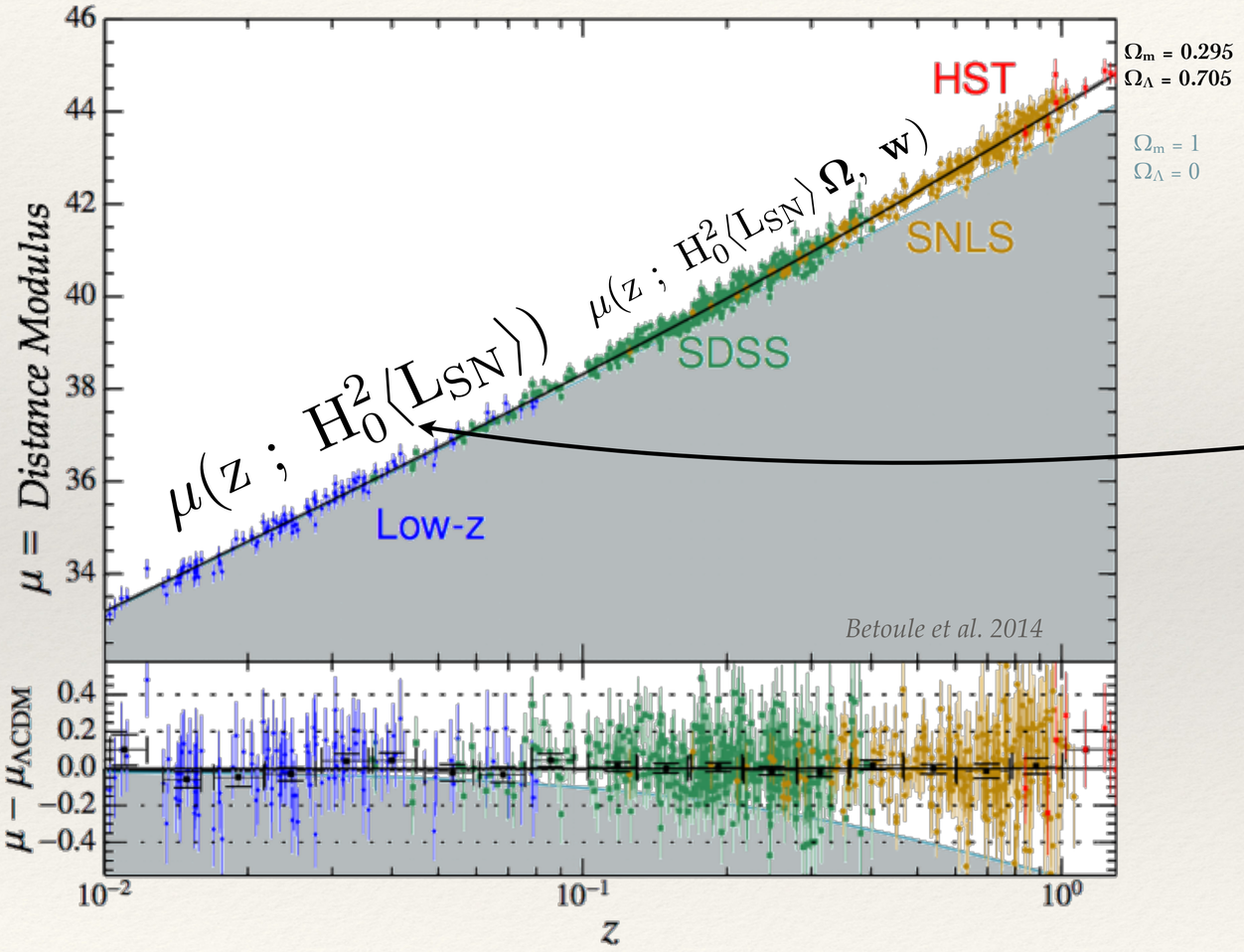
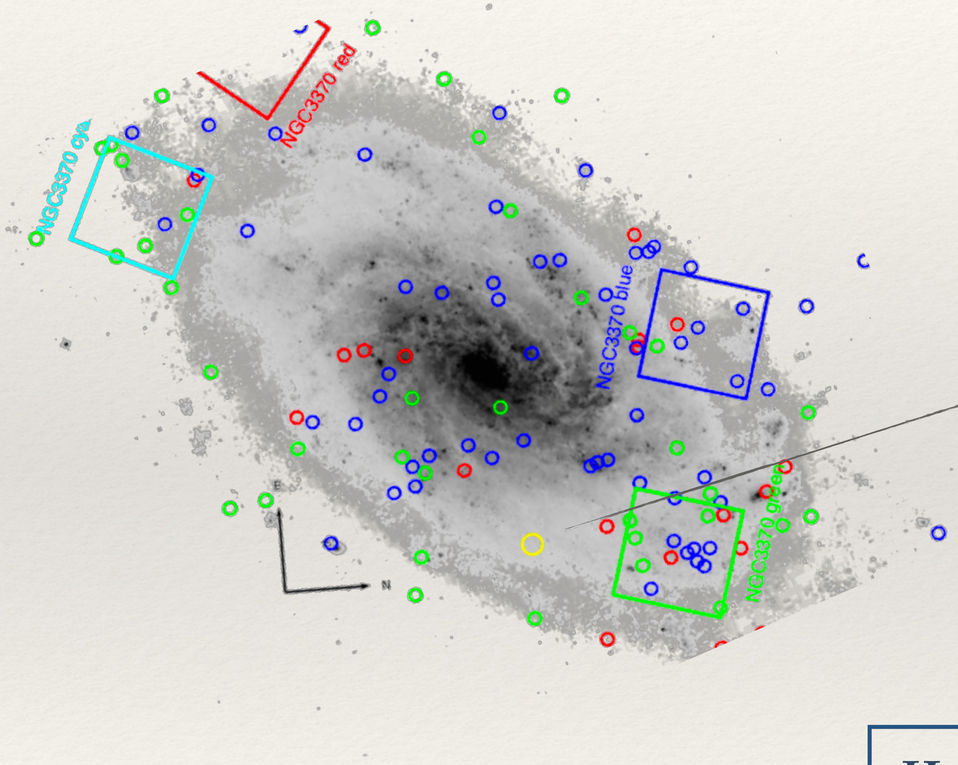
From Type Ia Supernovae to H_0

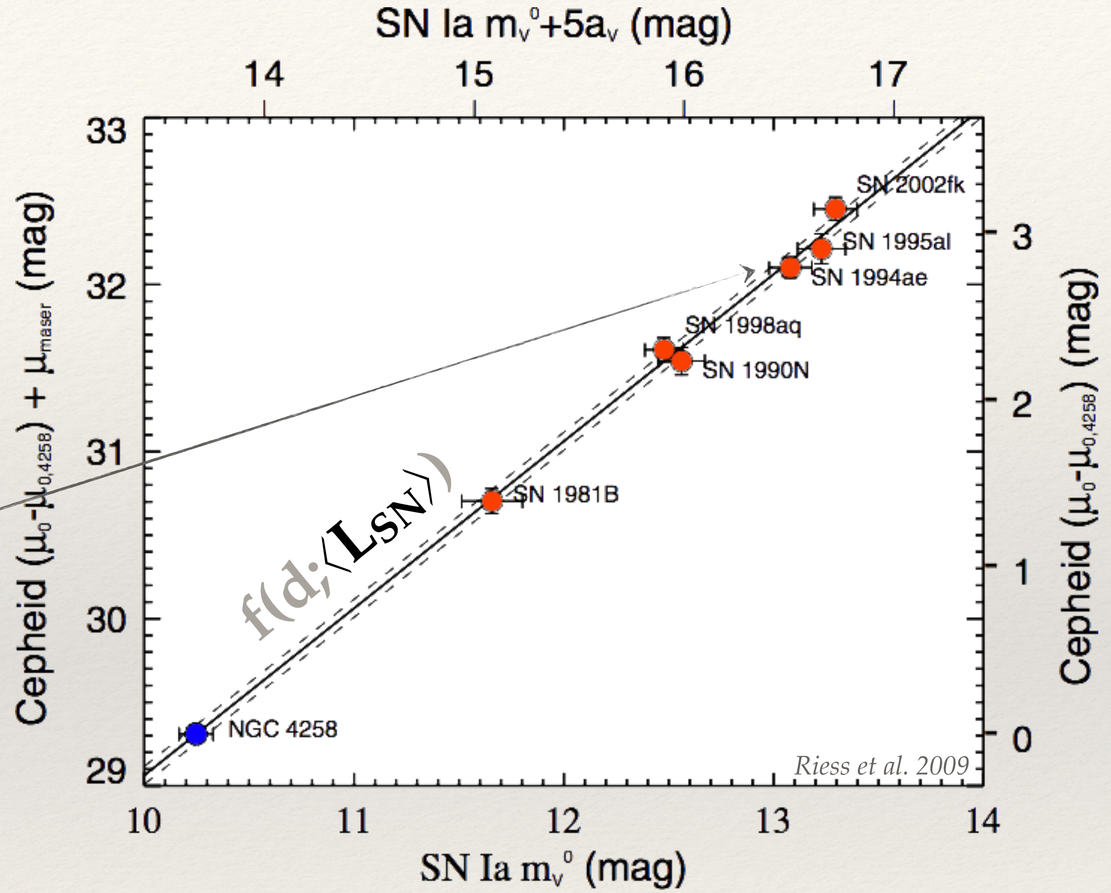


***To get H_0*: Independent distance measurements for some SNeIa**
→ *Cepheids (standard Candle)*

Disentangle H_0 from L_{SN}

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



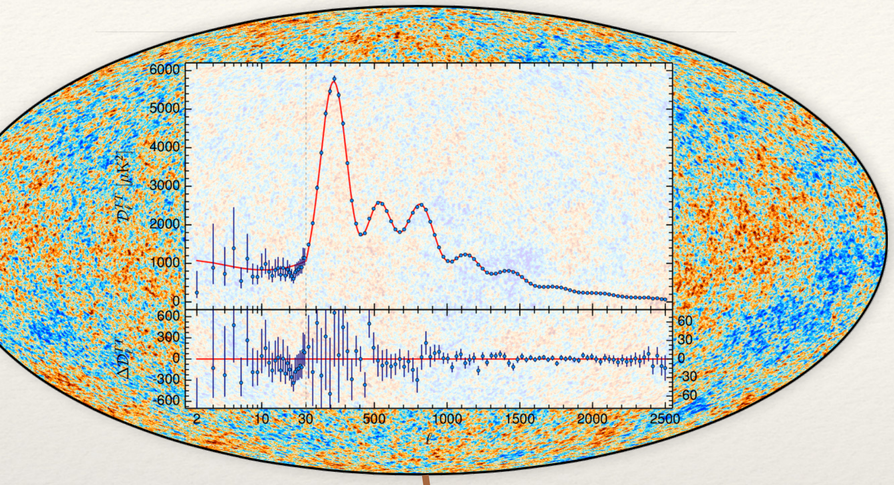


$H_0 = 74.0 \pm 1.4$ km s^{-1} Mpc^{-1}

(2% ; Riess et al 2019)

H_0 Prediction from ΛCDM | Planck

Planck 2018



z~1000

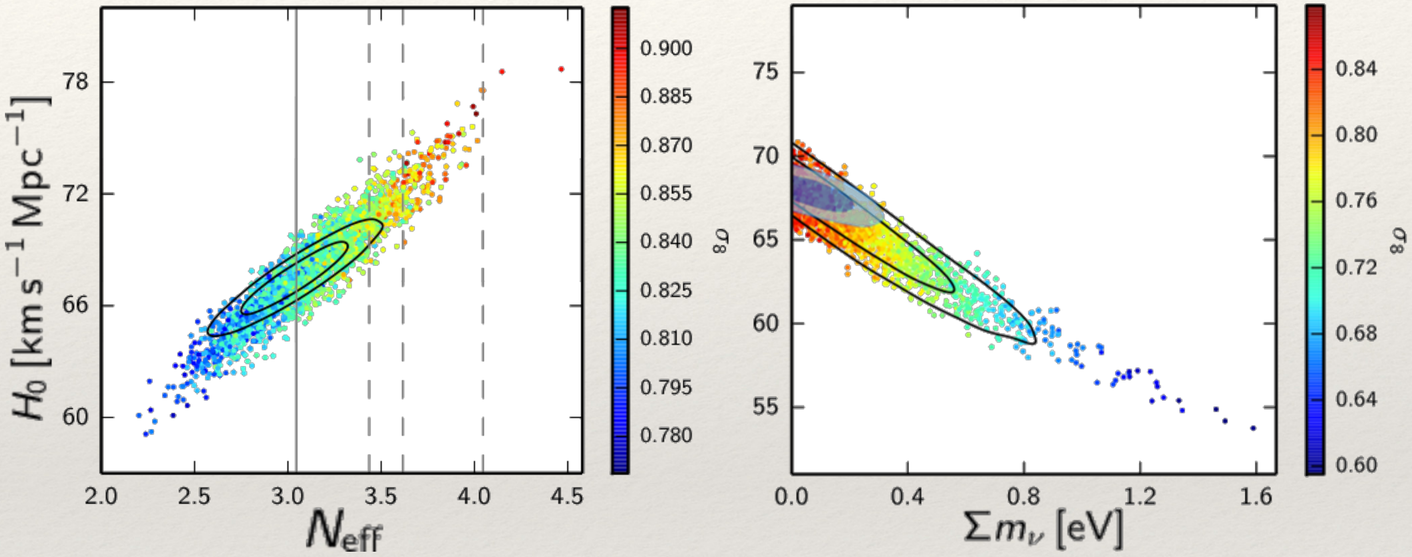
THE MODEL CONTRAINS H_0

z~0

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

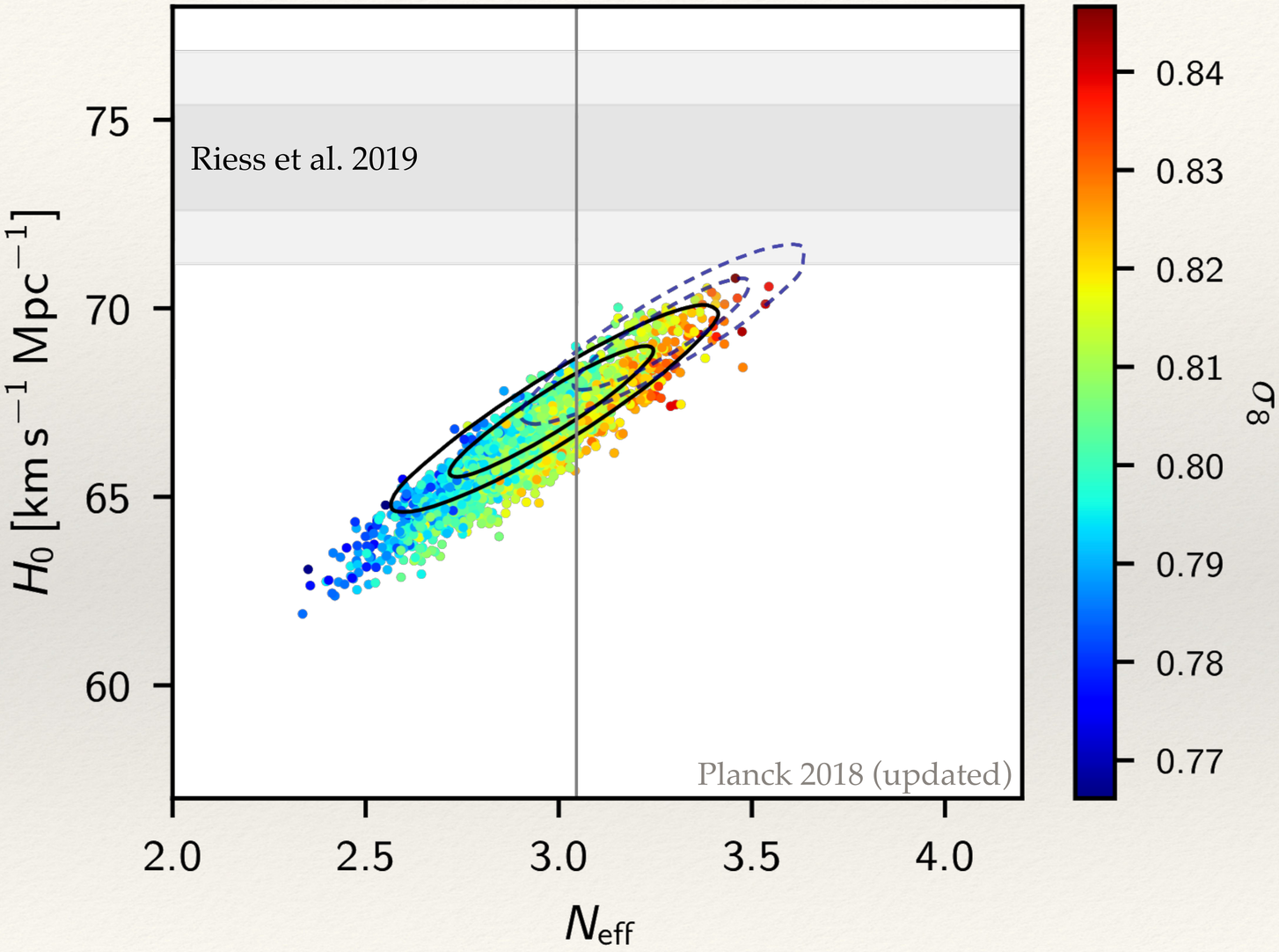
— based on ΛCDM —

Change the model, change H_0

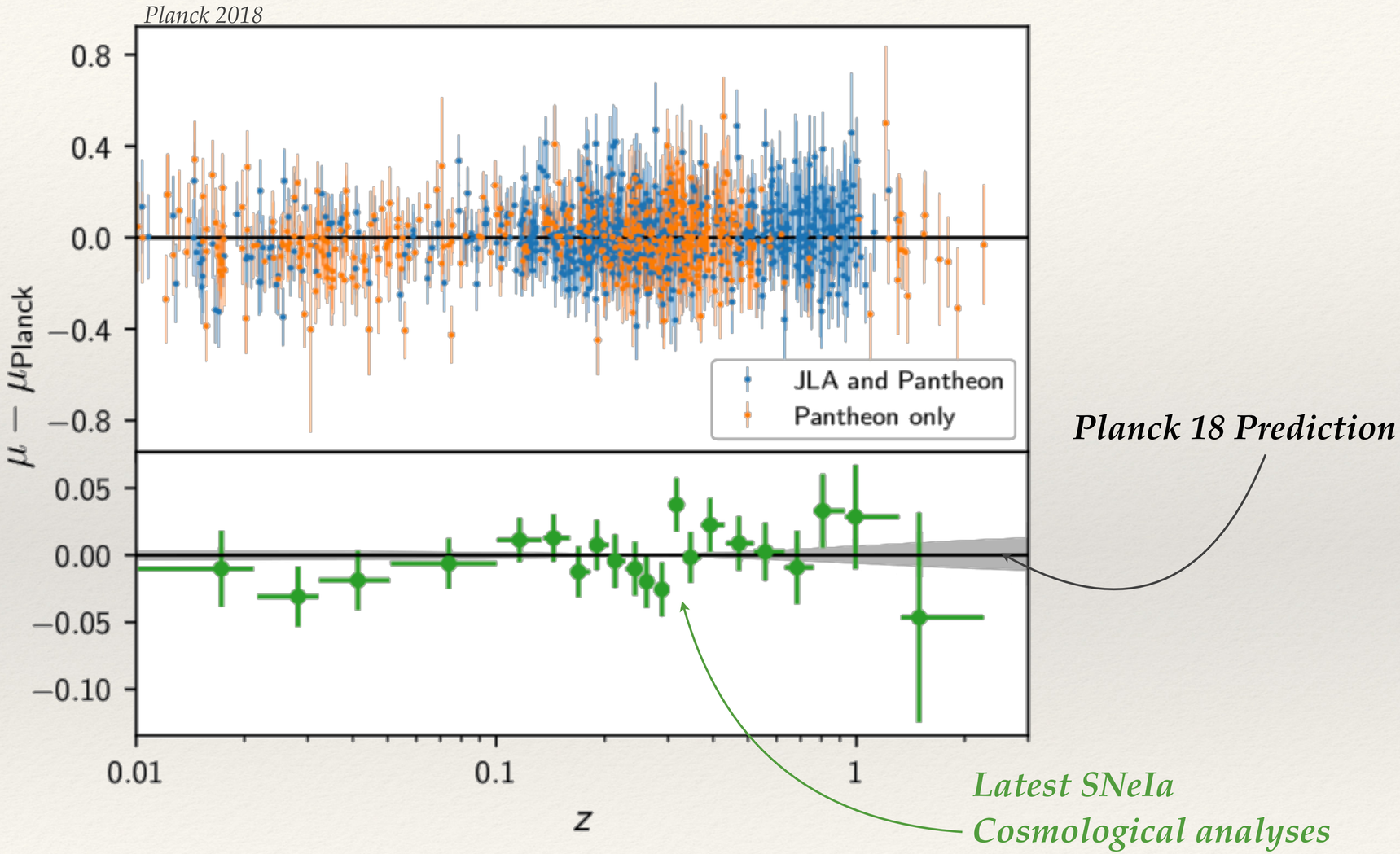


Illustrative plots from Planck 2015

Greatest tension in Cosmology (4.4σ)

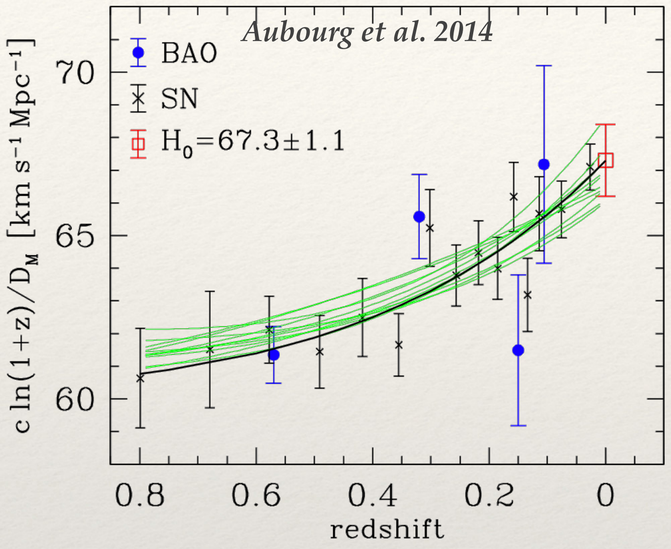


CMB & SNeIa in disagreement ? *No!*

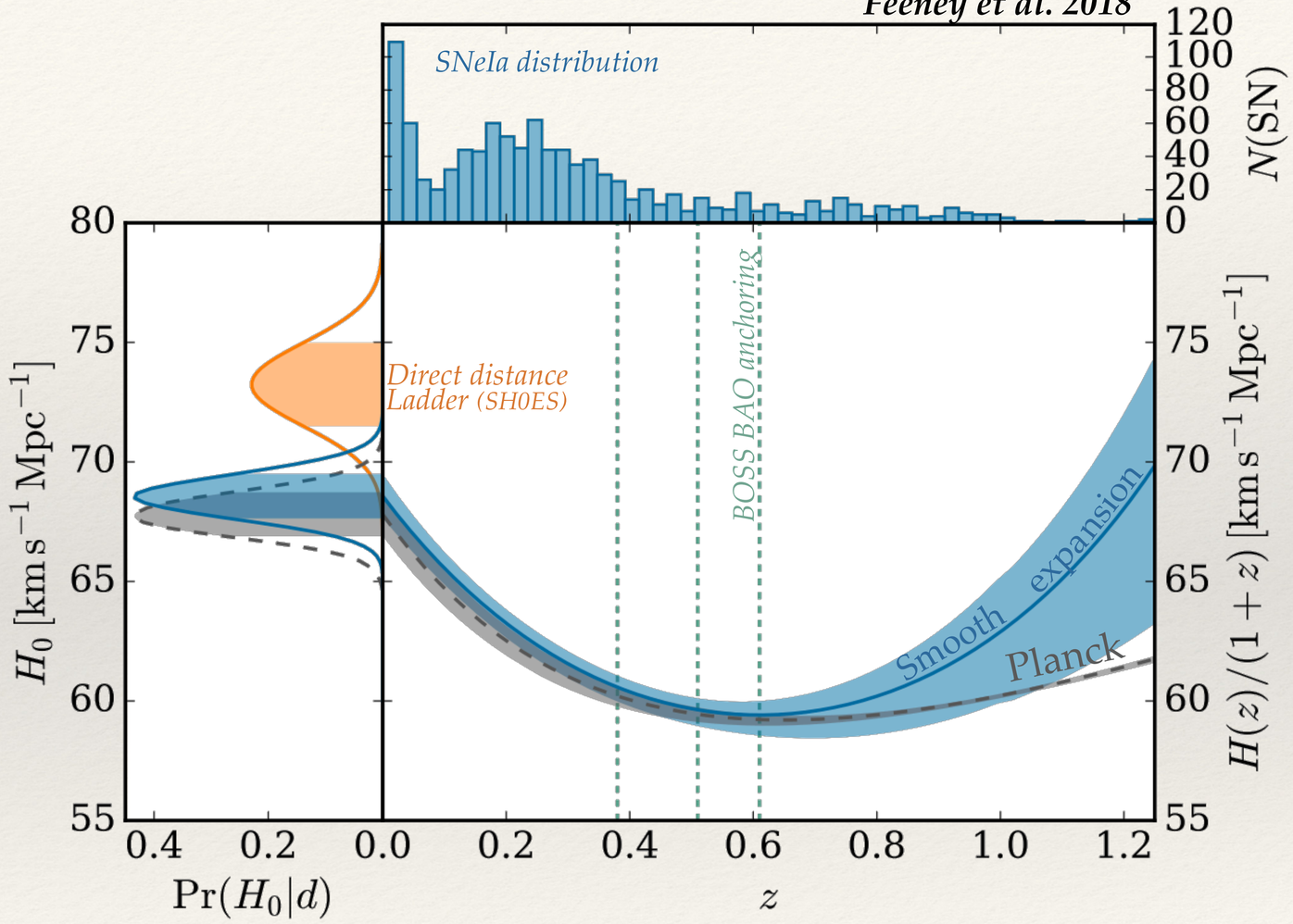


Inversed Distance Ladder

Only using "r_d" from CMB

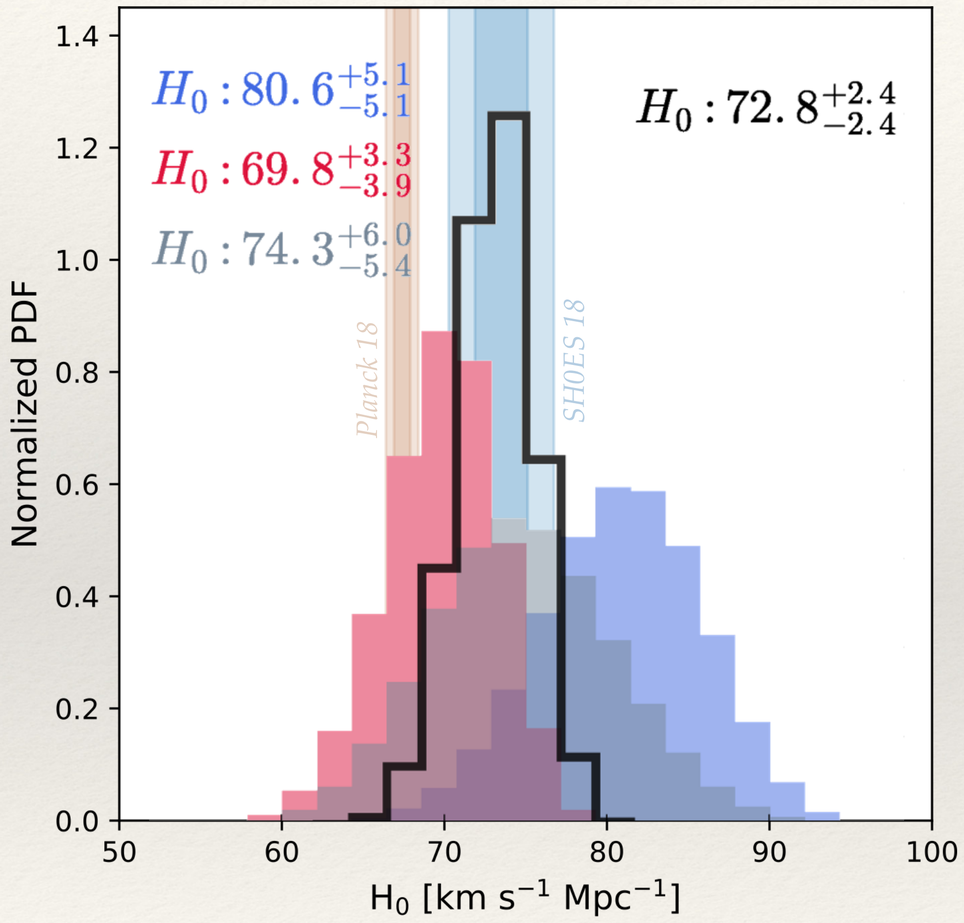


Feeney et al. 2018

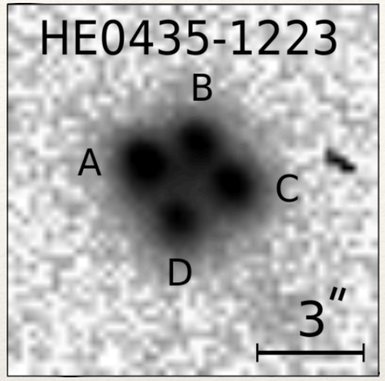


Tension in the concordance model?

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



New measurement @ 71.6 ± 4 km s^{-1} Mpc^{-1}

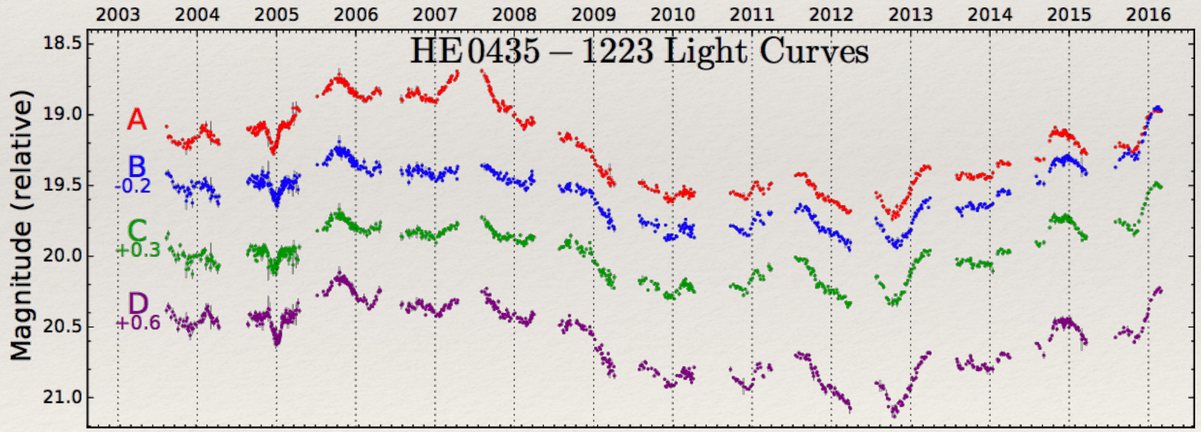


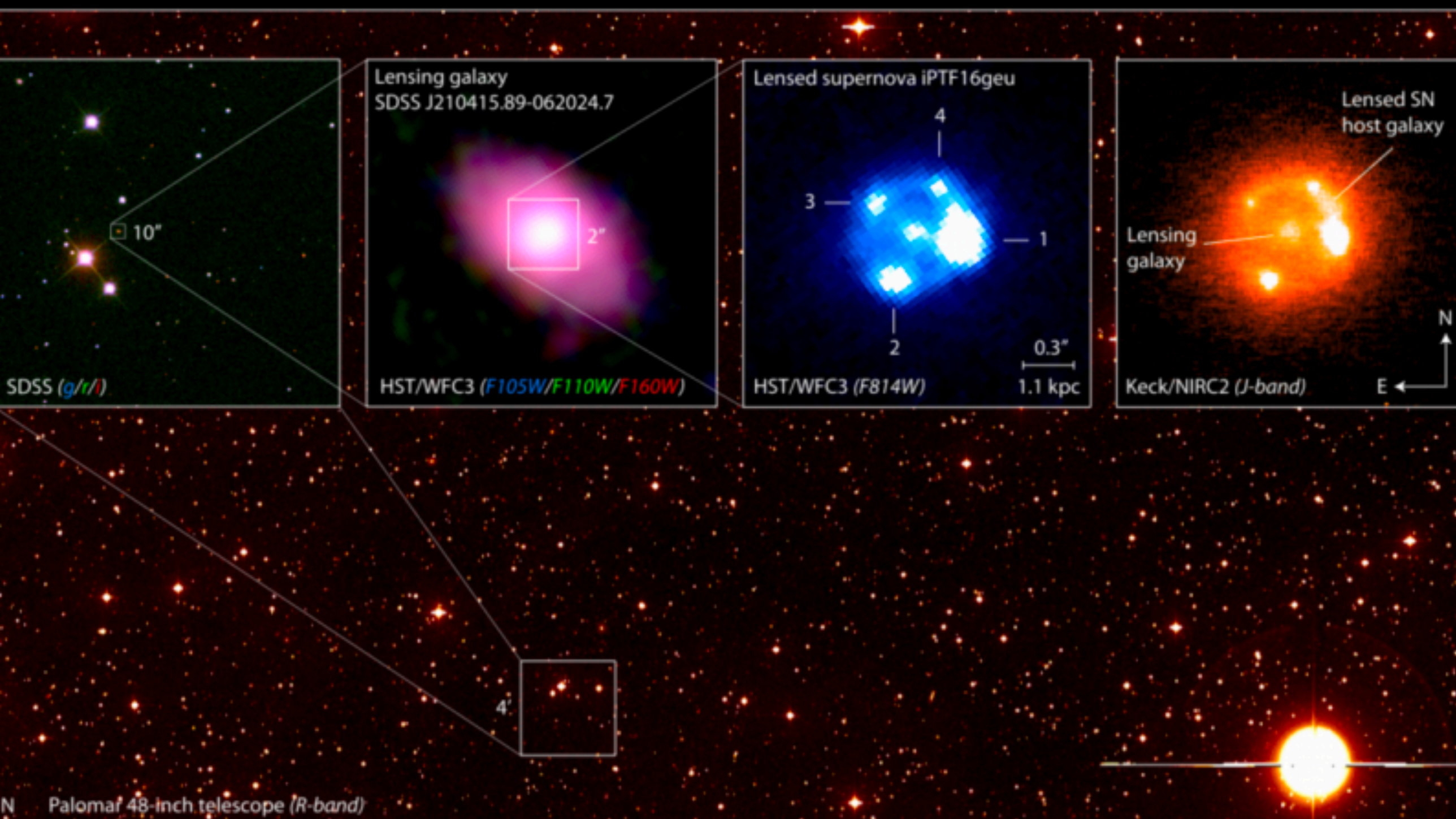
Strong Lensing

$\Delta t \rightarrow H_0$

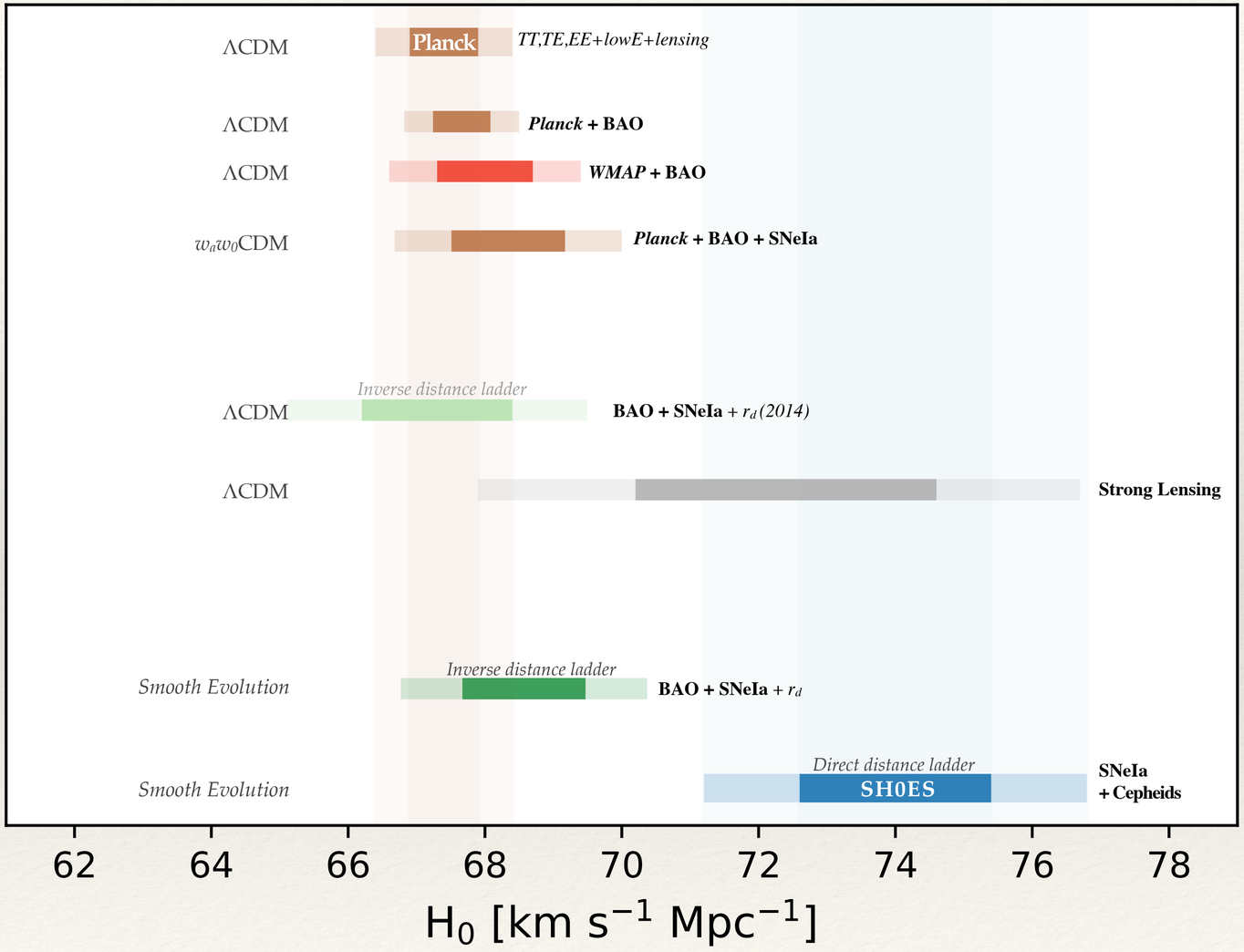
(assuming cosmo)

Bonvin et al. 2017




10″
SDSS (g/r/i)
Lensing galaxy
SDSS J210415.89-062024.7
2″
HST/WFC3 (F105W/F110W/F160W)
Lensed supernova iPTF16geu
4
3
1
2
0.3″
1.1 kpc
HST/WFC3 (F814W)
Lensed SN
host galaxy
Lensing
galaxy
N
E
Keck/NIRC2 (J-band)
4′
N
Palomar 48-inch telescope (R-band)

The H_0 Tension (4.4σ)

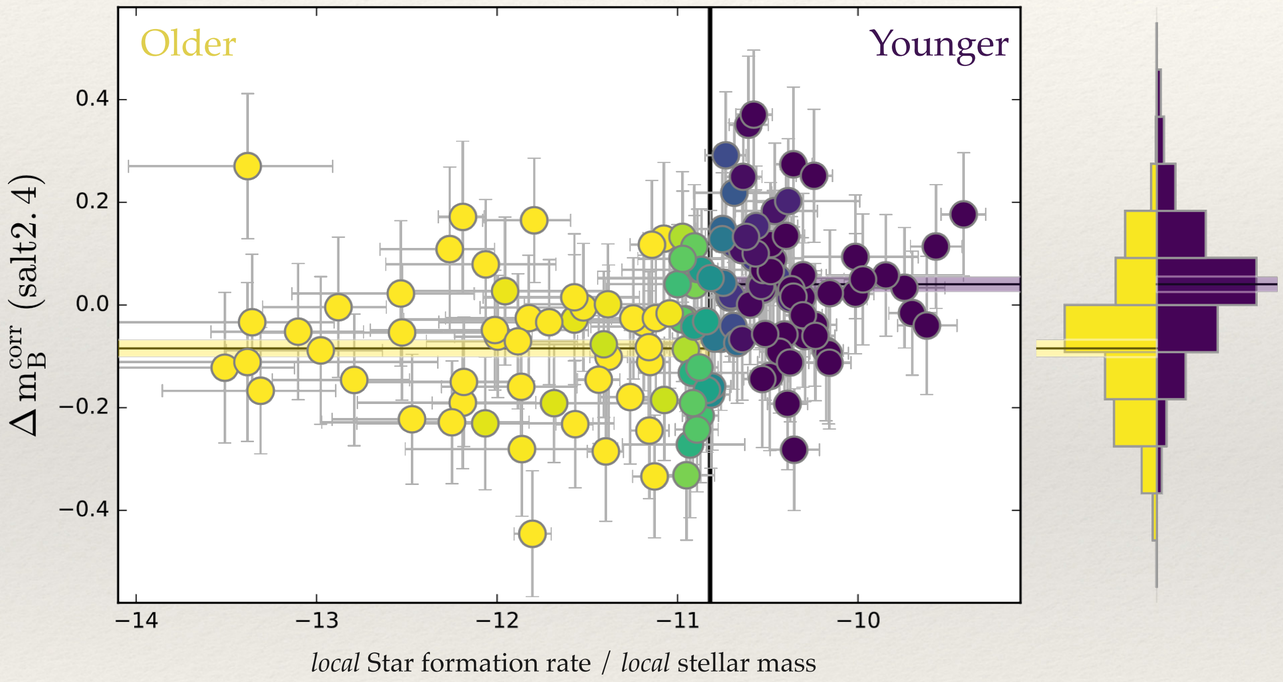


SNeIa Astrophysical dependencies

Low-Z | SNf

Rigault et al. 2018

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

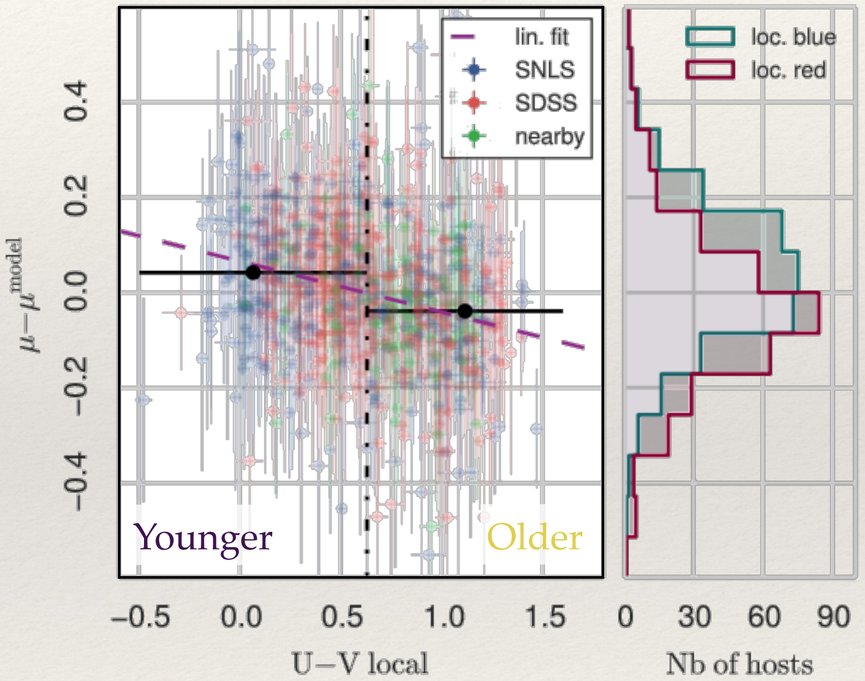


Fraction of young star at the SN location

All Z | SDSS & SNLS & Nearby

Roman et al. 2018

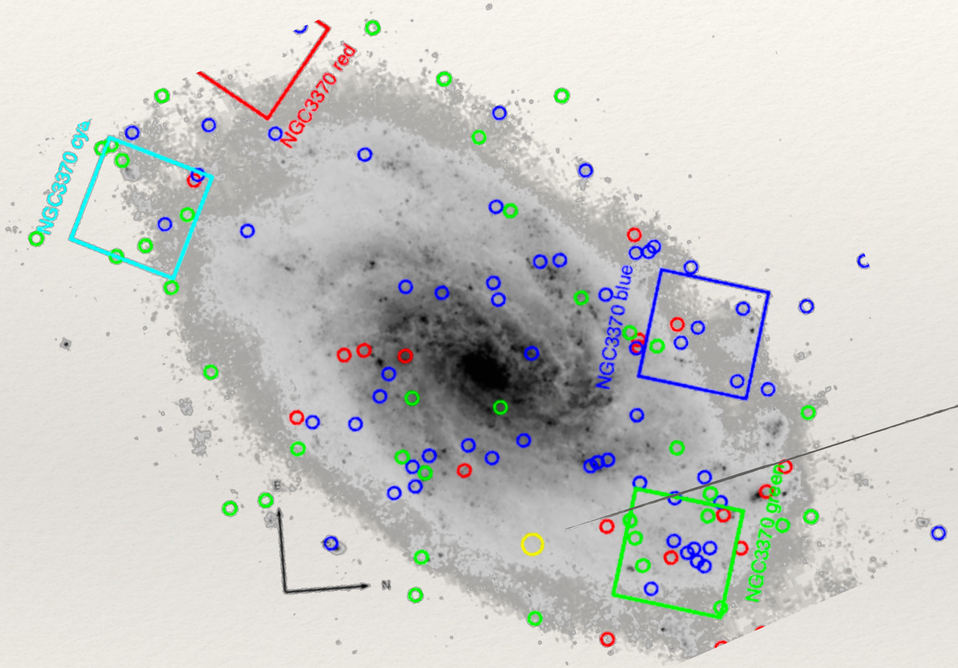
non-zero at ~7σ level | $\Delta_Y = 0.09 \pm 0.02$

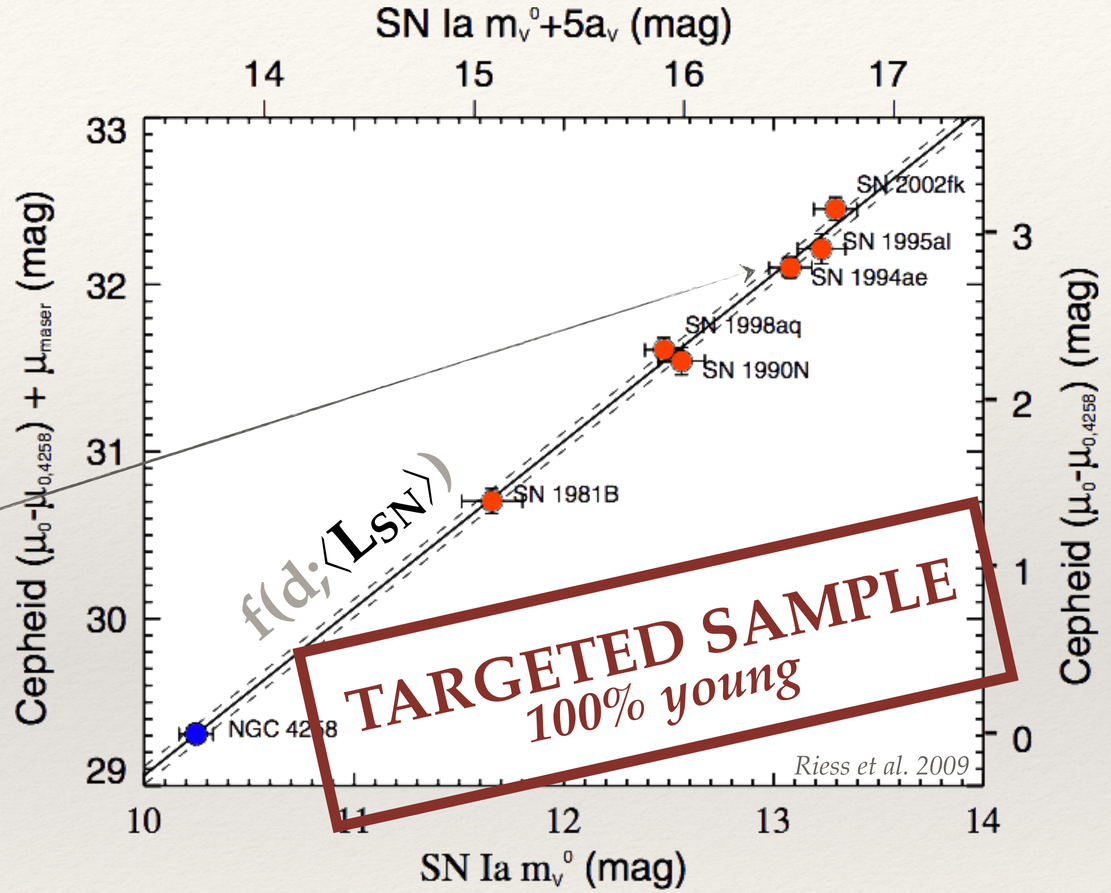


Fraction of young star at the SN location

Disentangle H_0 from L_{SN}

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





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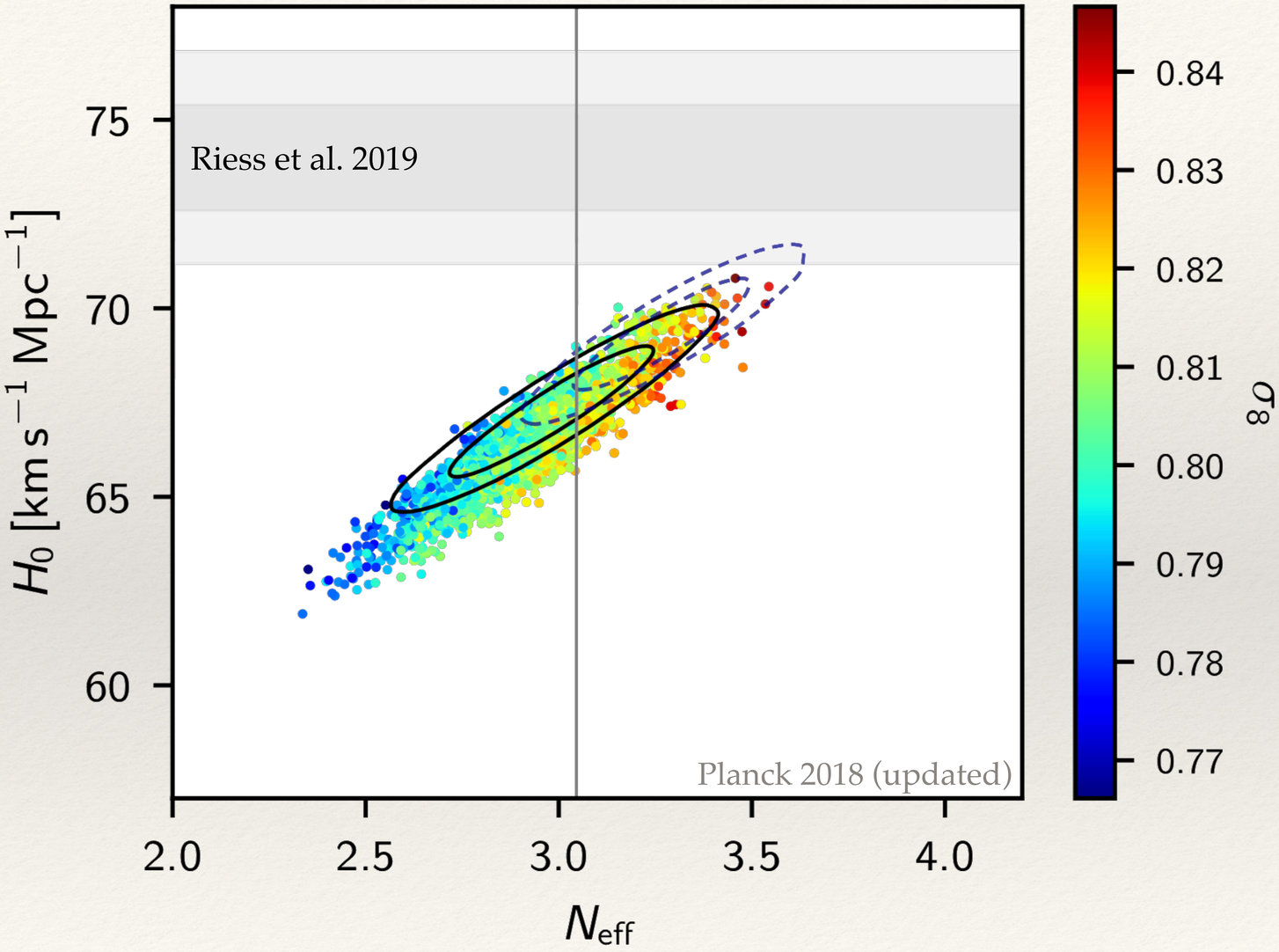
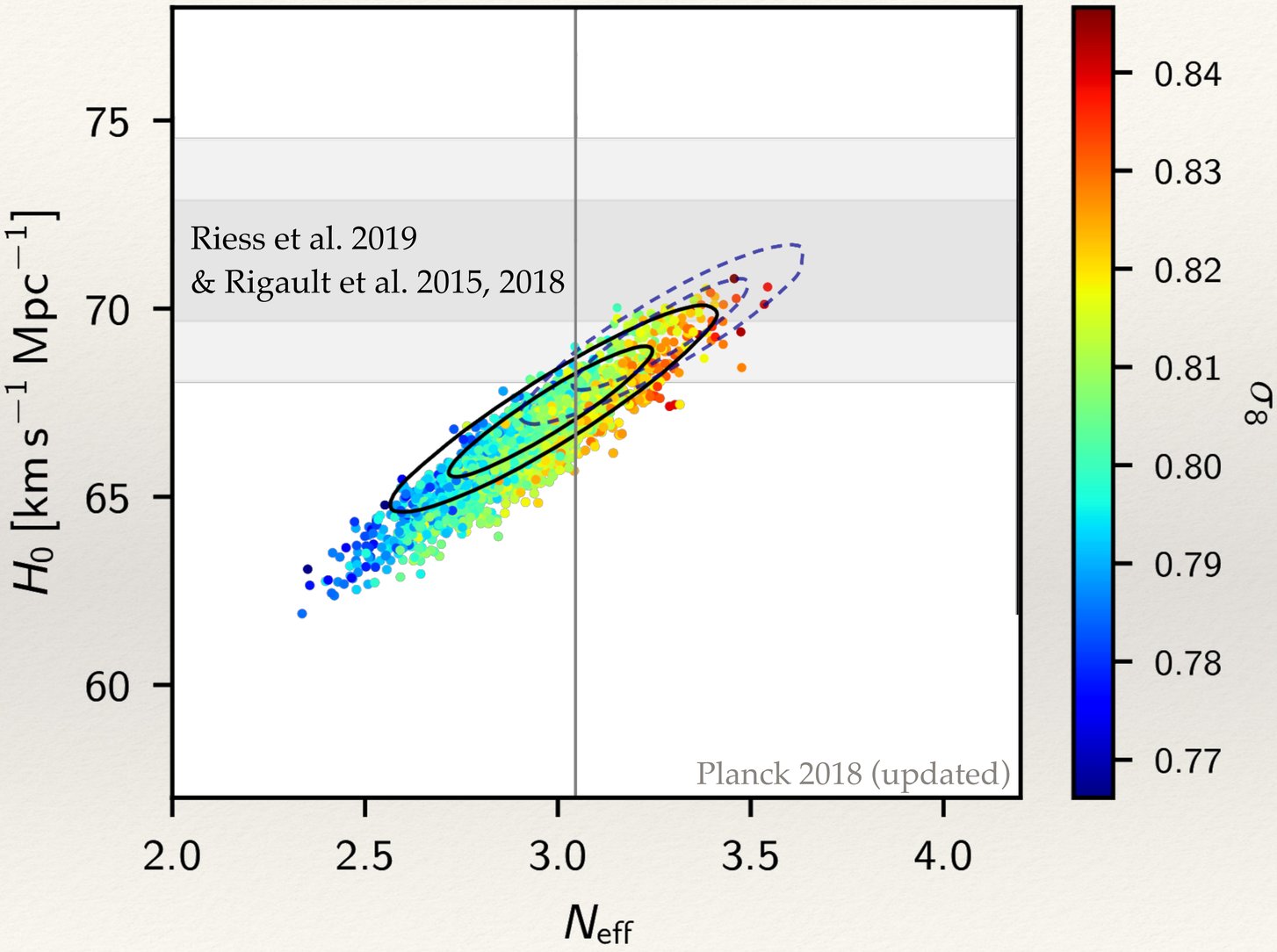


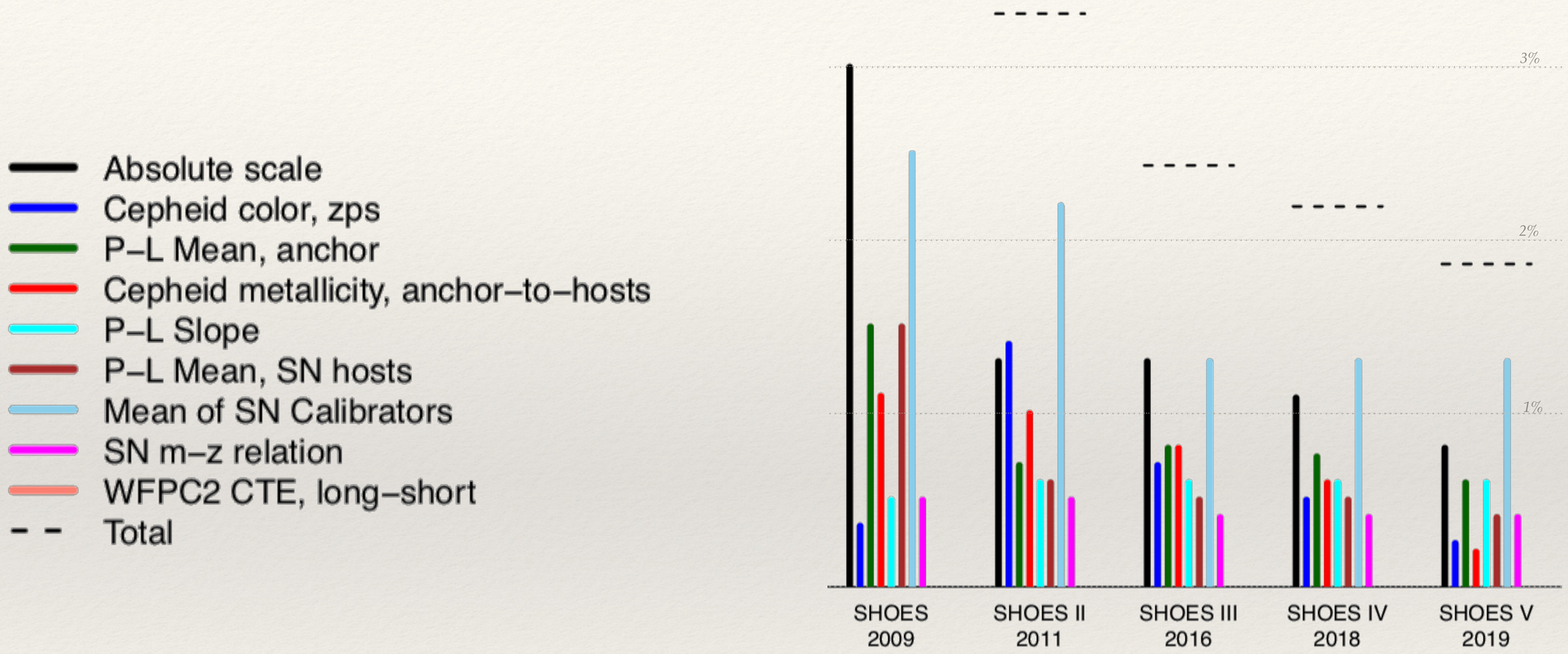
tension *(?)* in Cosmology (~~4.4σ~~)



(2σ)

Error Budget

Riess et al. 2019



More SNeIa in the Hubble flow is (almost) **useless** | ***More nearby is key !***

Issue Analysis

Source	Effect	Importance	Solution
LightCurve Extraction	Reduce the relative weight of SNeIa	Very Weak	Model your PSF
Calibration	Matching issues between Cepheid and Hubble Flow	Mild	Use the same instrument ?
Host		Extreme	Discard Hubble Flow SNeIa and understand host variations
Sélection Function		Very	Model the selection function
SN Typing	Change zero points & increase scatter	Very	Don't use Photo-Typing
Photo-Z	Reduce the relative weight of each SNeIa	Very	Don't use Photo-Redshift
SN Model	Change relative weight of each SNe	Weak	Make sure you are consistant