

# Cosmological Parameters via HII galaxies

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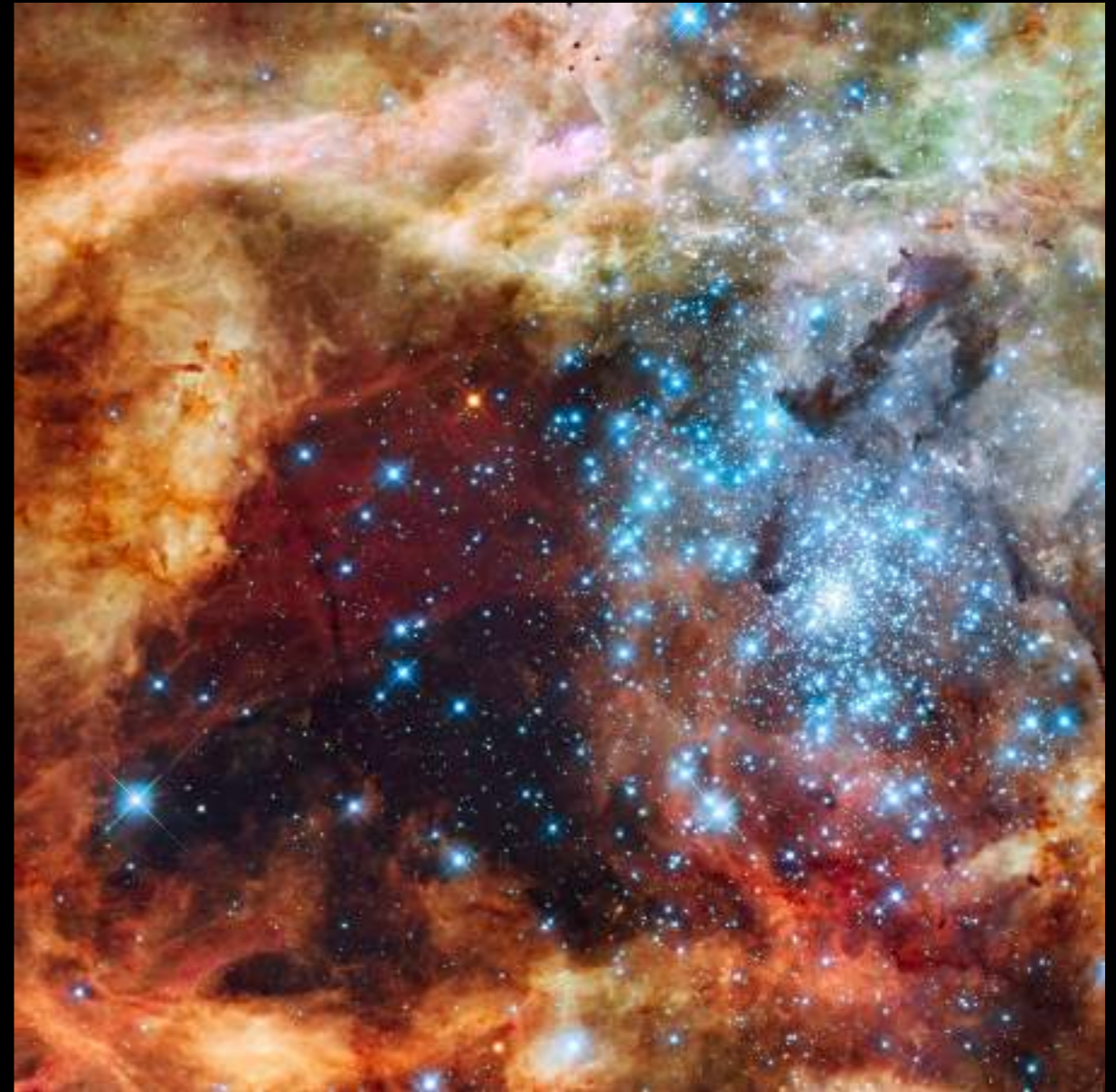
CosmoVerse, Lisbon, May 2023



# Giant Extragalactic HII Regions

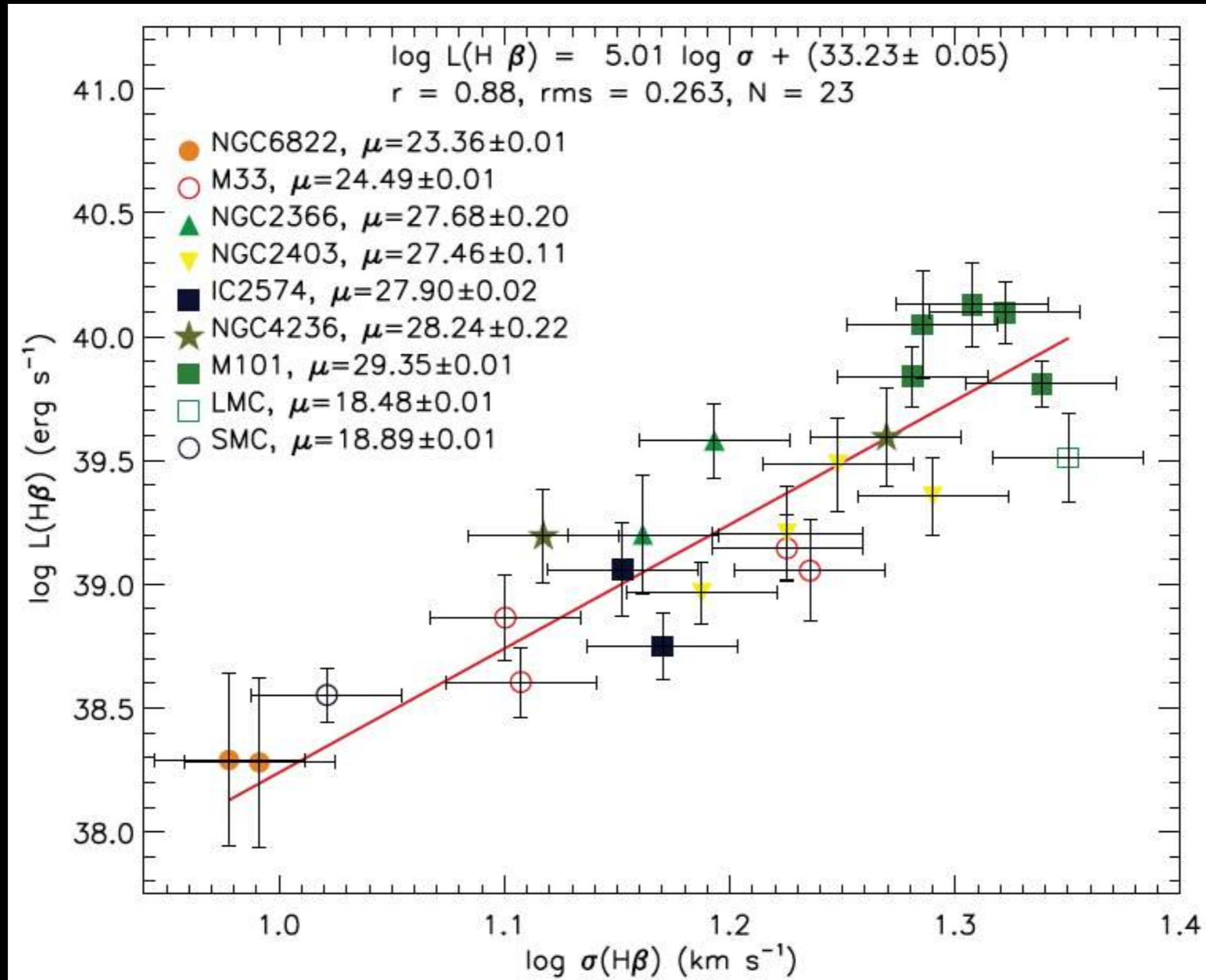


NGC 5455 @ M101



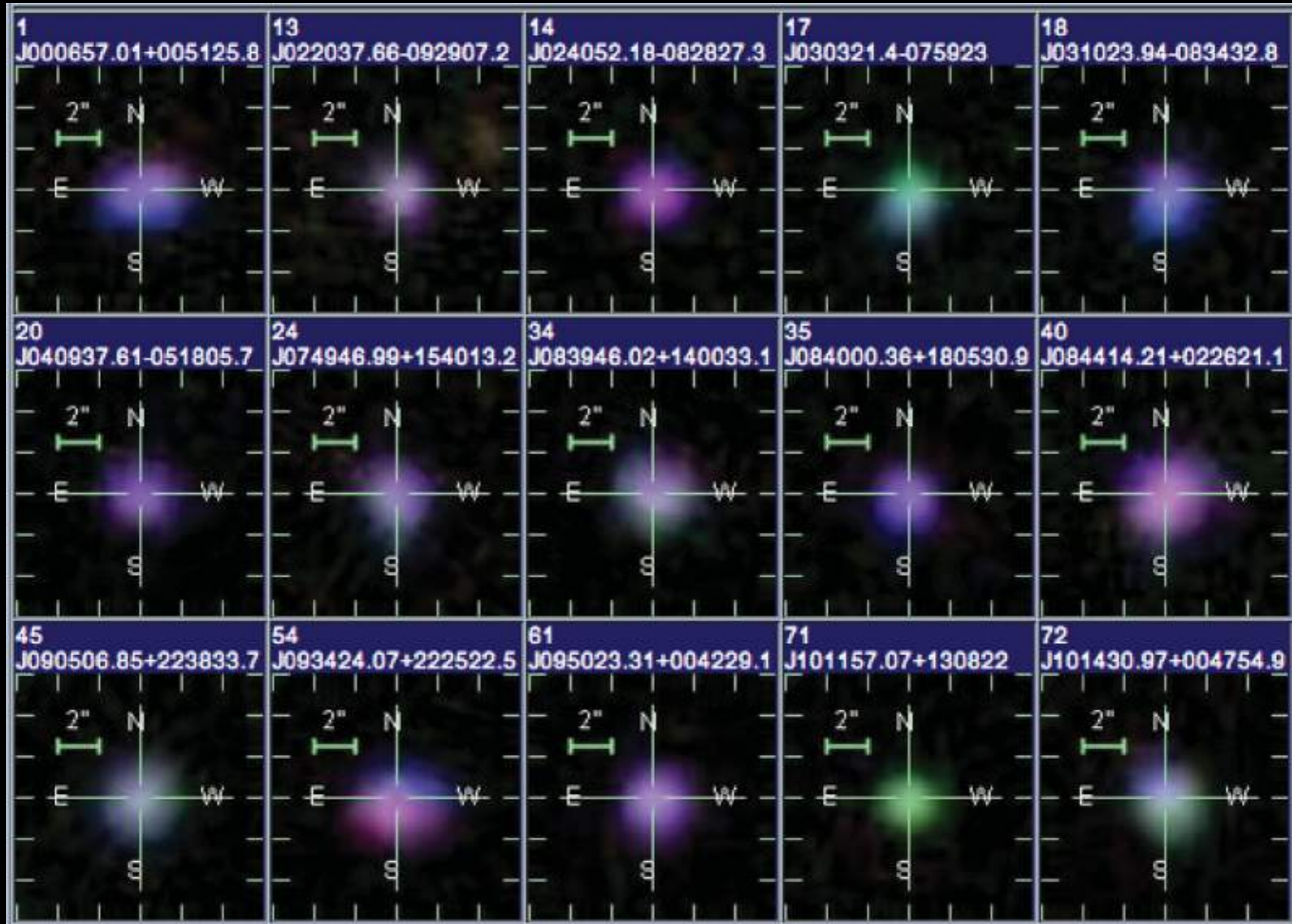
30 Dor @ LMC

# The L- $\sigma$ Relation of GEHR



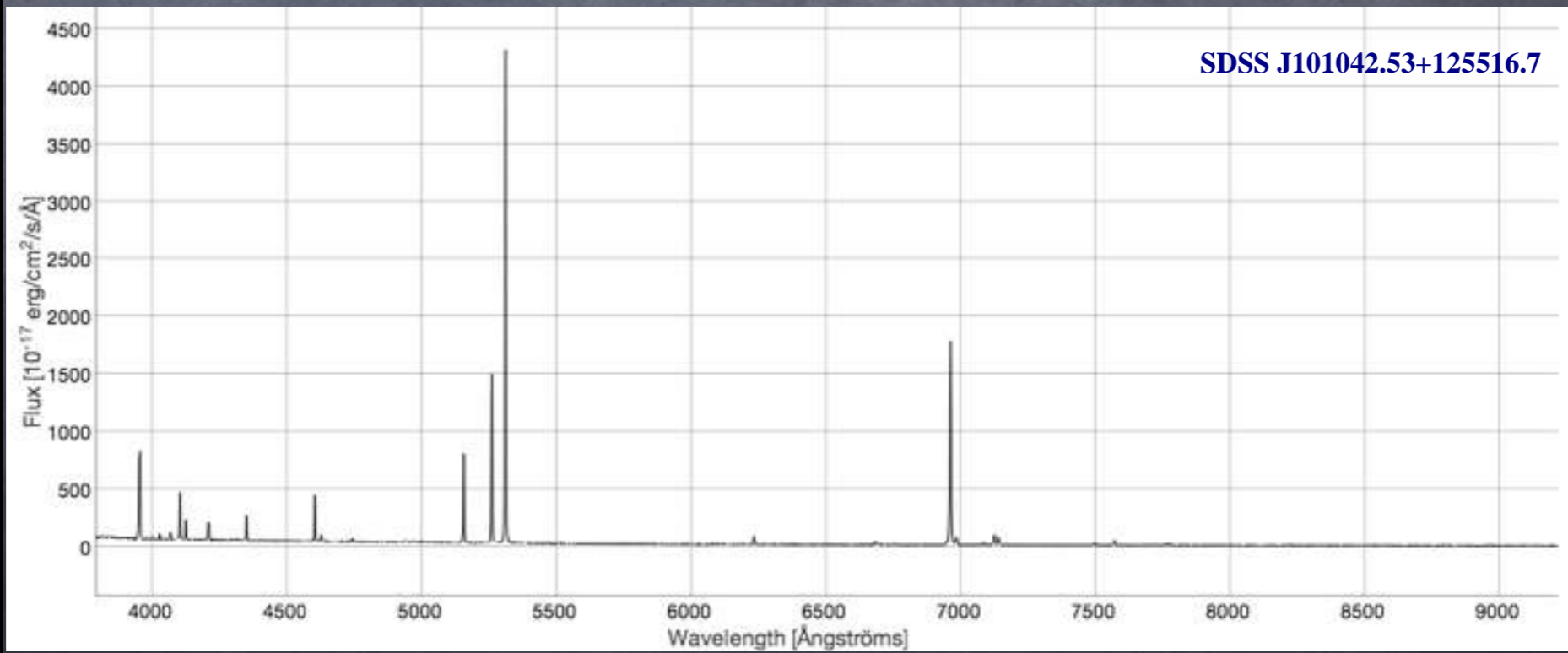
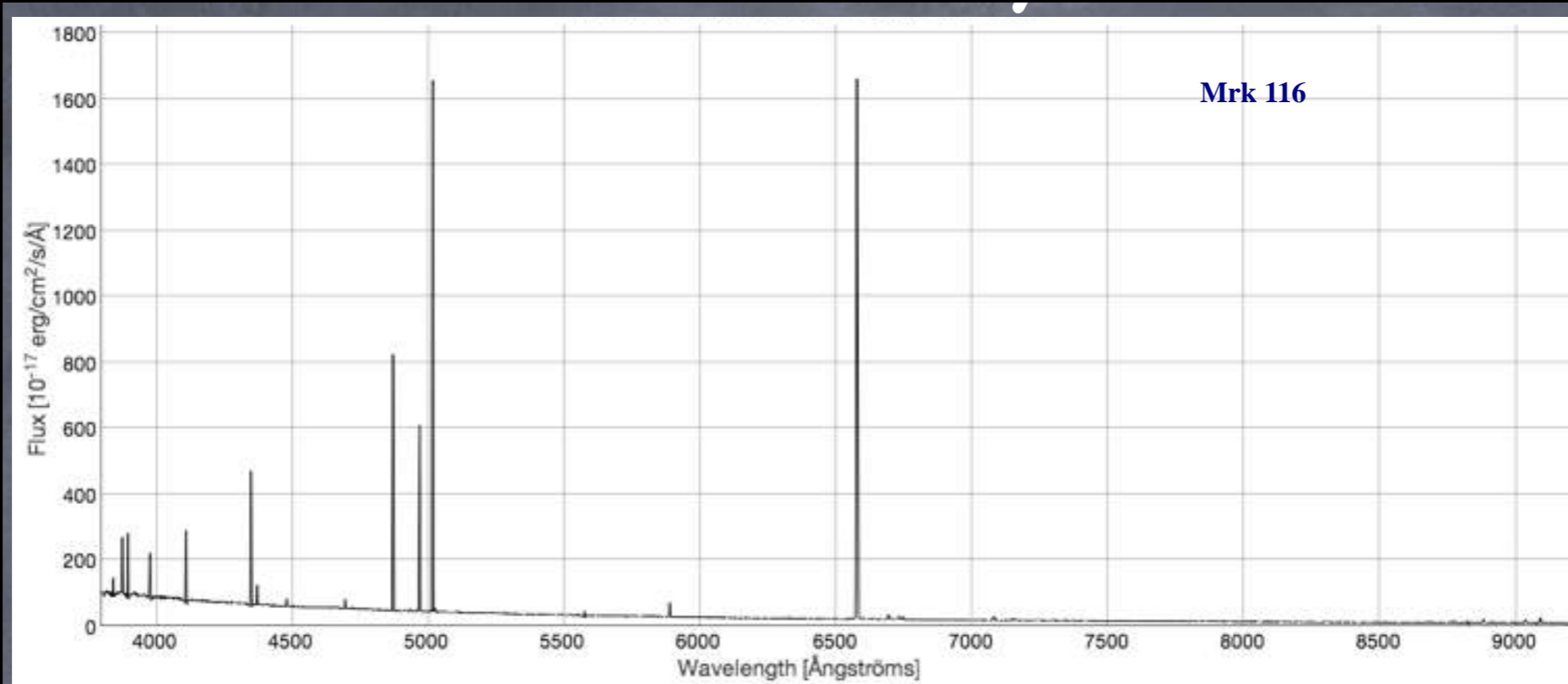
From Chávez et al. 2012

# HII Galaxies

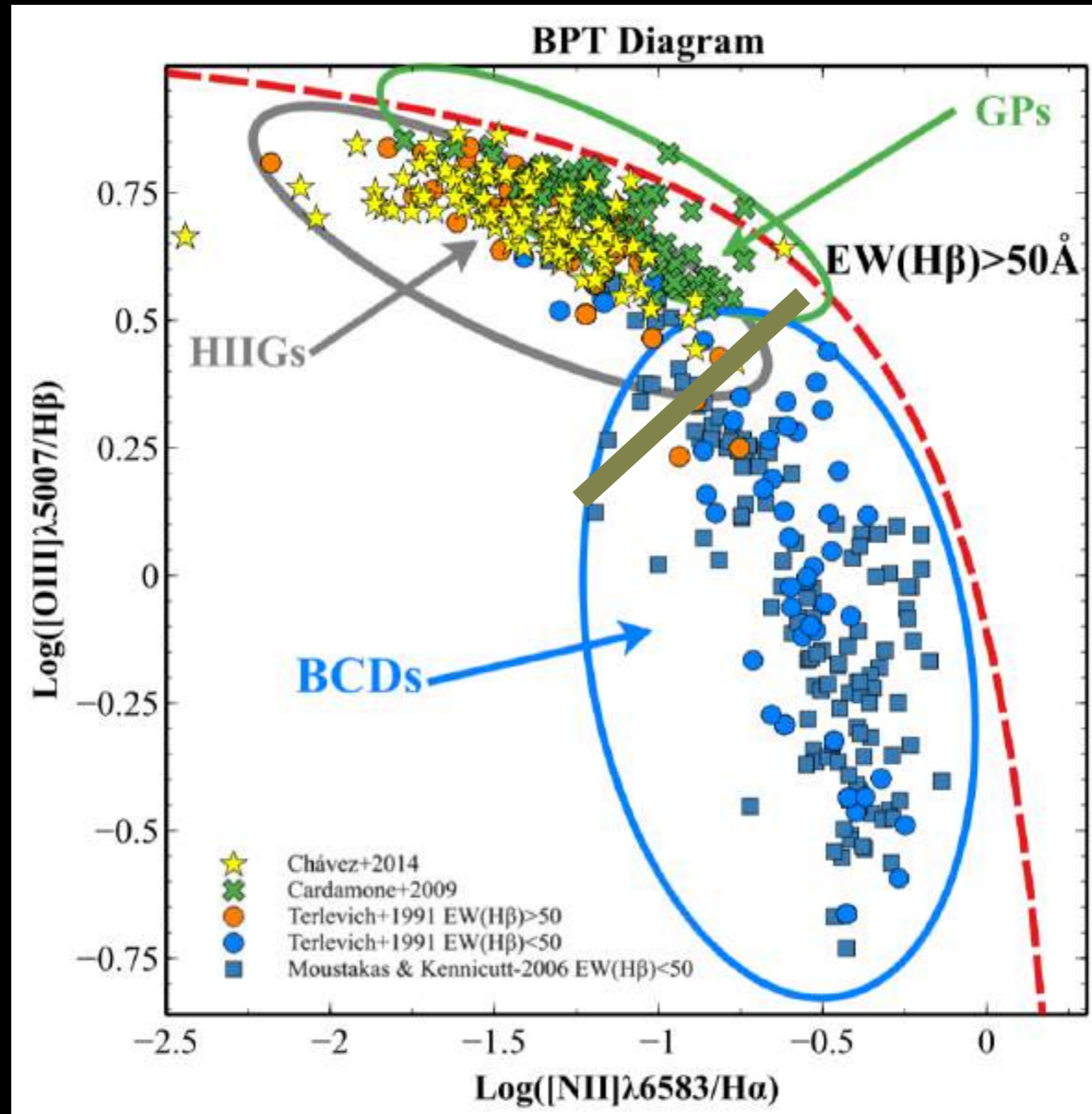


From Chávez et al. 2014

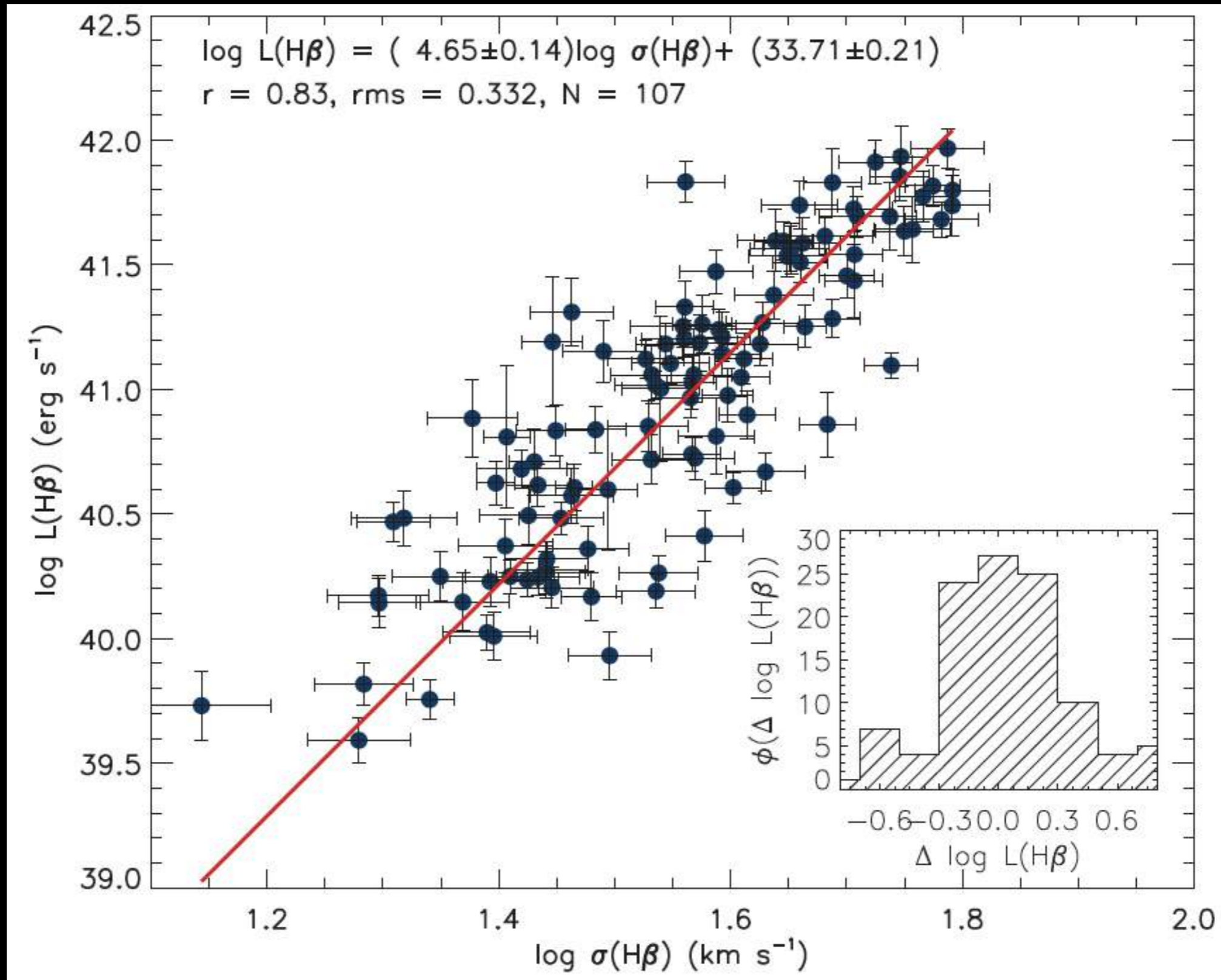
# HII Galaxies: Optical Spectra



# HII Galaxies Properties: BPT Diagram

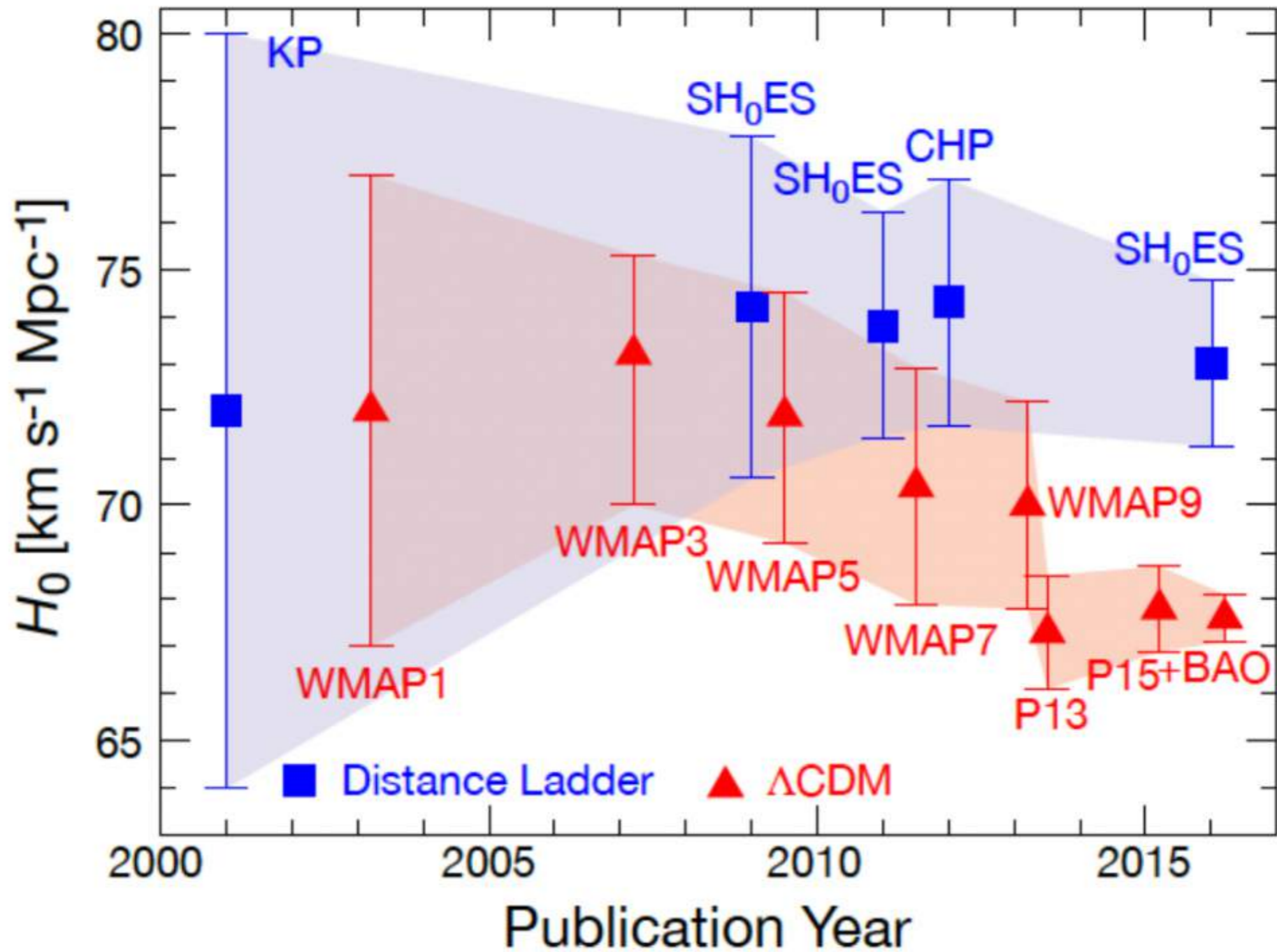


# The L- $\sigma$ Relation: Local HIIG



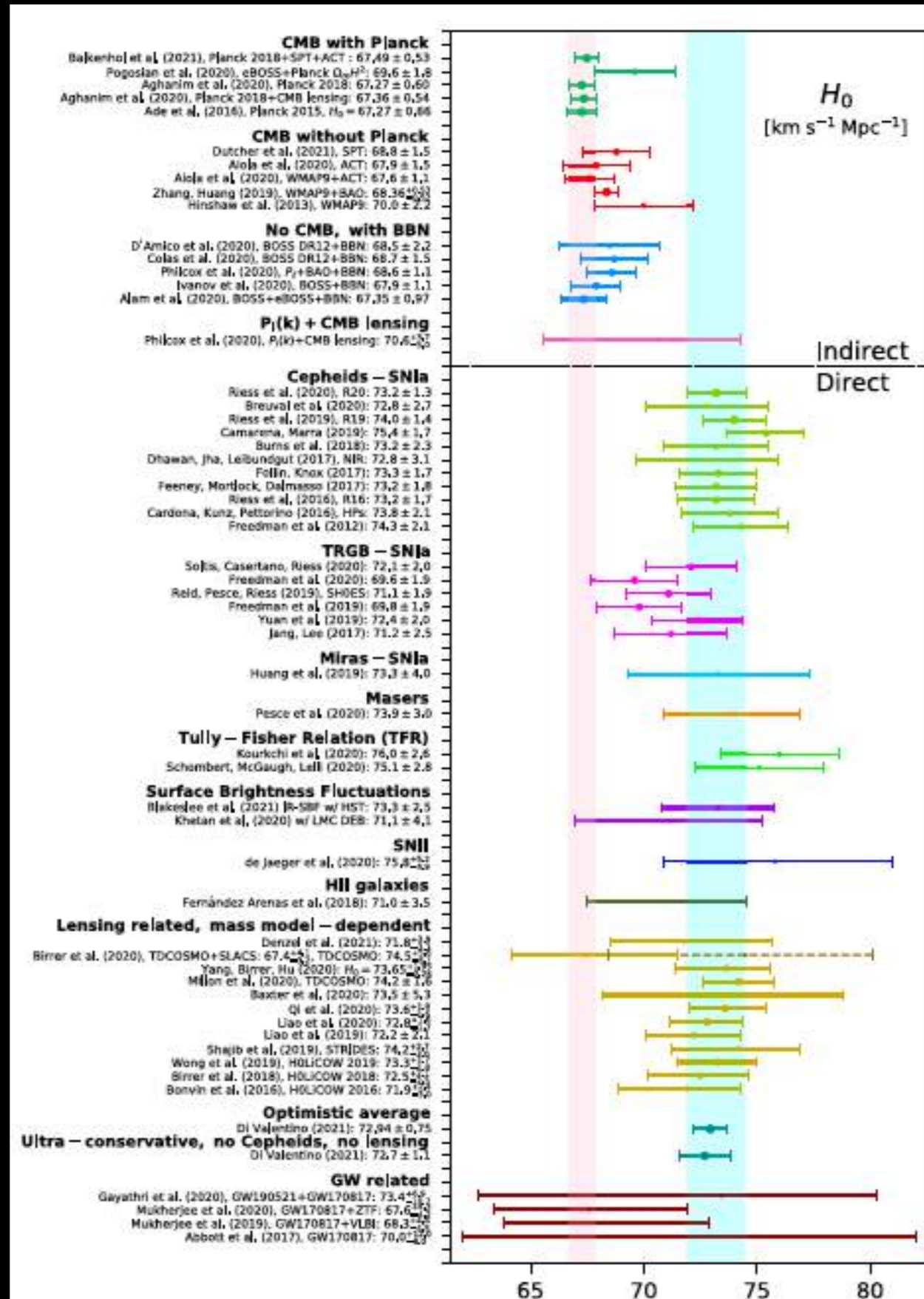
From Chávez et al. 2014

# The Hubble Constant Tension

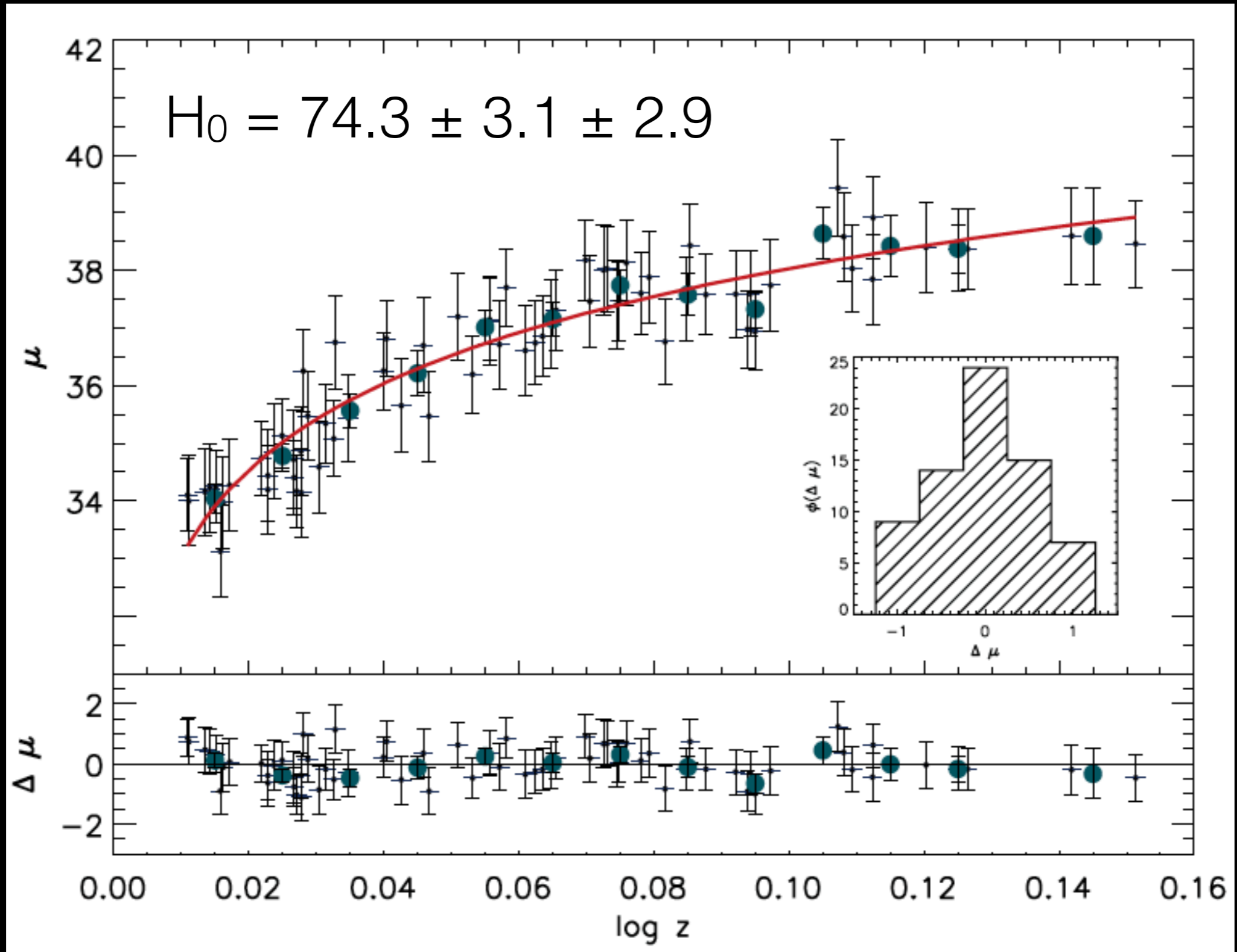




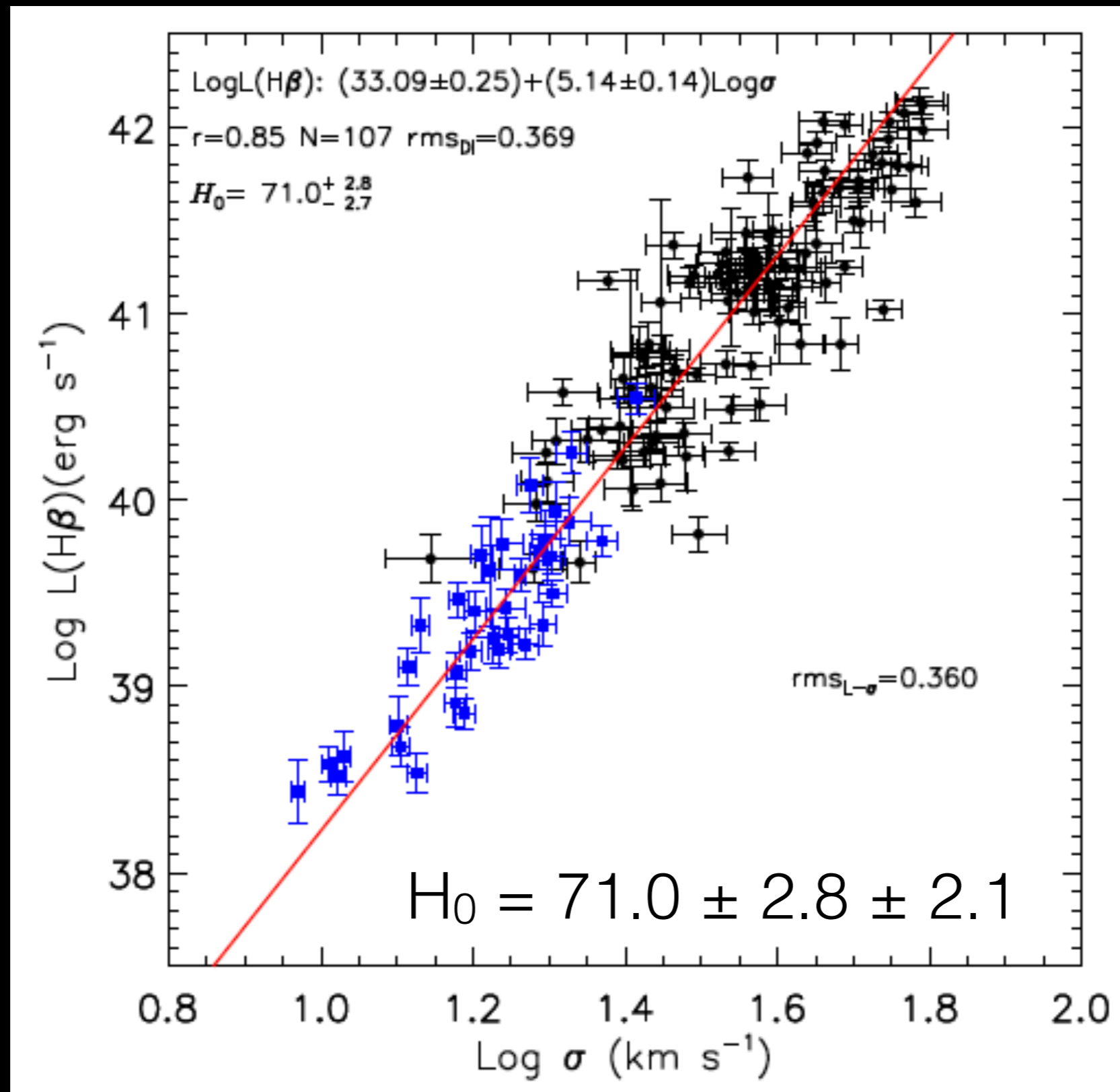
# The Hubble Constant Tension



# HIIG as Cosmological Probes: The Hubble Constant



# HIIG as Cosmological Probes: The Hubble Constant



# HIIG as Cosmological Probes: Systematics

- Size of the starburst: 0.03 mag  $\rightarrow$  0.97 km/s/Mpc
- Age of the starburst: 0.025 mag  $\rightarrow$  0.8 km/s/Mpc
- Spectrophotometry: 0.015 mag  $\rightarrow$  0.48 km/s/Mpc
- Chemical abundances: 0.02 mag  $\rightarrow$  0.6 km/s/Mpc
- Internal extinction: 0.025 mag  $\rightarrow$  0.8 km/s/Mpc
- Total: 0.053 mag  $\rightarrow$  1.68 km/s/Mpc

# A Picture of our Universe

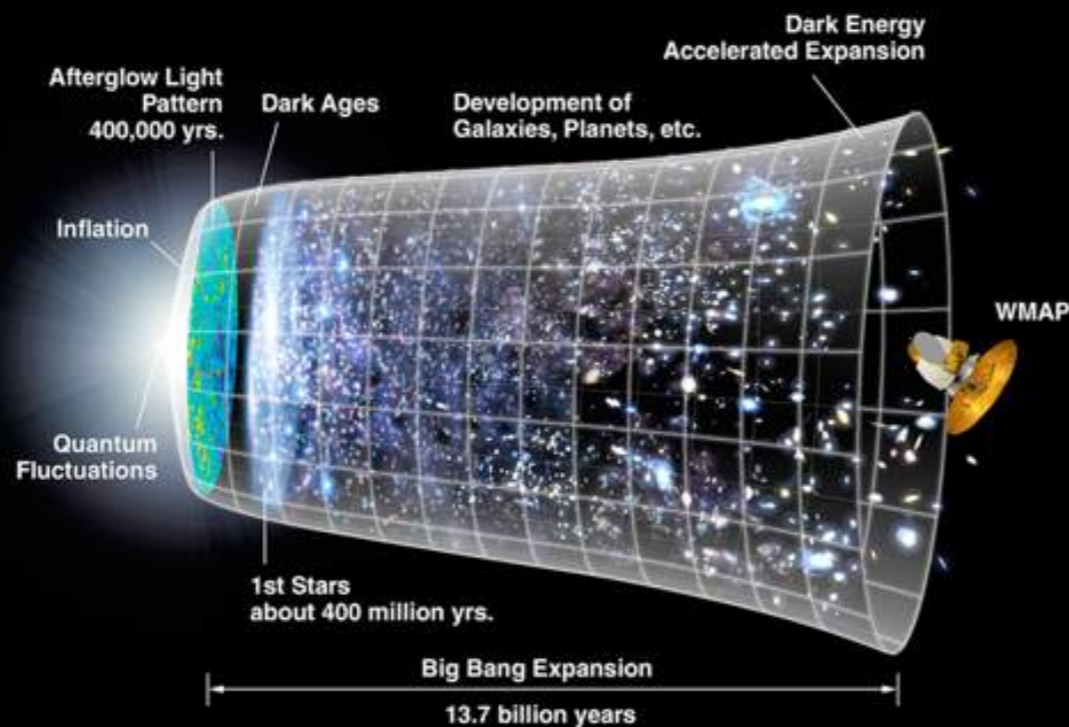
$$R_{\mu\nu} - \frac{1}{2}g_{\mu\nu}R + \Lambda g_{\mu\nu} = -\kappa T_{\mu\nu}$$

+

$$ds^2 = dt^2 - a^2(t) \left[ \frac{dr^2}{1 - kr^2} + r^2(d\theta^2 + \sin^2\theta d\phi^2) \right]$$

↕

$$H^2(z) = H_0^2 \left[ \Omega_r(1+z)^4 + \Omega_m(1+z)^3 + \Omega_k(1+z)^2 + \Omega_w \exp \left( 3 \int_0^z \frac{1+w(x)}{1+x} dx \right) \right]$$



$$p_w = w(z)\rho_w$$

$$w(z) = w_0 + w_1 f(z)$$

$$f(z) = z/(1+z)$$

NASA/WMAP Science Team

# Observations: High-z Sample

## VLT Telescope:

2 half nights in the period 95A with KMOS

→ Visitor mode.  
Lost due to rain!!!!.

16 hours in the period 97A with KMOS. Priority A, first Q

→ Service mode.  
Observing period from 3/2016 to 9/2017(extended)

39 hours in the period 98A with KMOS. Priority A, first Q

→ Service mode.  
Observing period from 10/2016 to 3/2017

## KECK Telescope:

1 night with MOSFIRE in January 27th, 2016.

→ Visitor mode.



# Independent cosmological constraints from high- $z$ H II galaxies: new results from VLT-KMOS data

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David Fernández-Arenas<sup>ID</sup>,<sup>4</sup> Fabio Bresolin<sup>ID</sup>,<sup>5</sup> Manolis Plionis,<sup>6,7</sup> Jorge Melnick,<sup>8,9</sup> Spyros Basilakos<sup>10</sup>  
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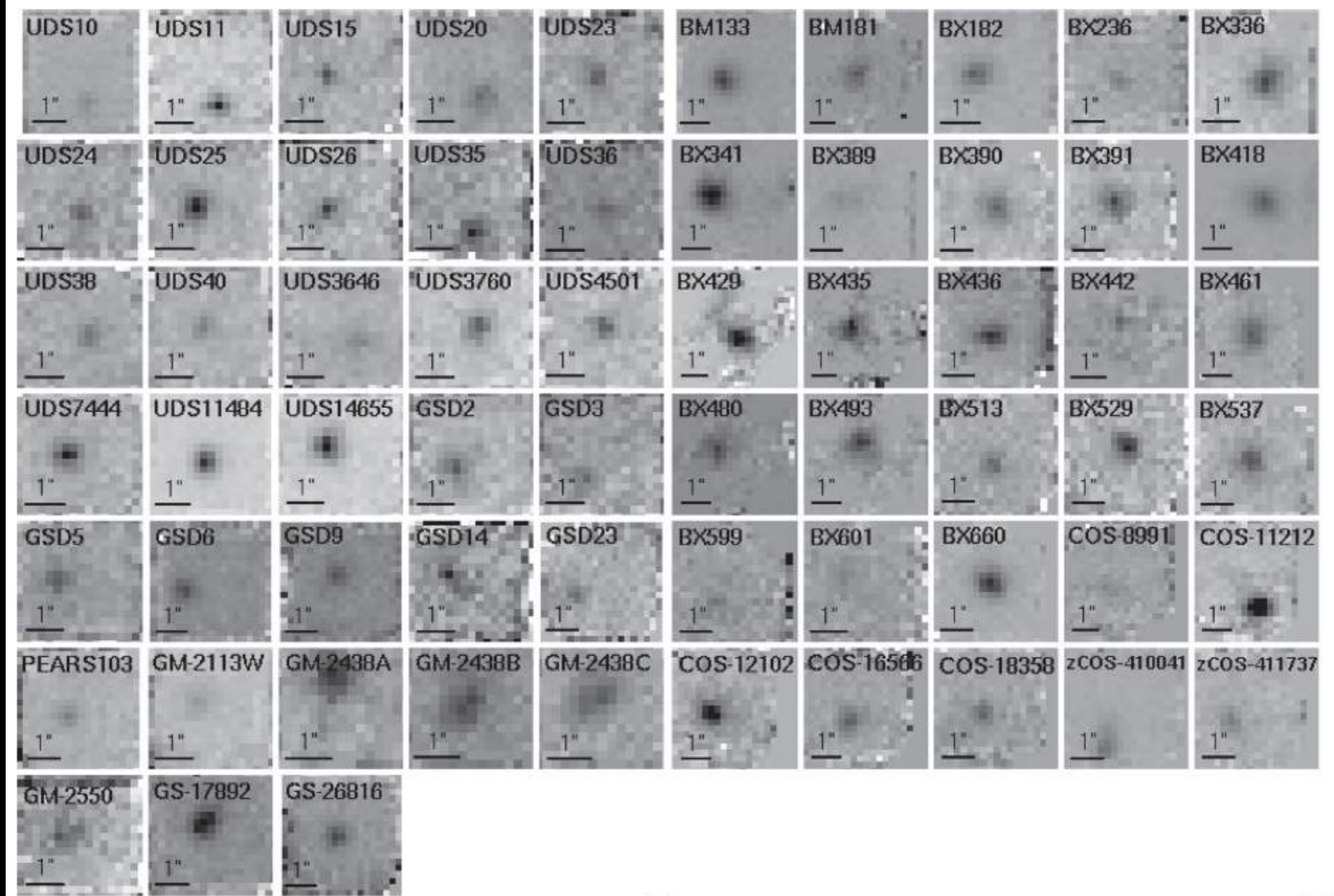
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# The VLT-KMOS sample

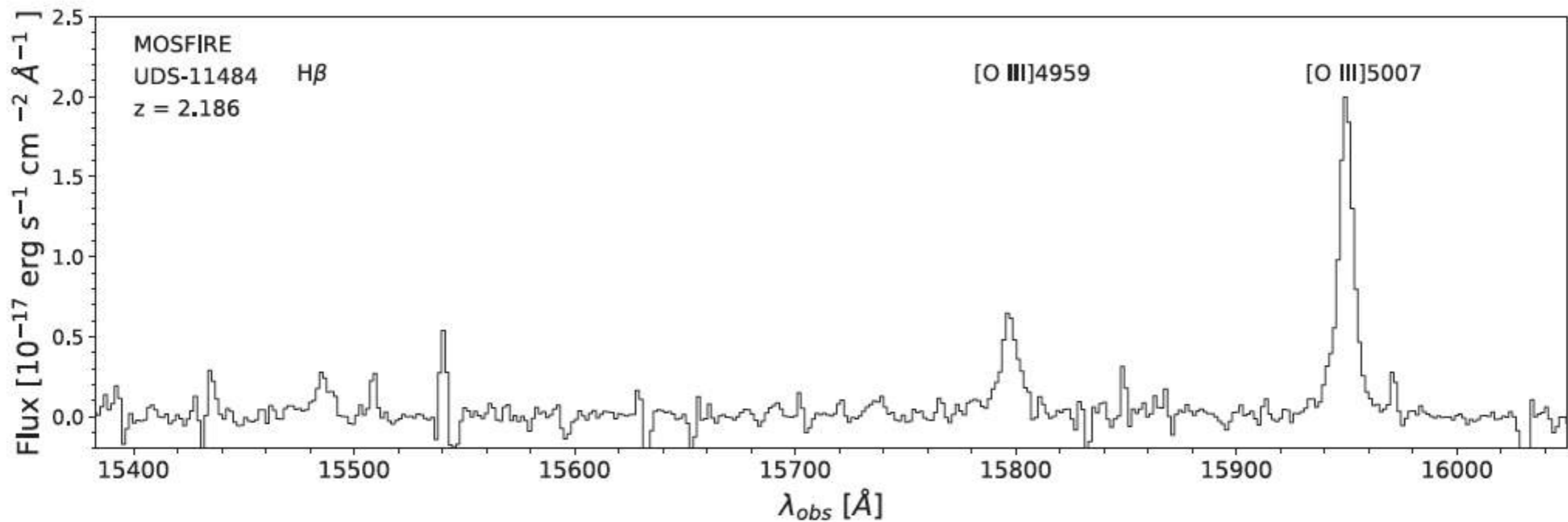
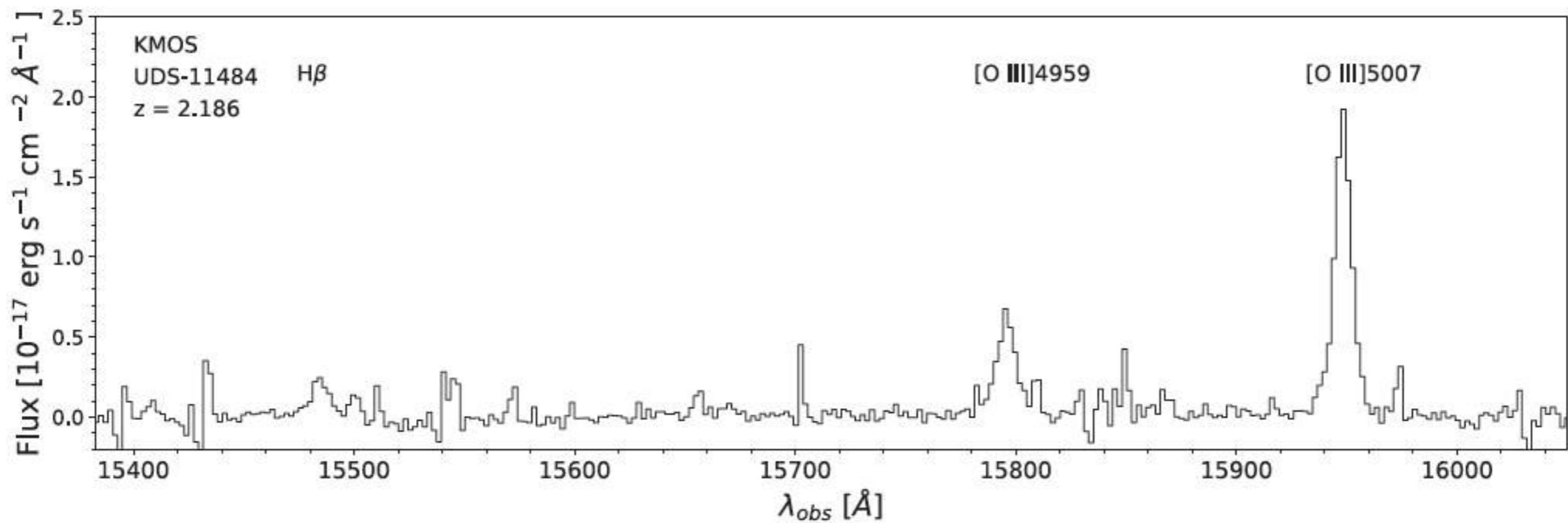


(a) UDS and GOODS-S fields

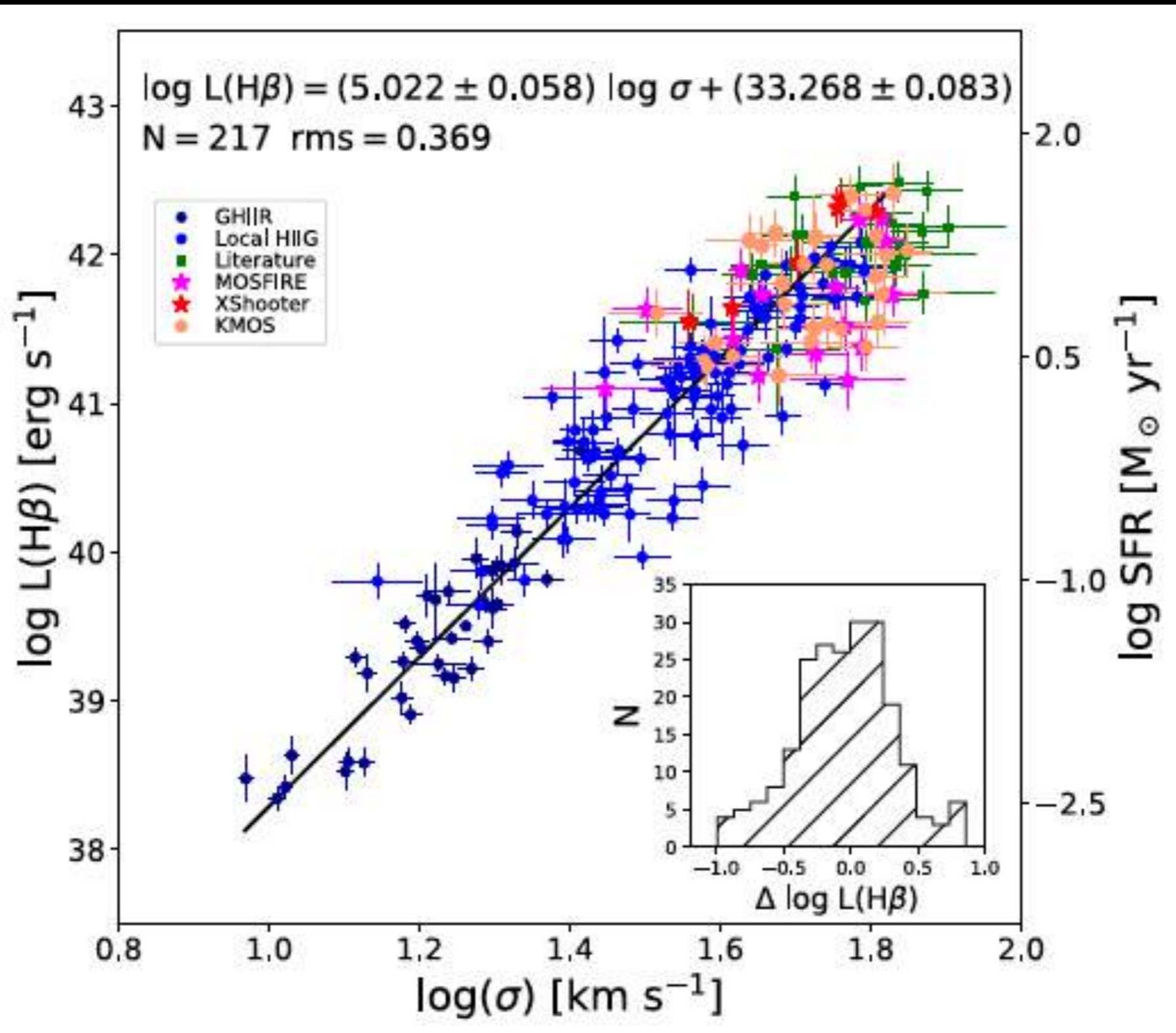
(b) Q2343 and COSMOS fields



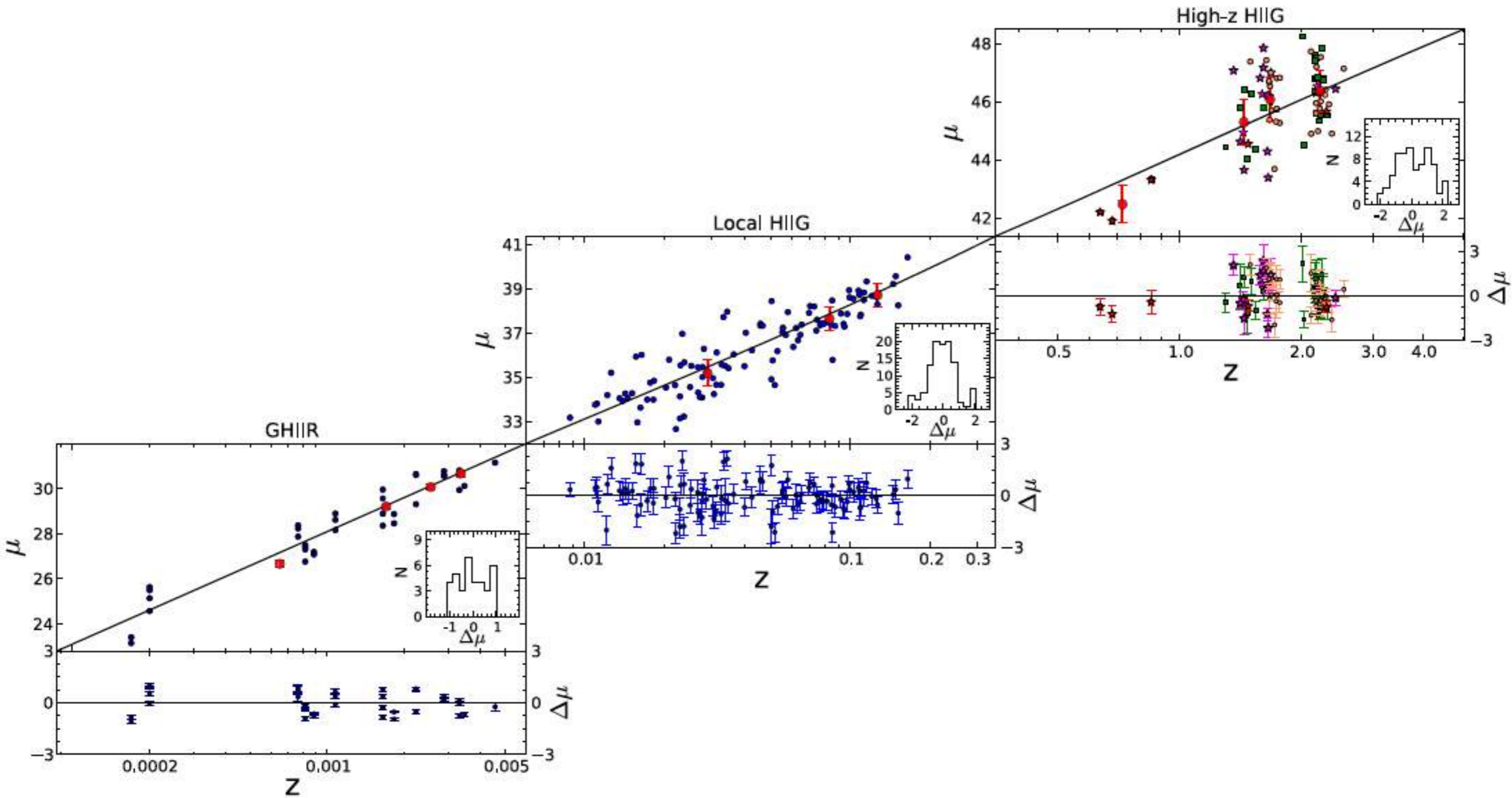
# The data



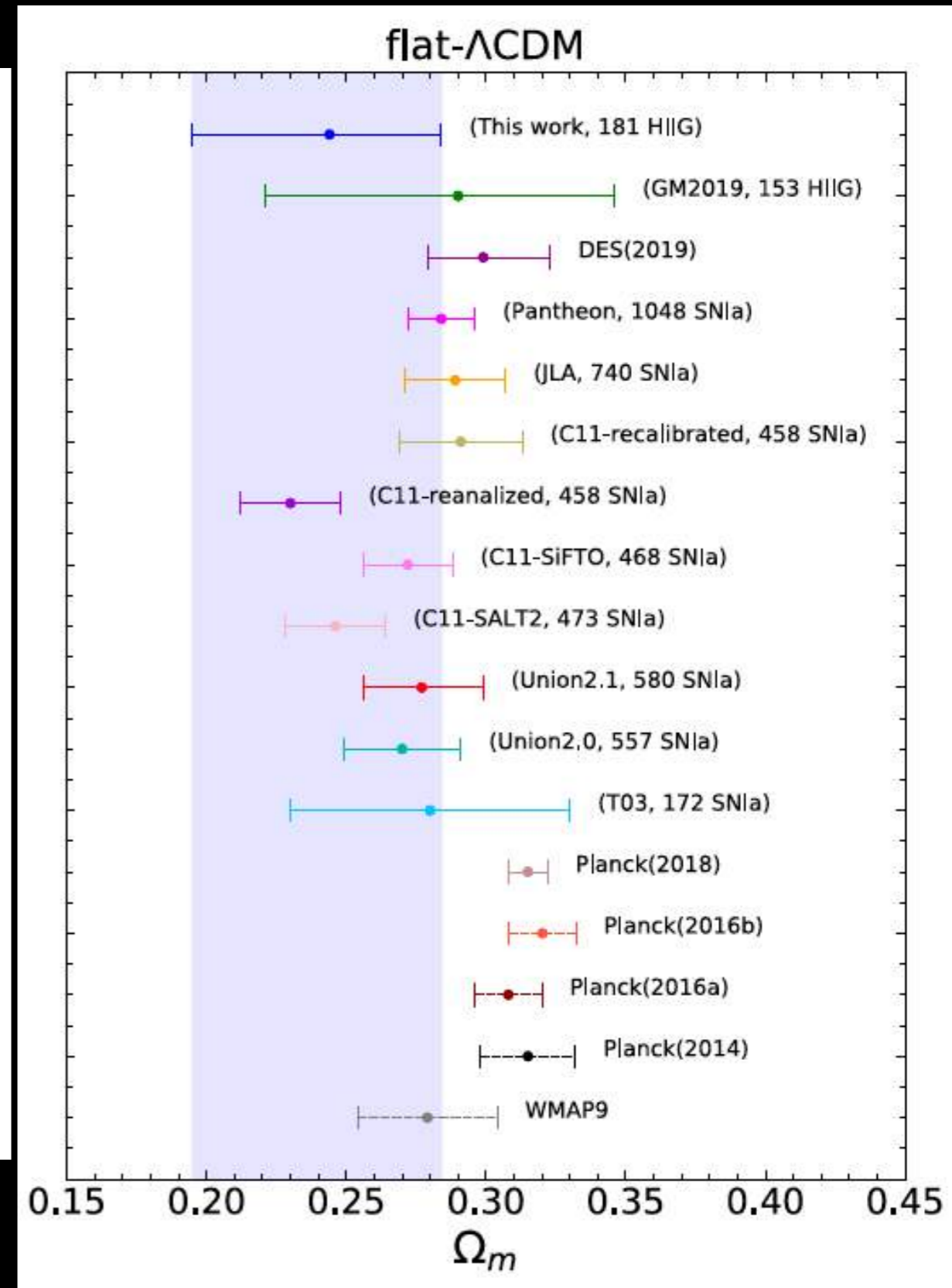
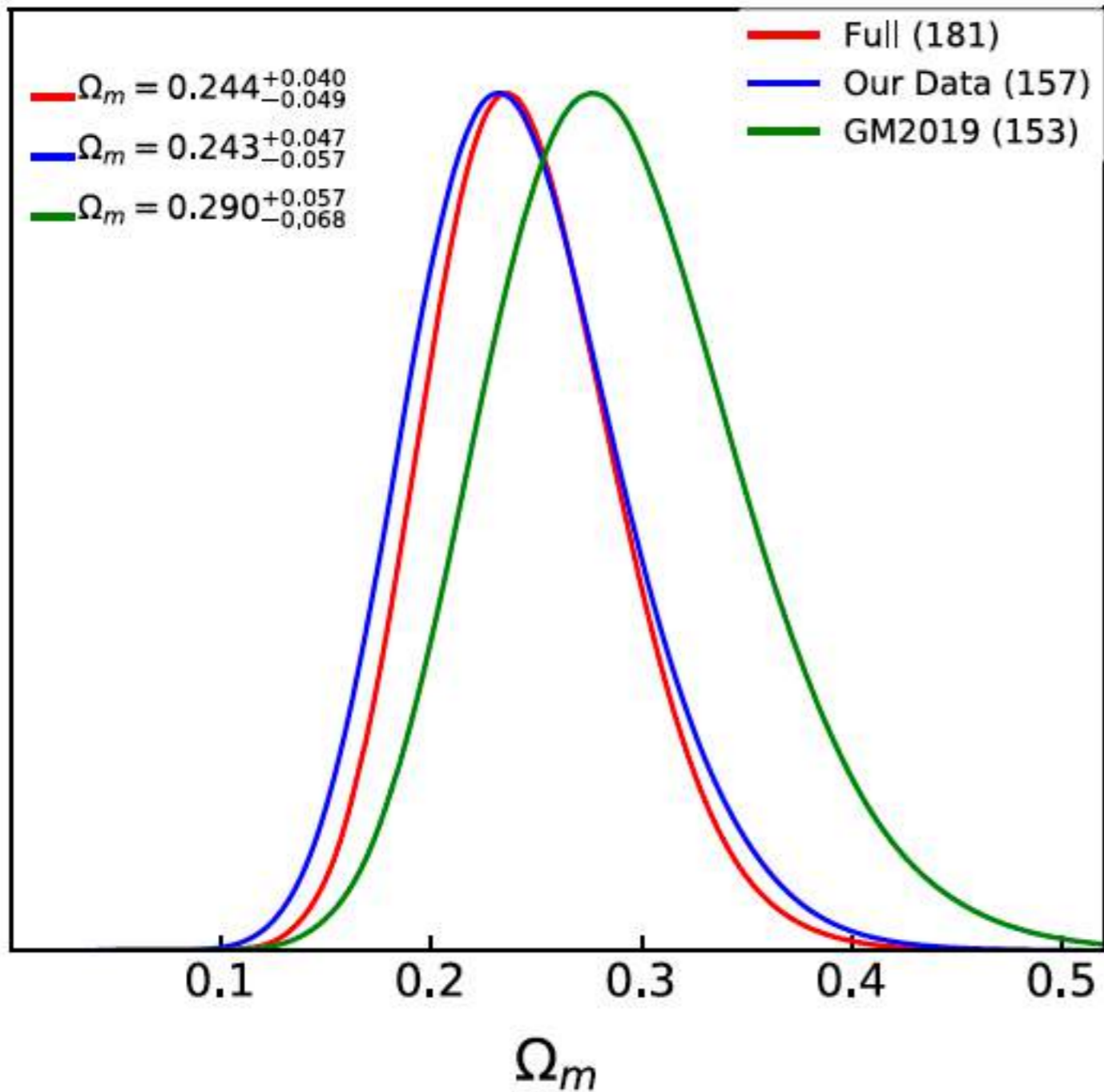
# The L- $\sigma$ Relation



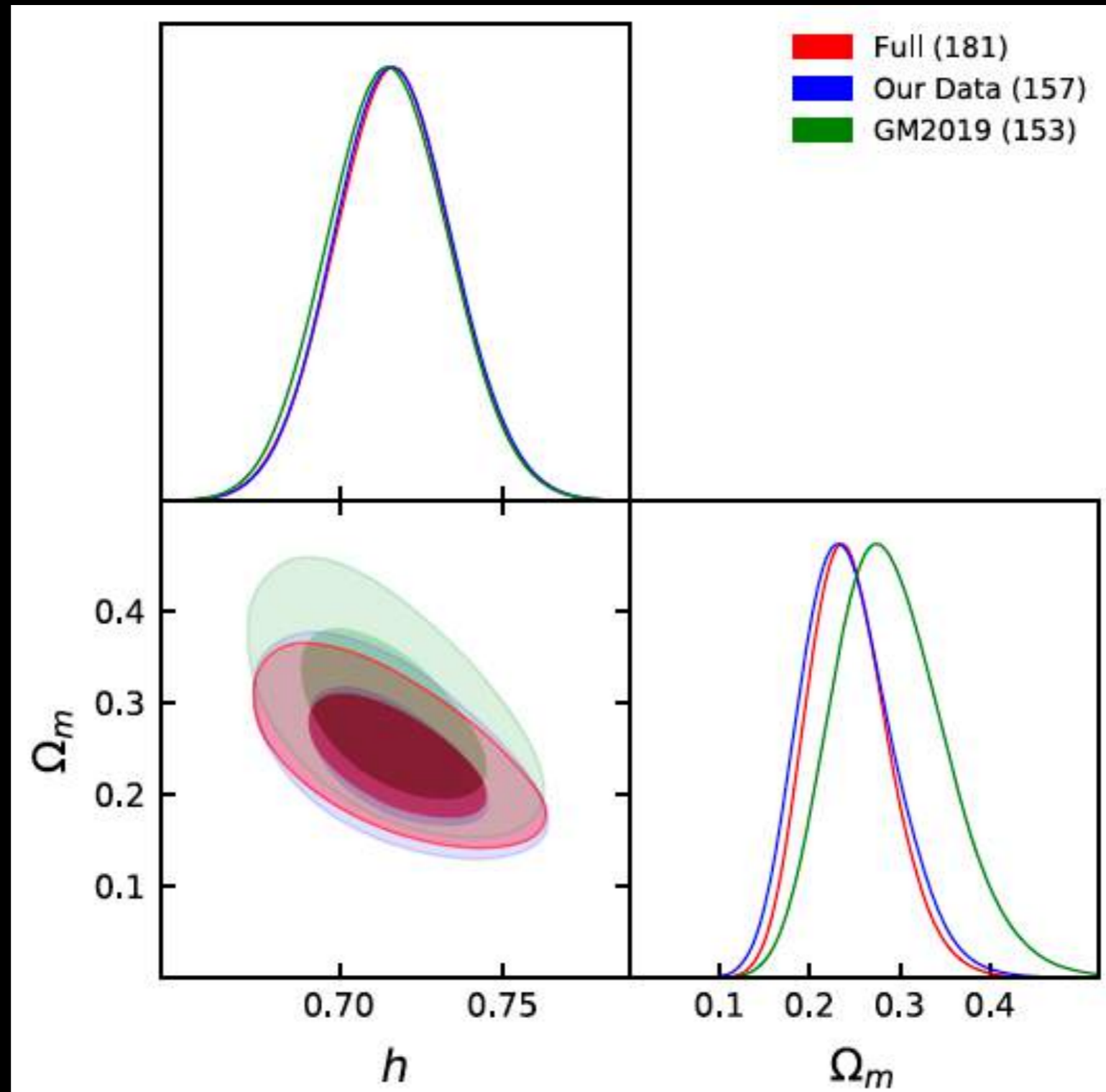
# The Hubble diagram



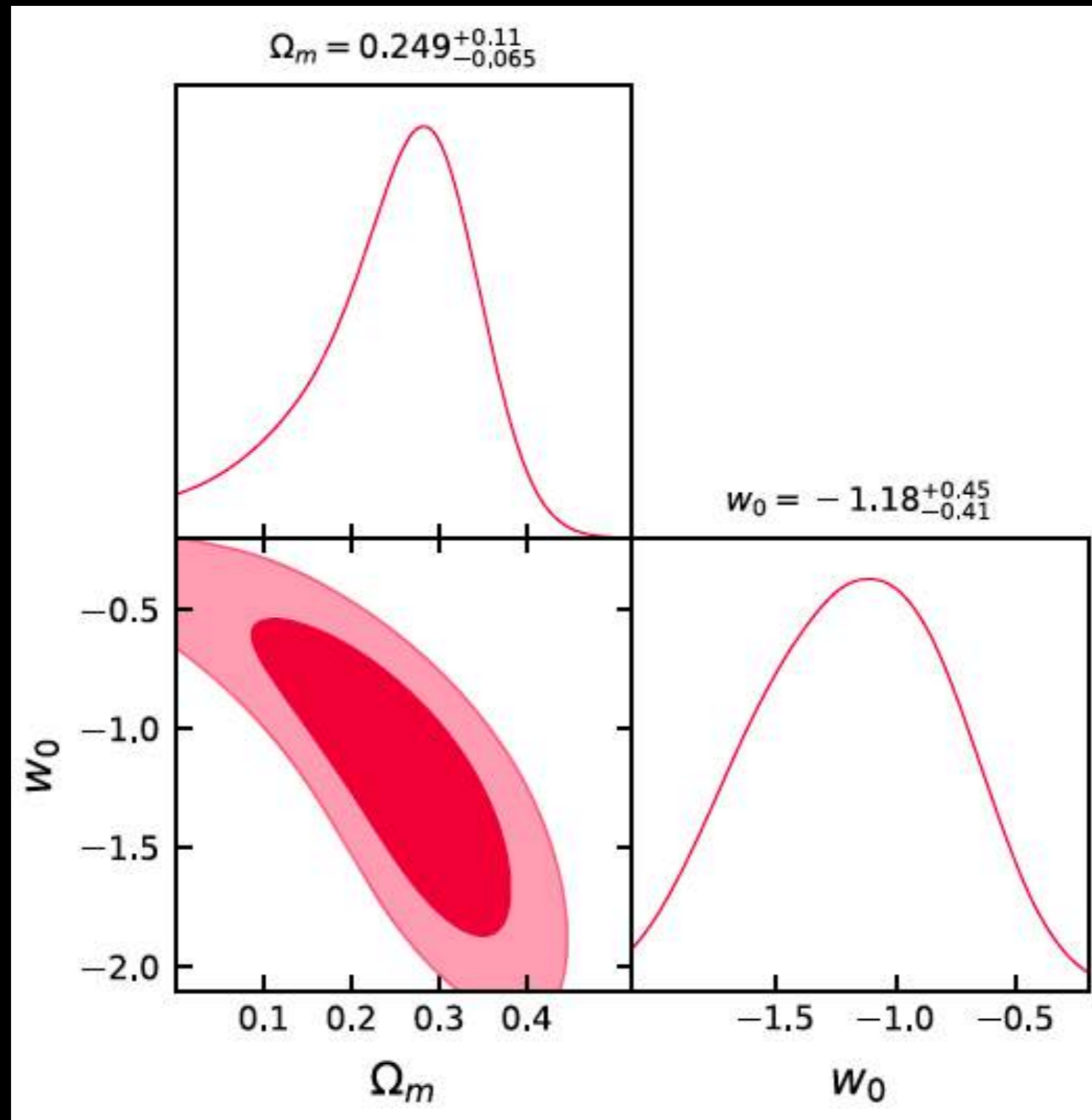
# Cosmological Constraints



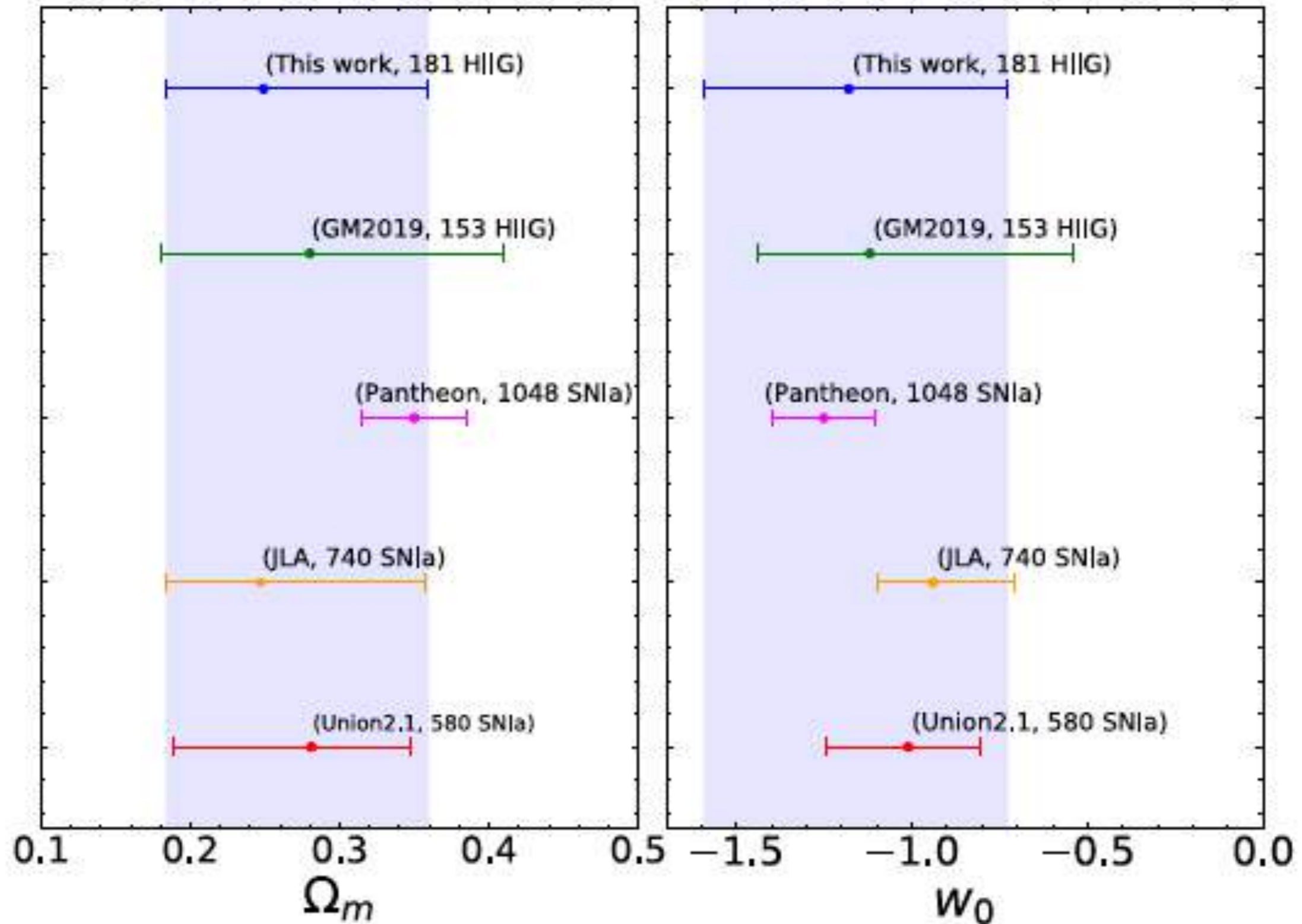
# Cosmological Constraints



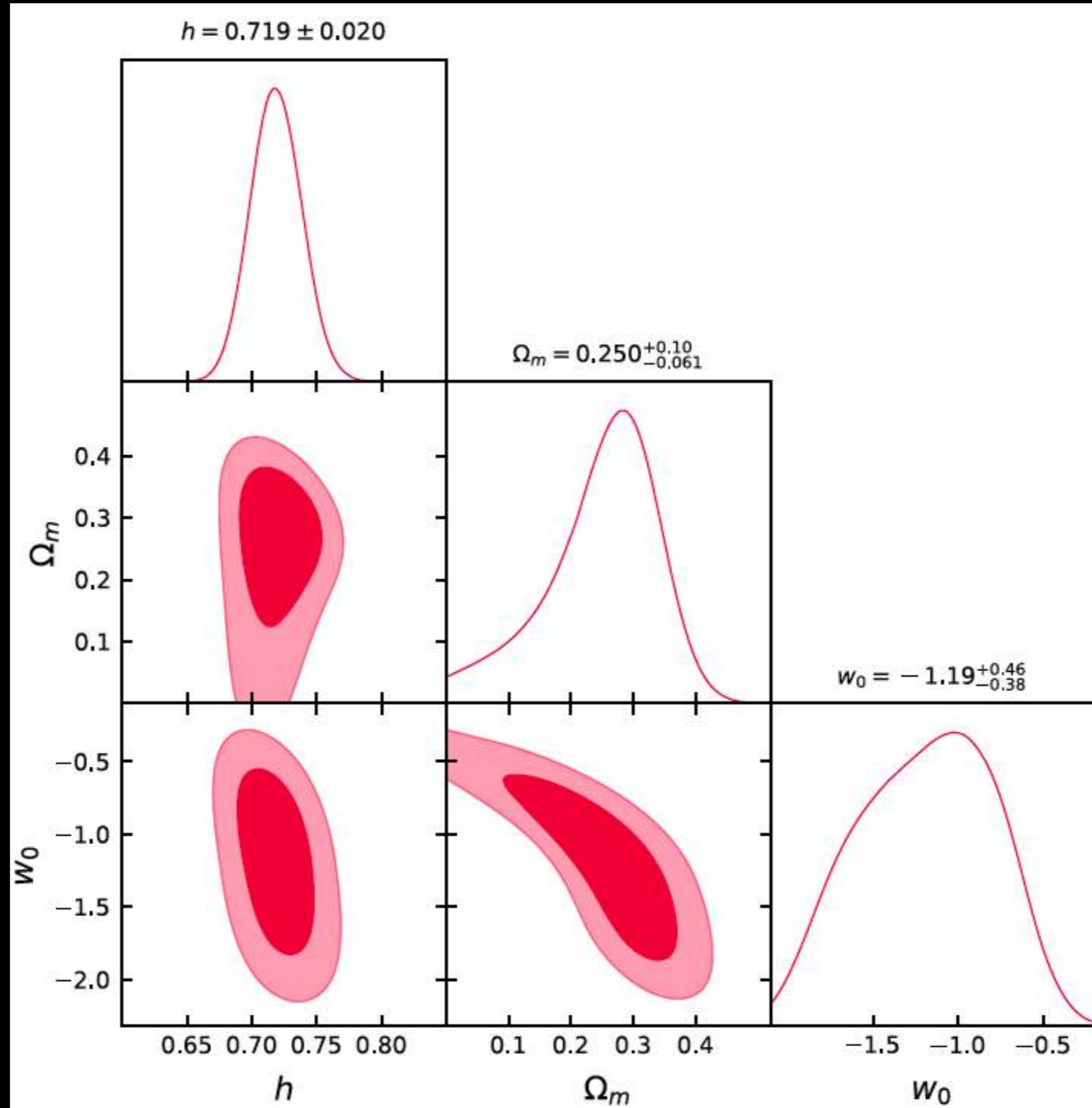
# Cosmological Constraints



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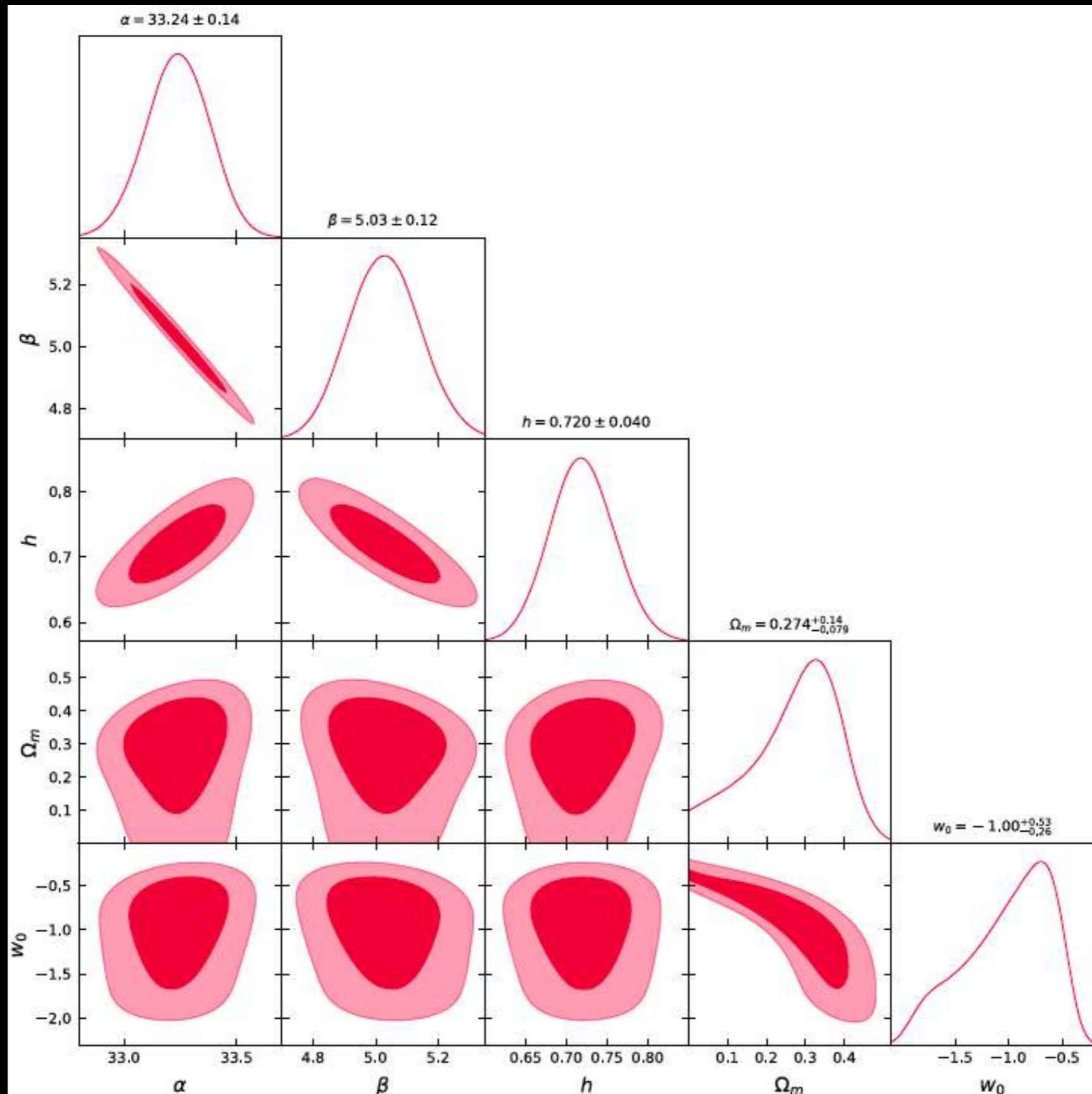


# Cosmological Constraints

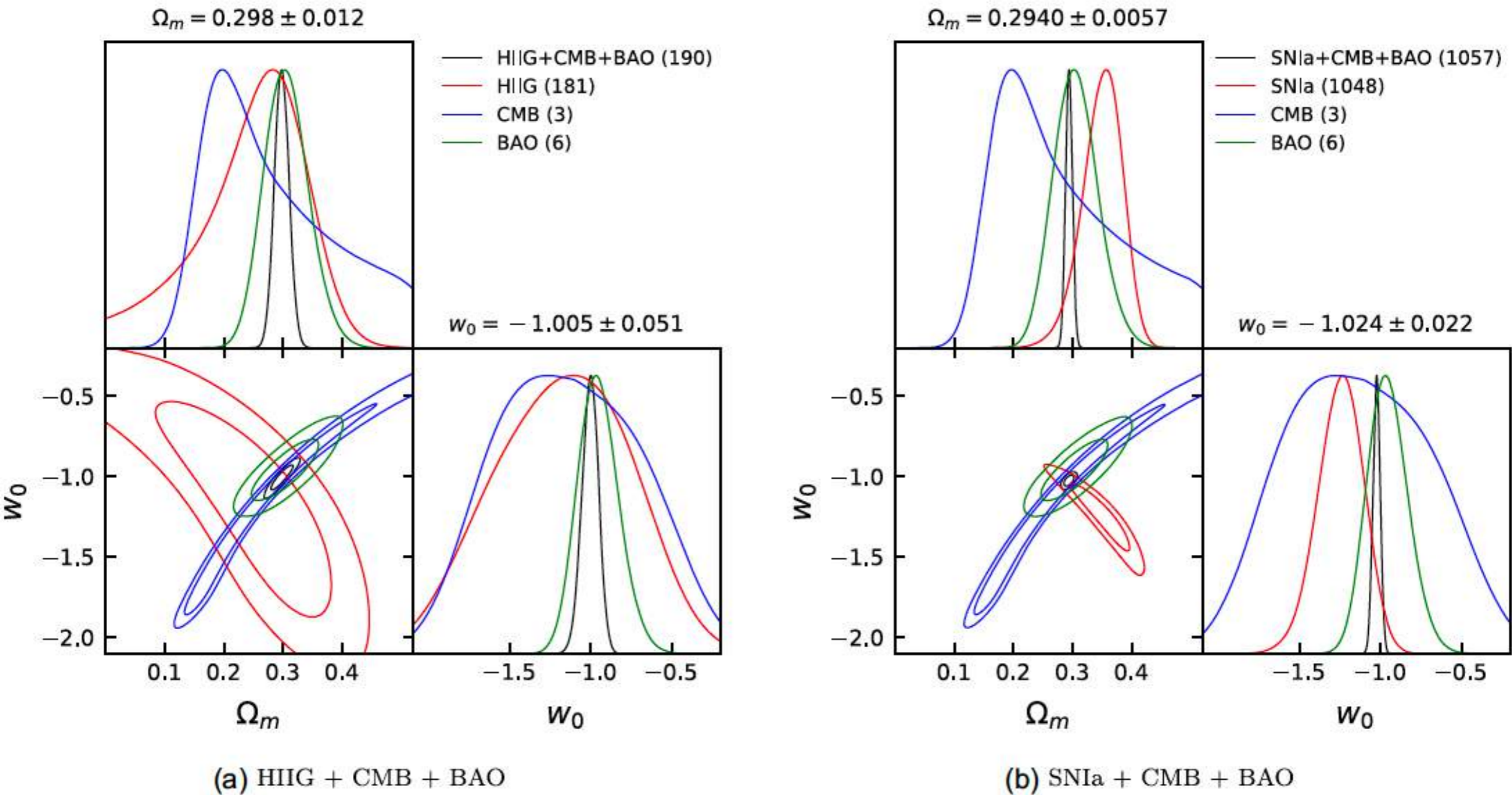




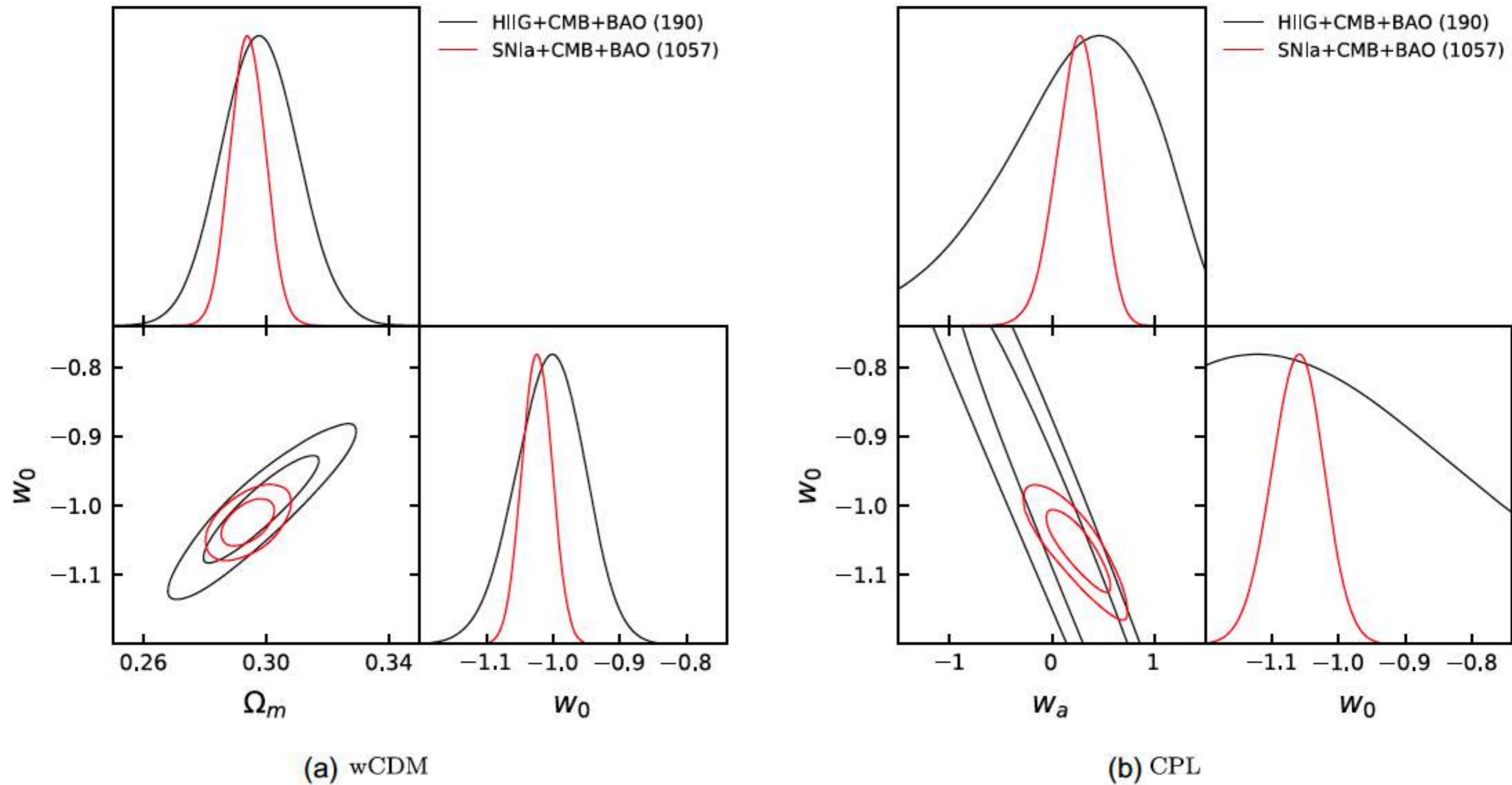
# Cosmological Constraints



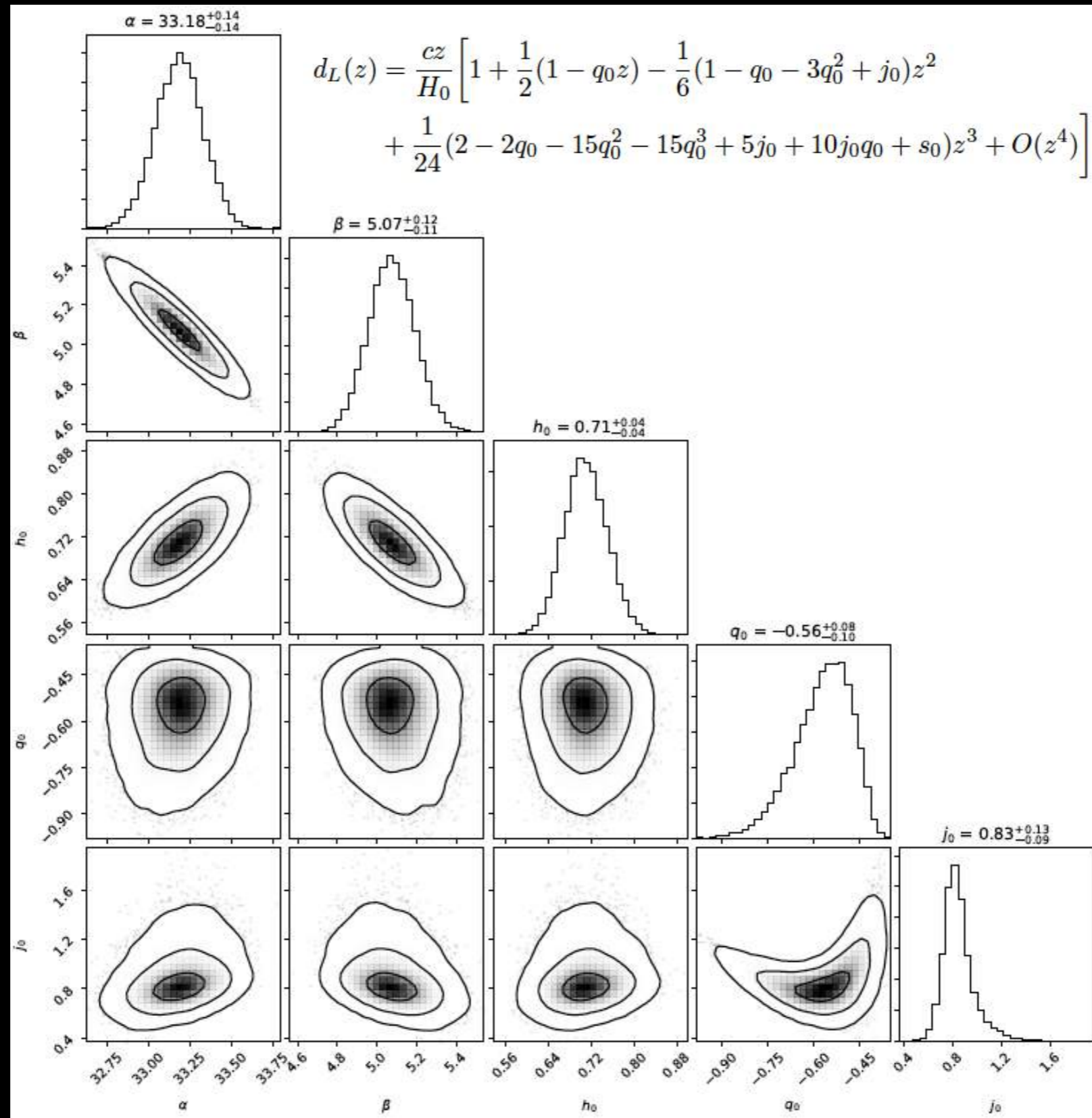
# Cosmological Constraints



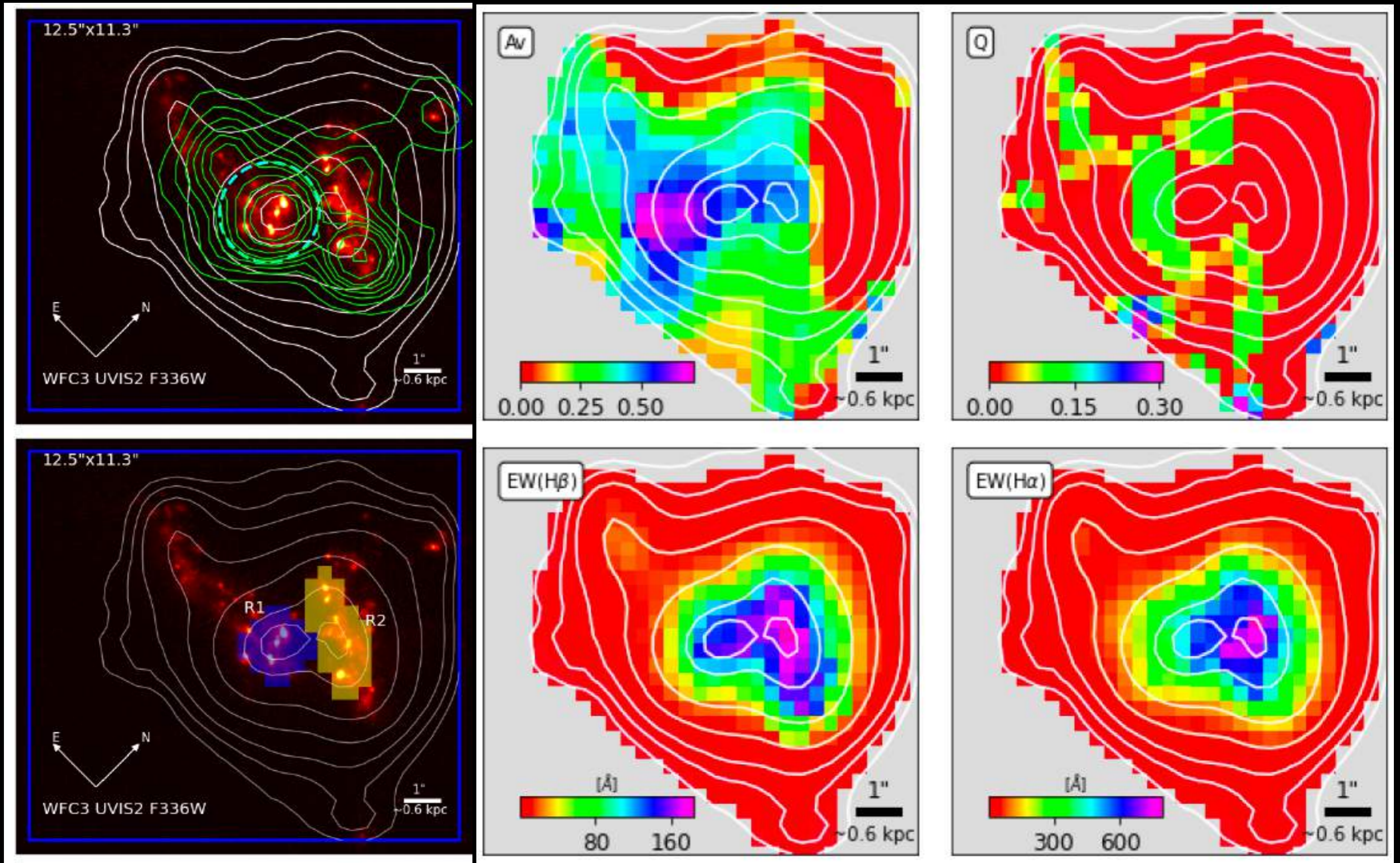
# Cosmological Constraints



# Cosmography with HII Galaxies

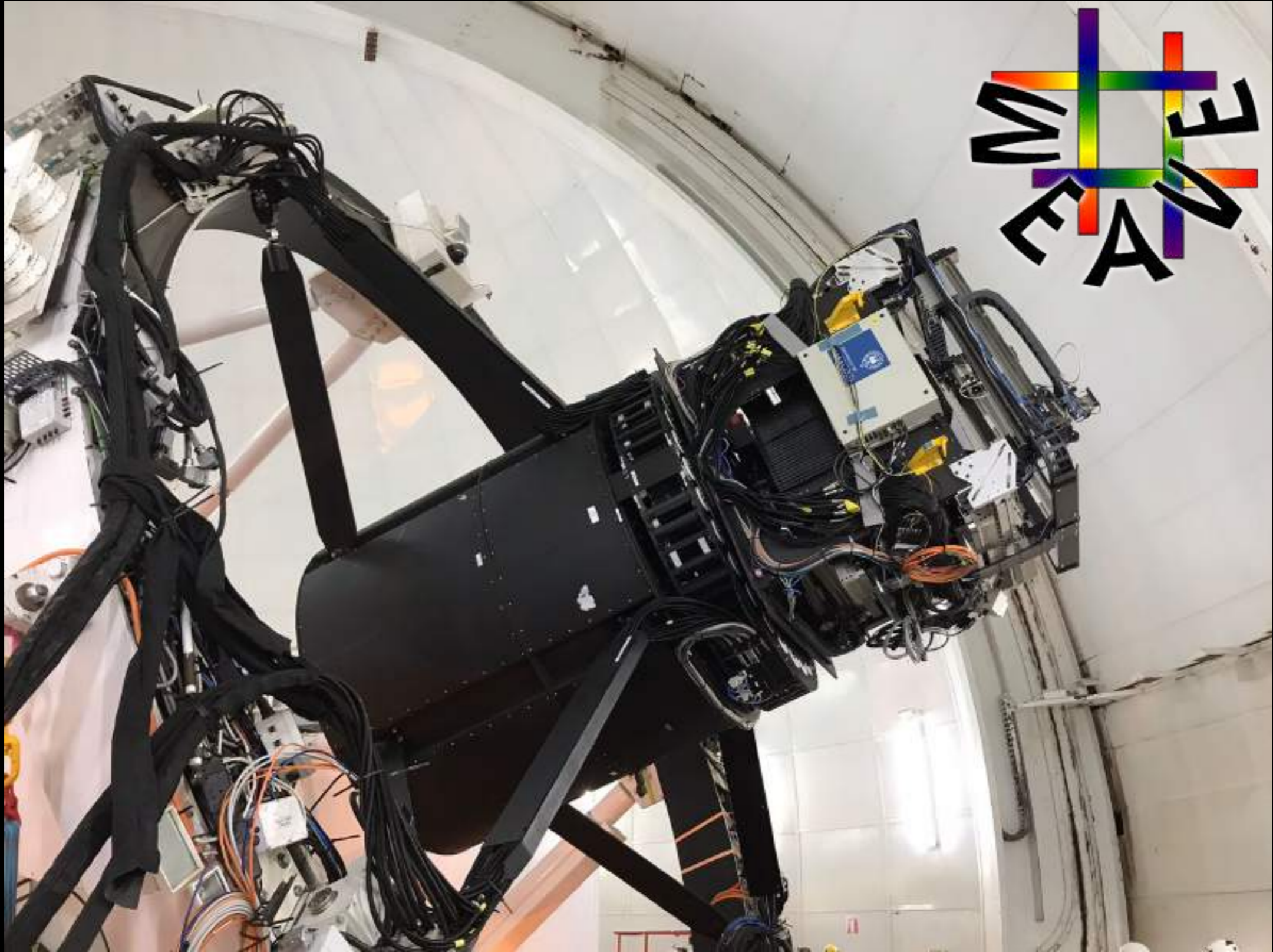


# J084220 with Megara



From Fernández-Arenas et al. 2022, submitted

# Future Work



# Concluding Remarks

- GEHR and HIIG are ideal laboratories to understand the feedback of star formation (SF) on the dynamics and energetics of the interstellar medium (ISM).
- We present constraints to  $H_0$  from a local sample of HII Galaxies.
- We present constraints to the parameter of the DE EoS from a sample of HII galaxies from the local Universe and up to redshift 2.5. Our constraints agree well with the results from other well developed methodologies.

# References

- González-Morán A.L., et al., 2019, MNRAS, 487, 4669
- Fernández-Arenas D., et al., 2018, MNRAS, 474, 1250
- Chávez R., et al., 2016, MNRAS, 462, 2431
- Terlevich R., et al., 2015, MNRAS, 451, 3001
- Chávez R., et al., 2014, MNRAS, 442, 3565
- Chávez R., et al., 2012, MNRAS, 425, L56
- Plionis M., et al., 2011, MNRAS, 416, 298