Putting Flat ΛCDM in the Bin

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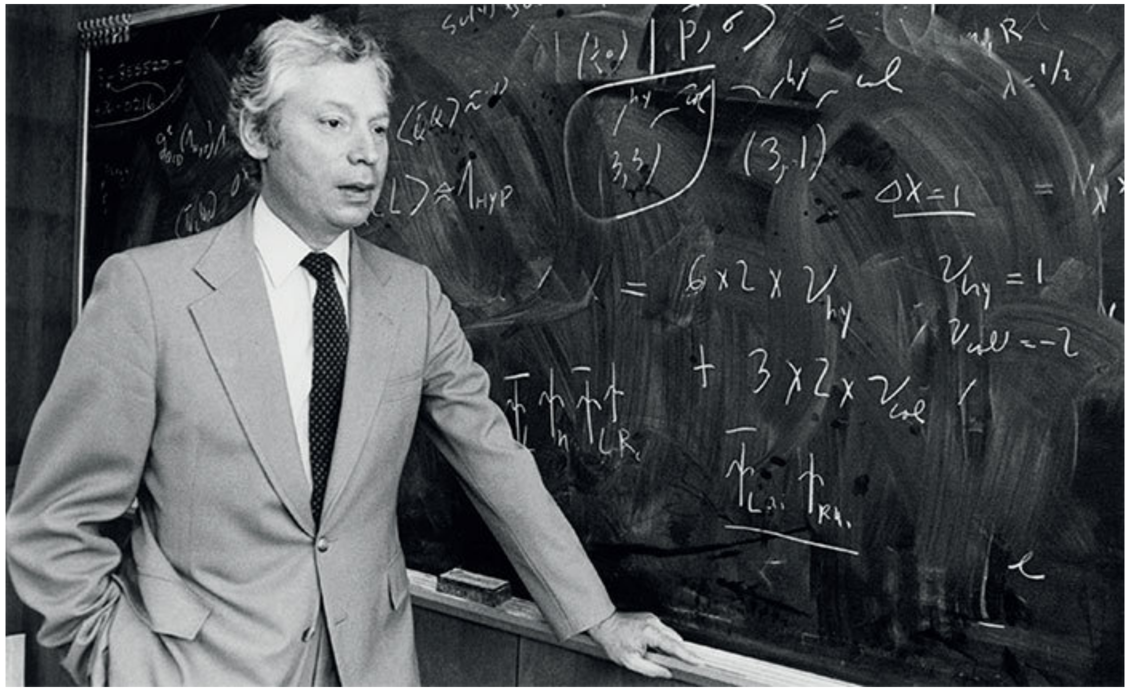
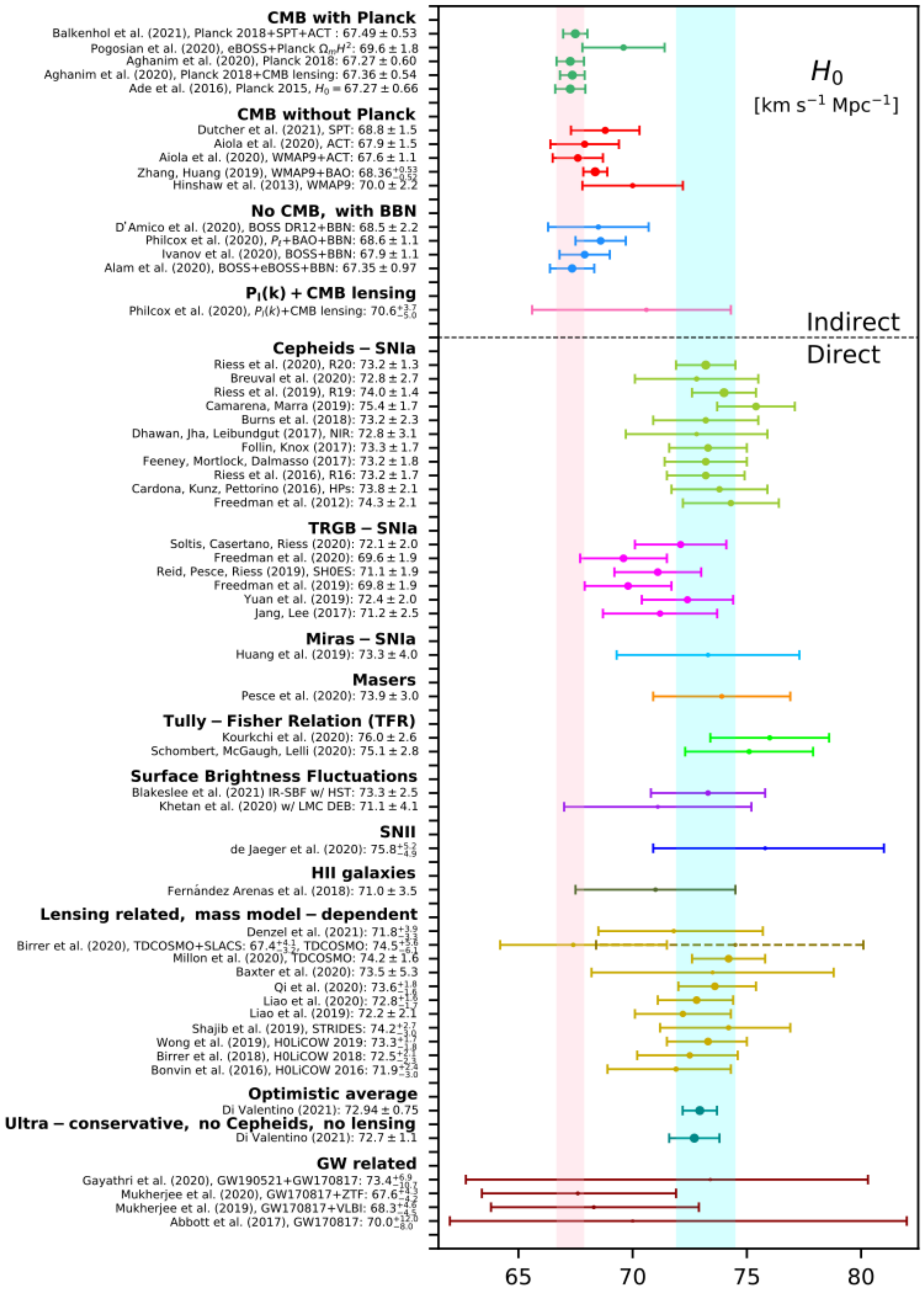
based on 2002.06044, 2203.10558, 2206.11447

"...in a period of normal science, scientists tend to agree about what phenomena are relevant and what constitutes an explanation of these phenomena, about what problems are worth solving and what is a solution of a problem. Near the end of a period of normal science a crisis occurs - experiments give results that don't fit existing theories, or internal contradictions are discovered in these theories. There is alarm and confusion. Strange ideas fill the scientific literature. Eventually there is a revolution. Scientists become converted to a new way of looking at nature, resulting eventually in a new period of normal science. The "paradigm" has shifted."



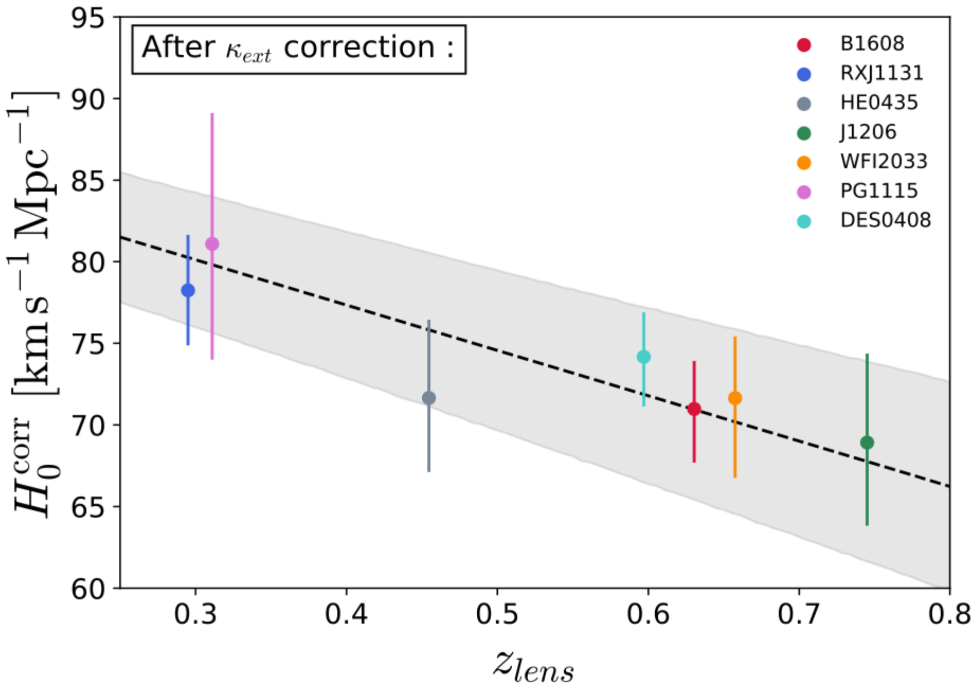
Weinberg on Kuhnian shifts

Di Valentino et al. (2103.01183)

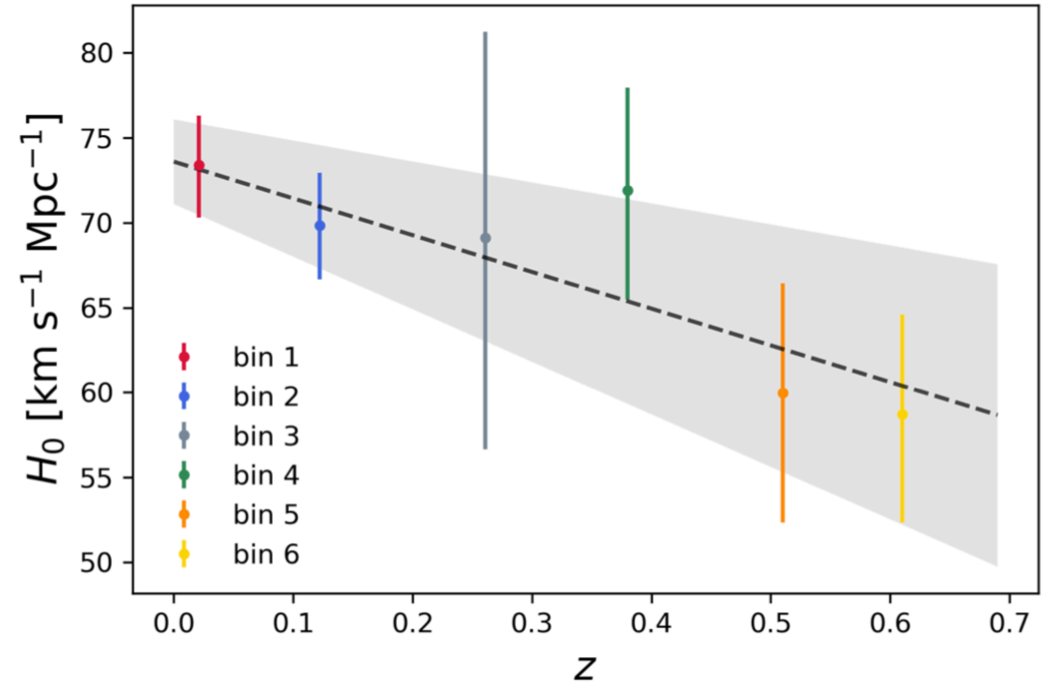


Hard to do cosmology when there is a 10% difference in the rate of expansion.

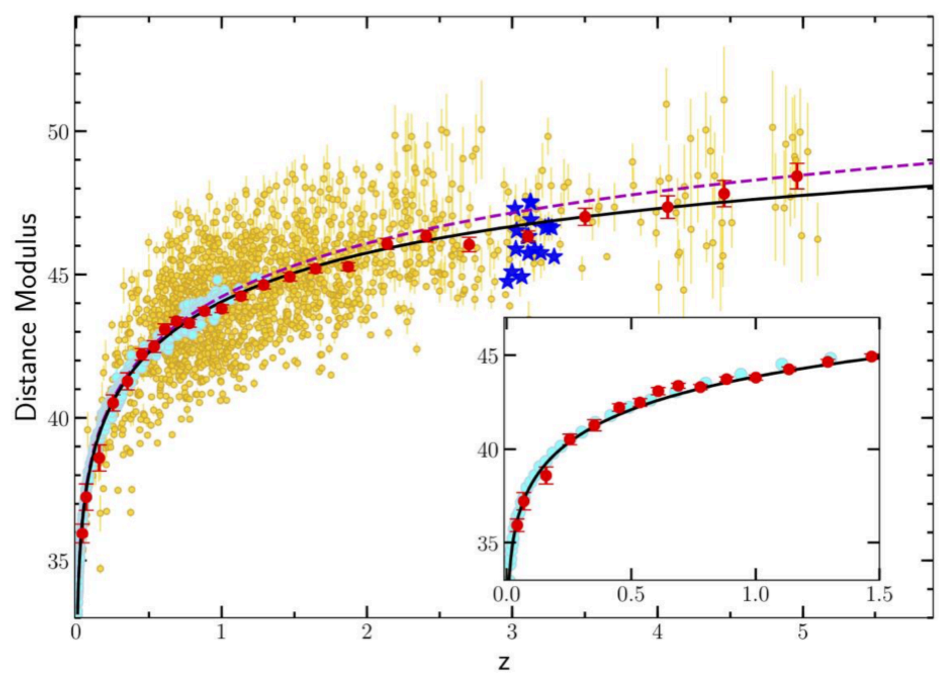
Is ΛCDM just too simple?



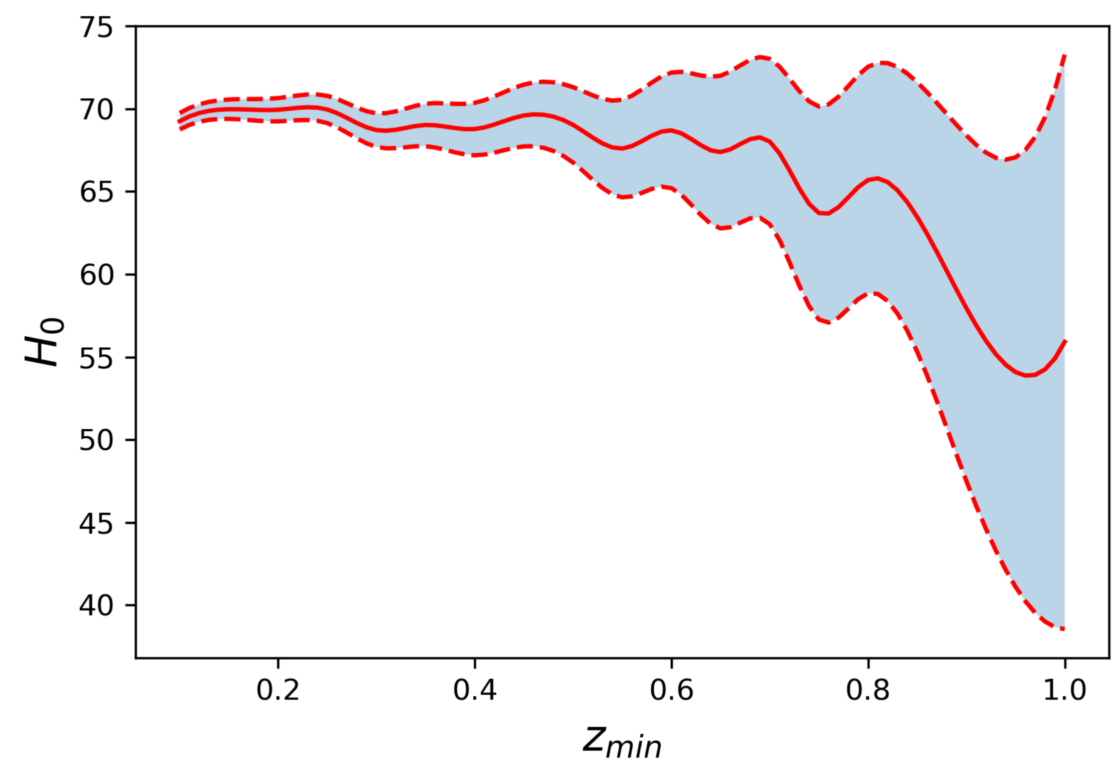
Millon et al. (1912.08027)



Krishnan, ÓC et al. (2002.06044)



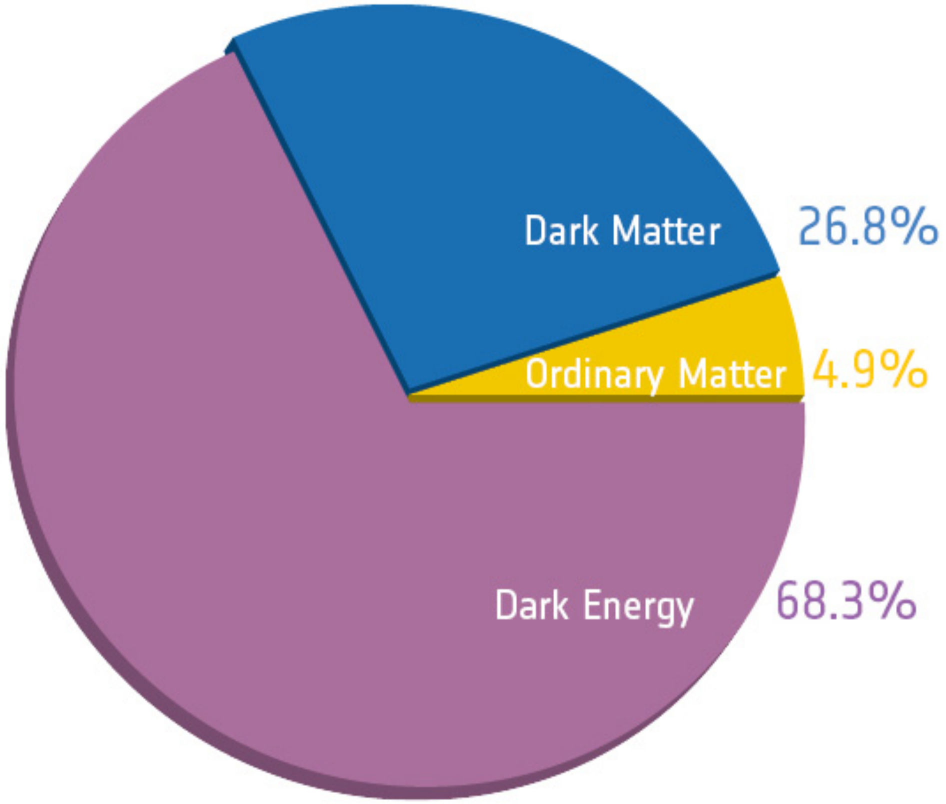
Risaliti, Lusso, 1811.02590



ÓC et al. (2203.10558)

$$H(z)^2 = H_0^2[1 - \Omega_m + \Omega_m(1+z)^3]$$
$$= A + B(1+z)^3$$

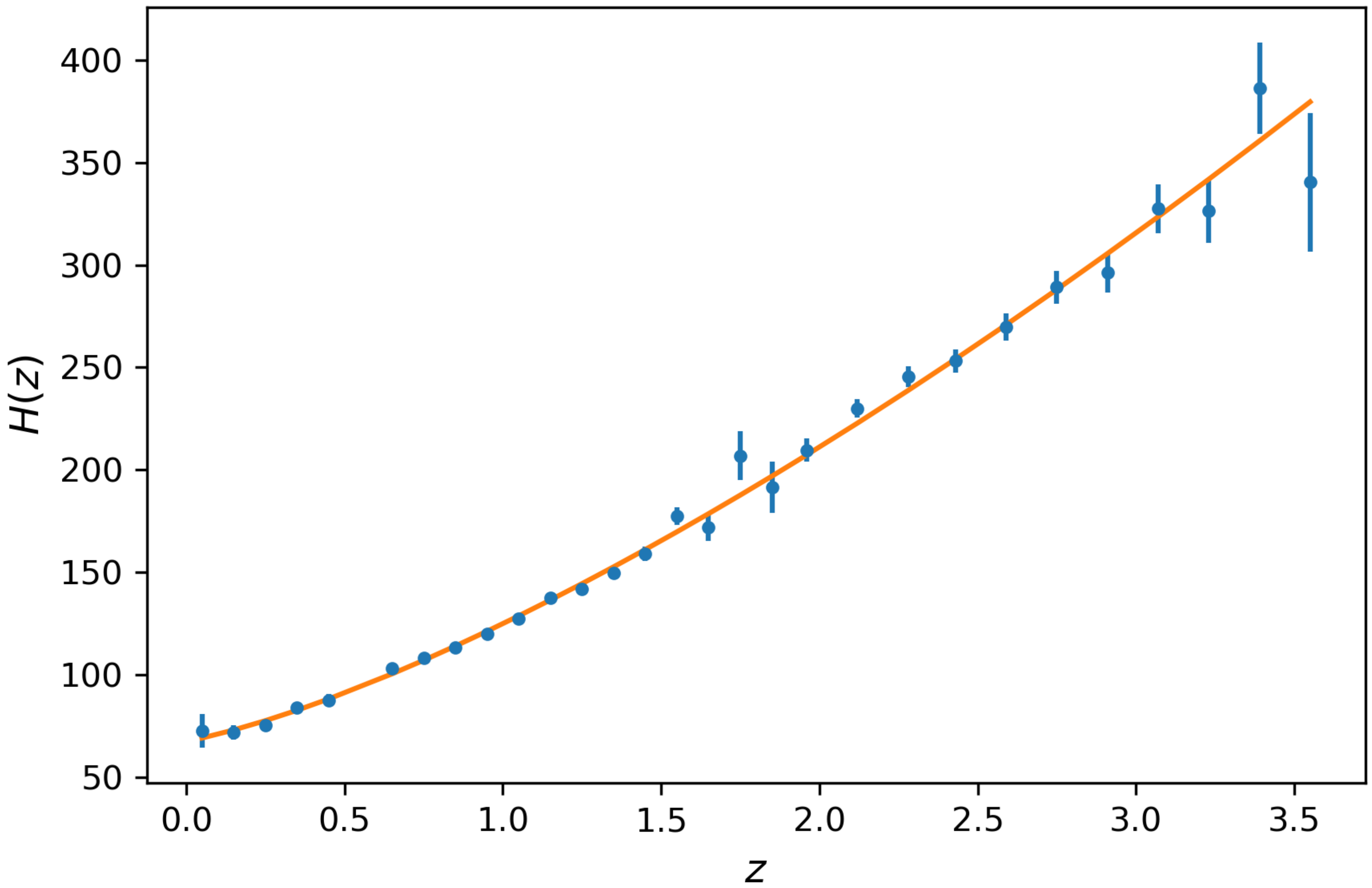
Planck-ΛCDM Universe



One can prove using analytics/mocks that the P(Ω_m=0.3) ~ 0 in high redshift bins.

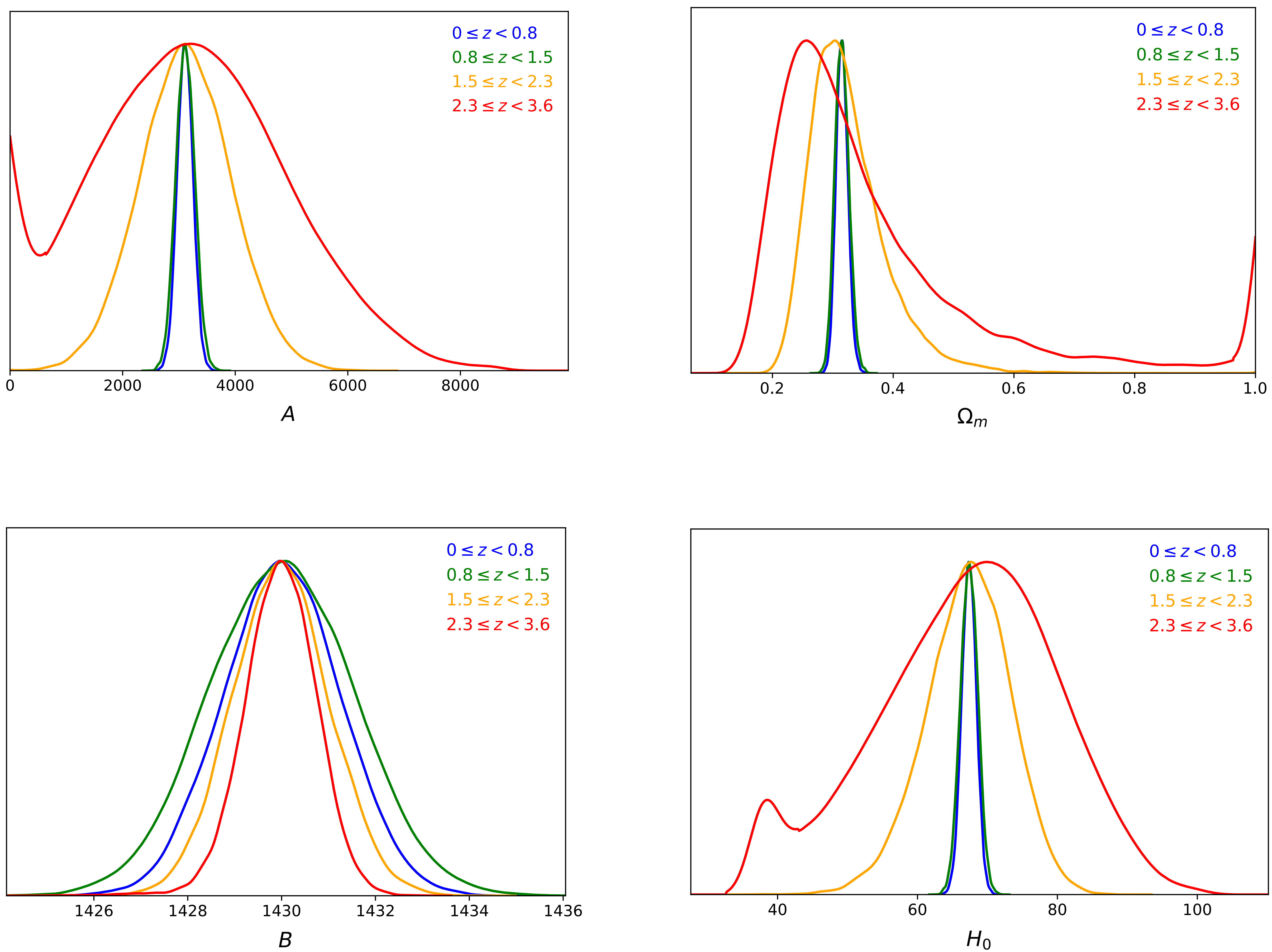
DESI forecasts for H(z)

Aghamousa et al, 1611.00036



Split 29 = (7, 7, 7, 8), mock up on Planck-ΛCDM

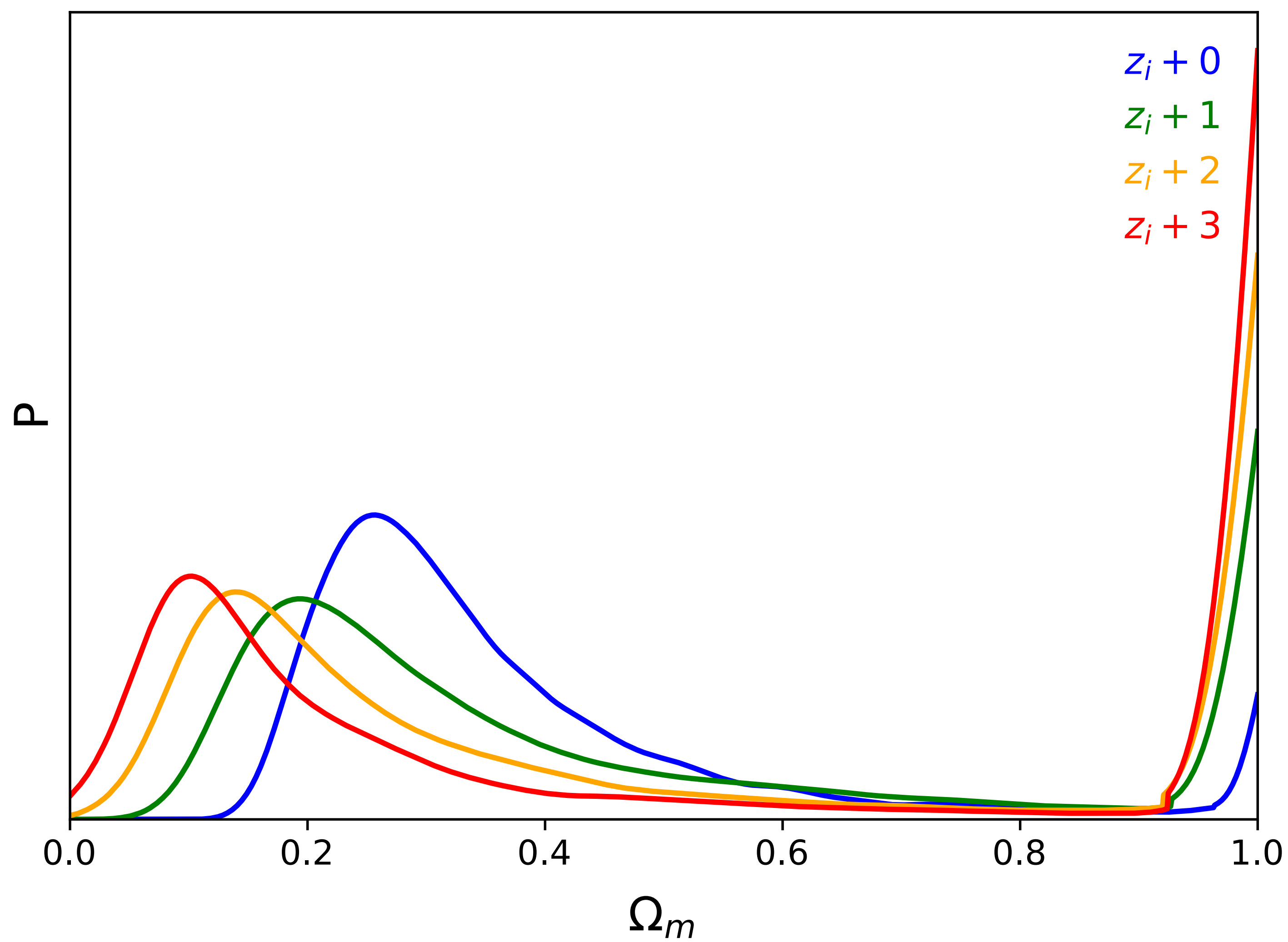
$$H_0 = 67.36 \text{ km/s/Mpc}, \quad \Omega_m = 0.315, \quad \Omega_m h^2 = 0.1430 \pm 0.0011$$



$0 \le z < 0.8$
$0.8 \le z < 1.5$
$1.5 \le z < 2.3$
$2.3 \le z < 3.6$
0
2000
4000
6000
8000
A
0.2
0.4
0.6
0.8
1.0
Ω_m
1426
1428
1430
1432
1434
1436
B
40
60
80
100
H_0

A = H_0^2-B spreads because DE is irrelevant.

If $0 \leq \Omega_m \leq 1$, mocks pile up at Ω_m=1 (due to prior) before piling up at Ω_m~0 at higher redshifts.



What about real (observed) data?

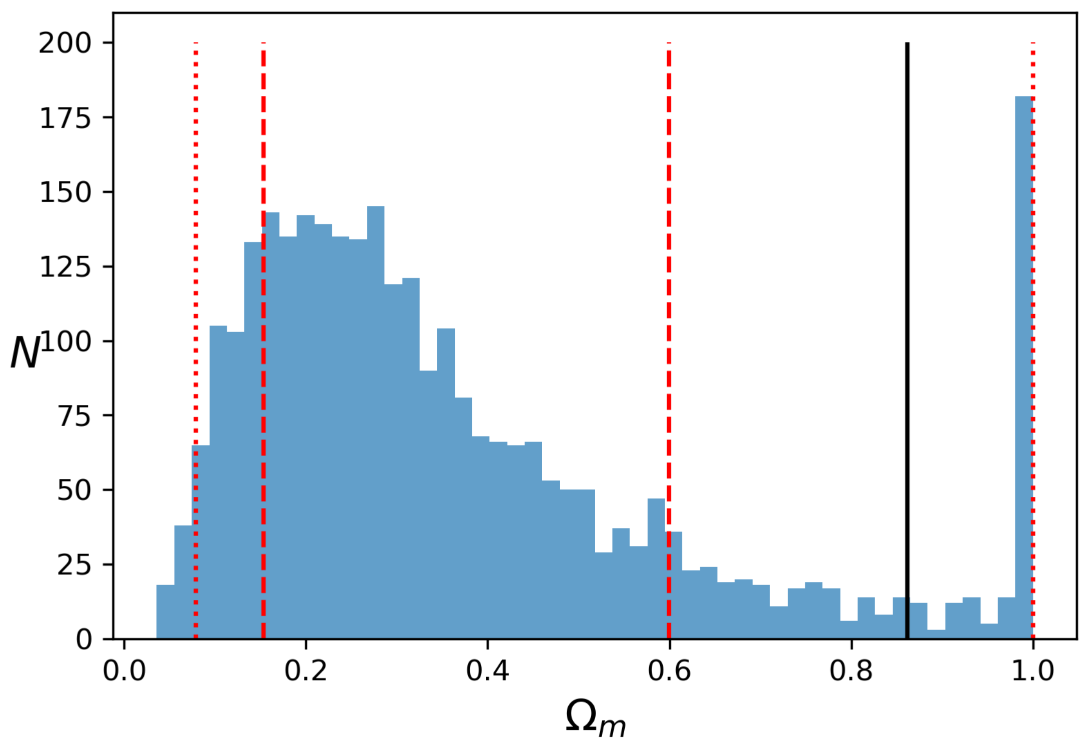
Type Ia SN, Observational Hubble Data and standardisable QSOs all show an increasing $\Omega_{\rm m}$ trend. Systematics?

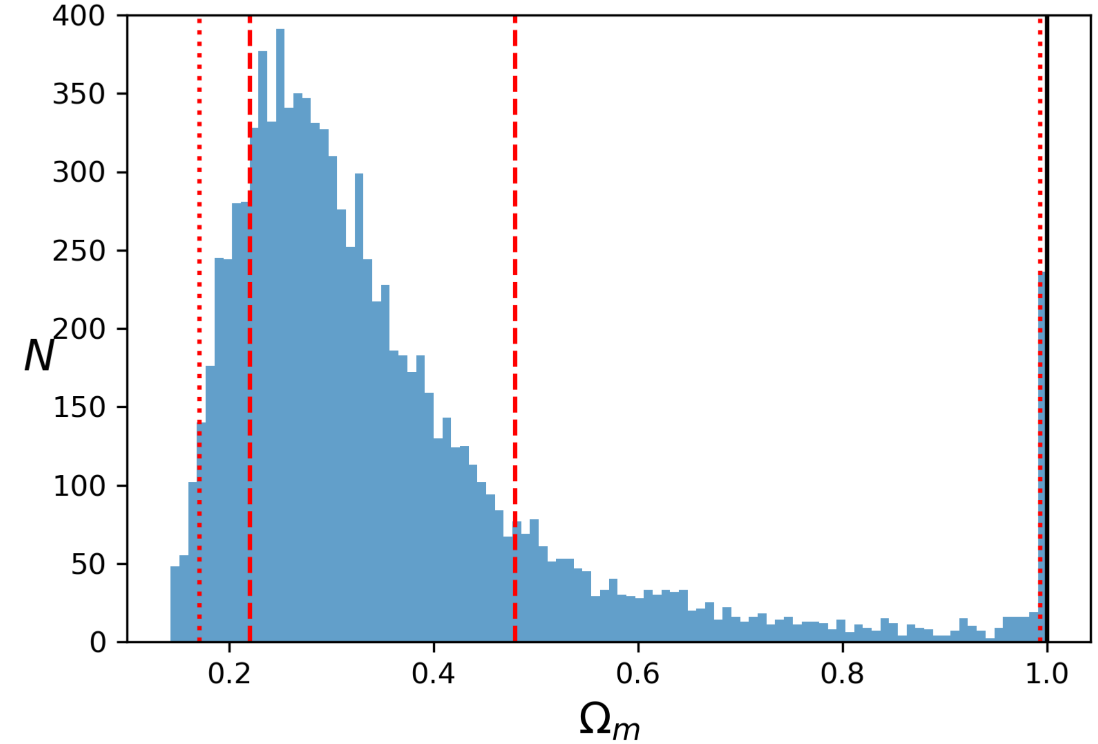
z	H_0 (km/s/Mpc)	Ω_m	Probability
$0.7 < z \leq 2.26$	64.37	0.345	0.381
$0.8 < z \leq 2.26$	58.99	0.411	0.258
$0.9 < z \leq 2.26$	45.88	0.679	0.117
$0.95 < z \leq 2.26$	40.73	0.862	0.081
$1 < z \leq 2.26$	43.16	0.768	0.170

z	H_0 (km/s/Mpc)	Ω_m	Probability
$0.5 \leq z \leq 2.36$	69.68	0.294	0.646
$0.7 \leq z \leq 2.36$	65.67	0.331	0.326
$1 \leq z \leq 2.36$	61.27	0.380	0.258
$1.2 \leq z \leq 2.36$	53.91	0.491	0.120
$1.4 \leq z \leq 2.36$	41.55	0.828	0.037
$1.45 \leq z \leq 2.36$	37.80	1	0.021
$1.5 \leq z \leq 2.36$	37.80	1	0.069

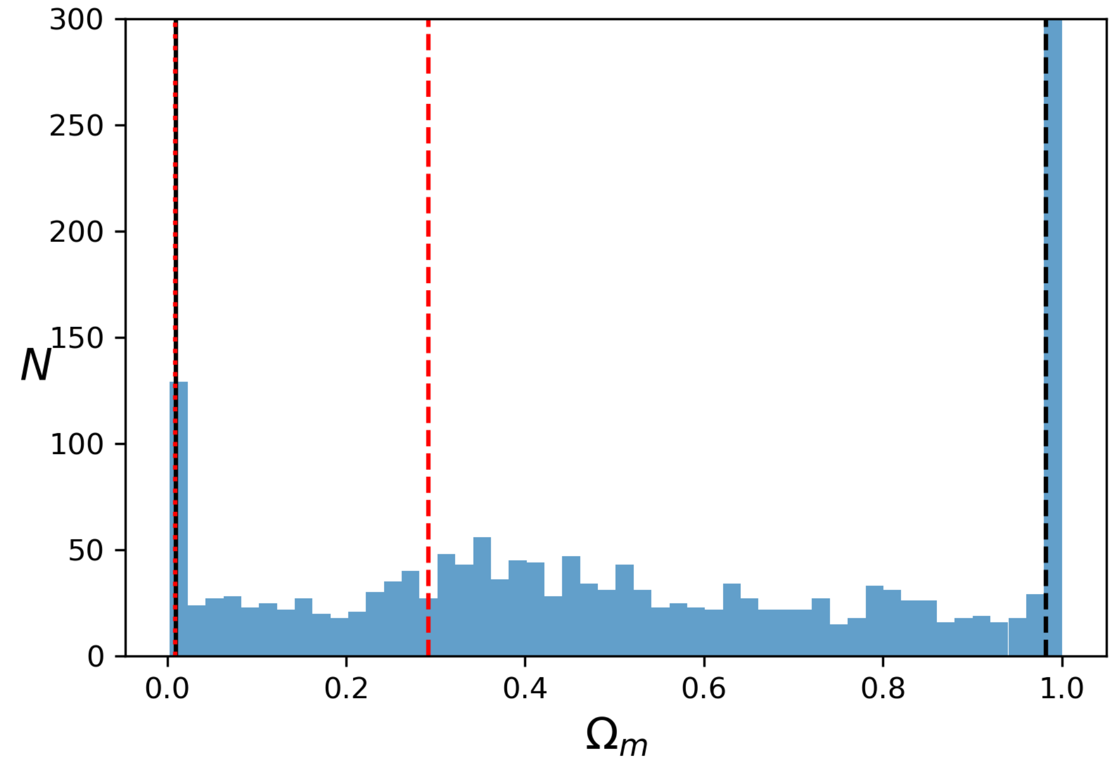
SN, OHD biased to low z, QSO biased to high z

z	H_0 (km/s/Mpc)	Ω_m	Probability
$0 < z \leq 0.3$	406.41	0.009	0.073
$0 < z \leq 0.5$	353.47	0.011	0.028
$0 < z \leq 0.55$	433.91	0.008	0.019
$0 < z \leq 0.6$	381.50	0.010	0.020
$0 < z \leq 0.7$	73.40	0.265	0.096
$0 < z \leq 0.8$	58.48	0.418	0.117
$0 < z \leq 1$	40.69	0.864	0.400





Evolution in the samples between low and high redshift at ~3**σ**



Cosmological tensions debate ASSUMES unique H_0, $S_8 \propto \sqrt{\Omega_m}$

Can now argue that $\Omega_m = 0.3$ is unlikely at some z! One can believe it (most people do), but it's a fluke.

All due to inevitable $A = H_0$^2 $(1 - \Omega_m)$ spreading.

Evolution should be expected in redshift bins.

Naturally, if confirmed, any model with evolving (constant) fitting parameters is dead.