Measuring H_0 from supernovae without anchors

Davide Piras (with Francesco Sorrenti, Ruth Durrer and Martin Kunz)

UNIVERSITÉ
DE GENÈVE

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- First time I present this work

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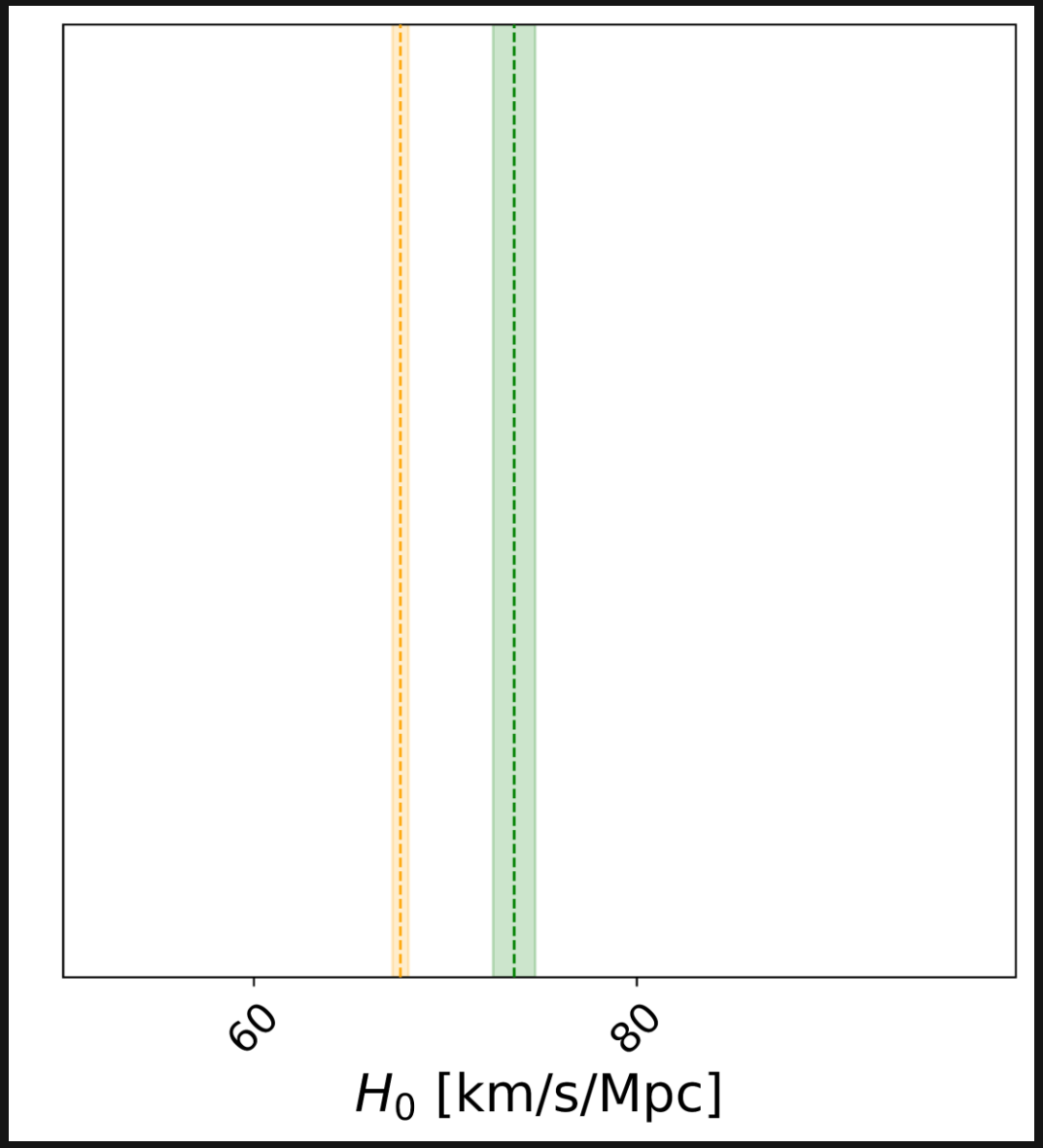
- … including jokes

In a nutshell

- There is a Hubble tension

Cosmic microwave background
Supernovae (with anchors)



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- We find ~68±10

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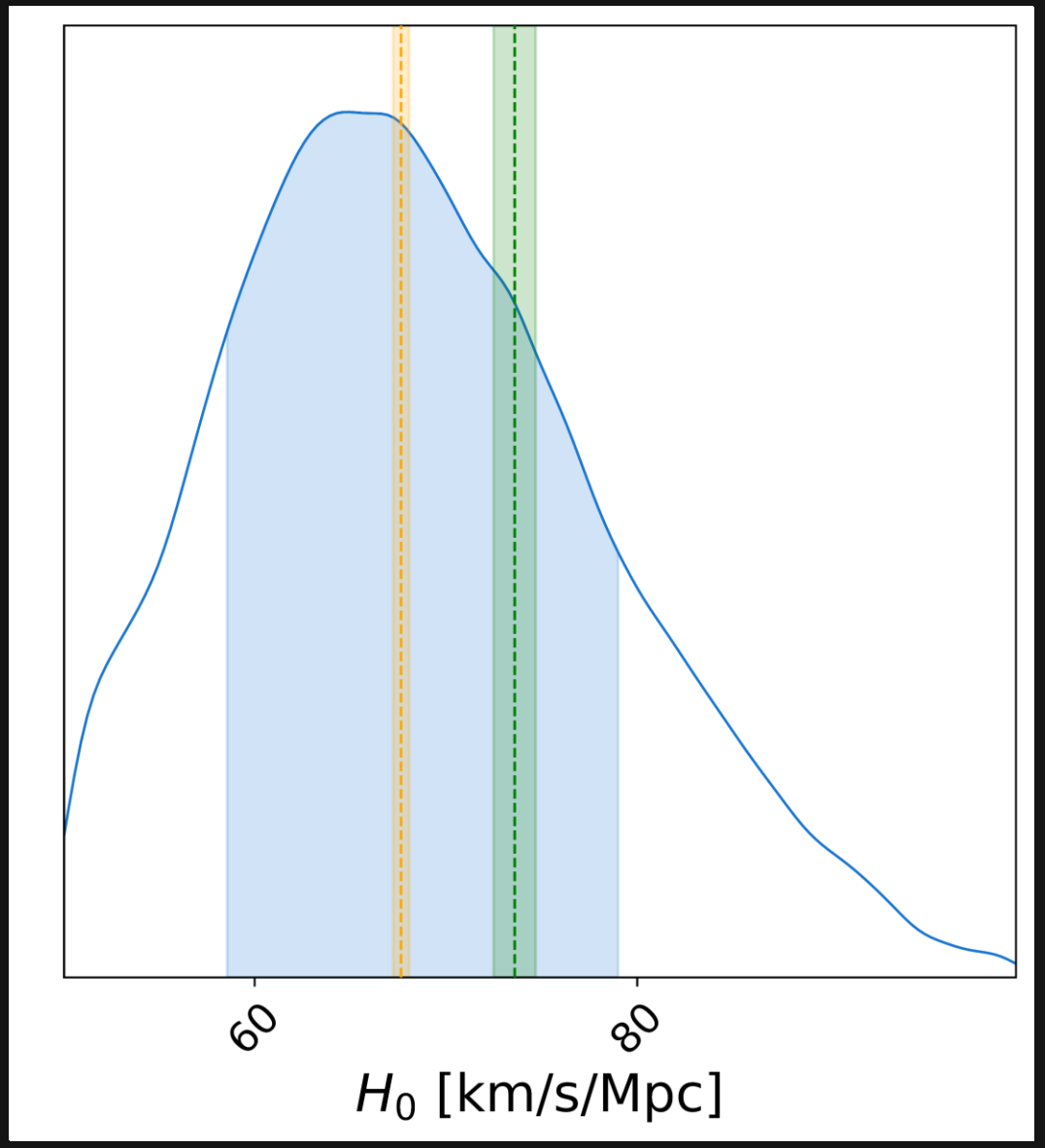

Thank you for your attention

Cast

Davide	**DAVIDE PIRAS**
Francesco	**FRANCESCO SORRENTI**
Martin	**MARTIN KUNZ**
Ruth	**RUTH DURRER**

Directed by	**DAVIDE PIRAS**
Produced by	**DAVIDE PIRAS**
Director of Photography	**DAVIDE PIRAS**

No animals were harmed in the making of this presentation

Let’s take a step back

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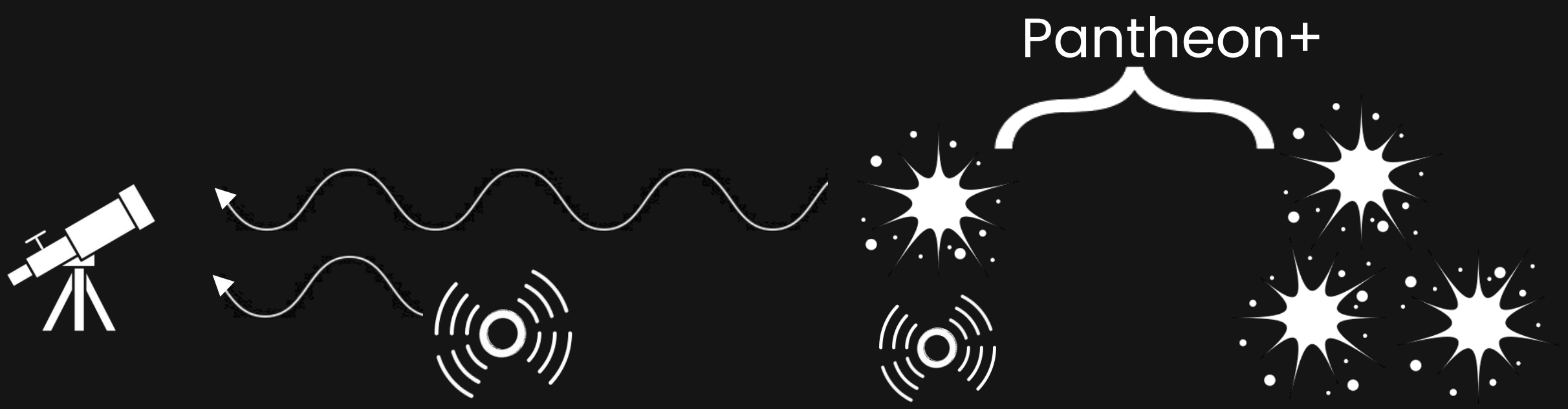

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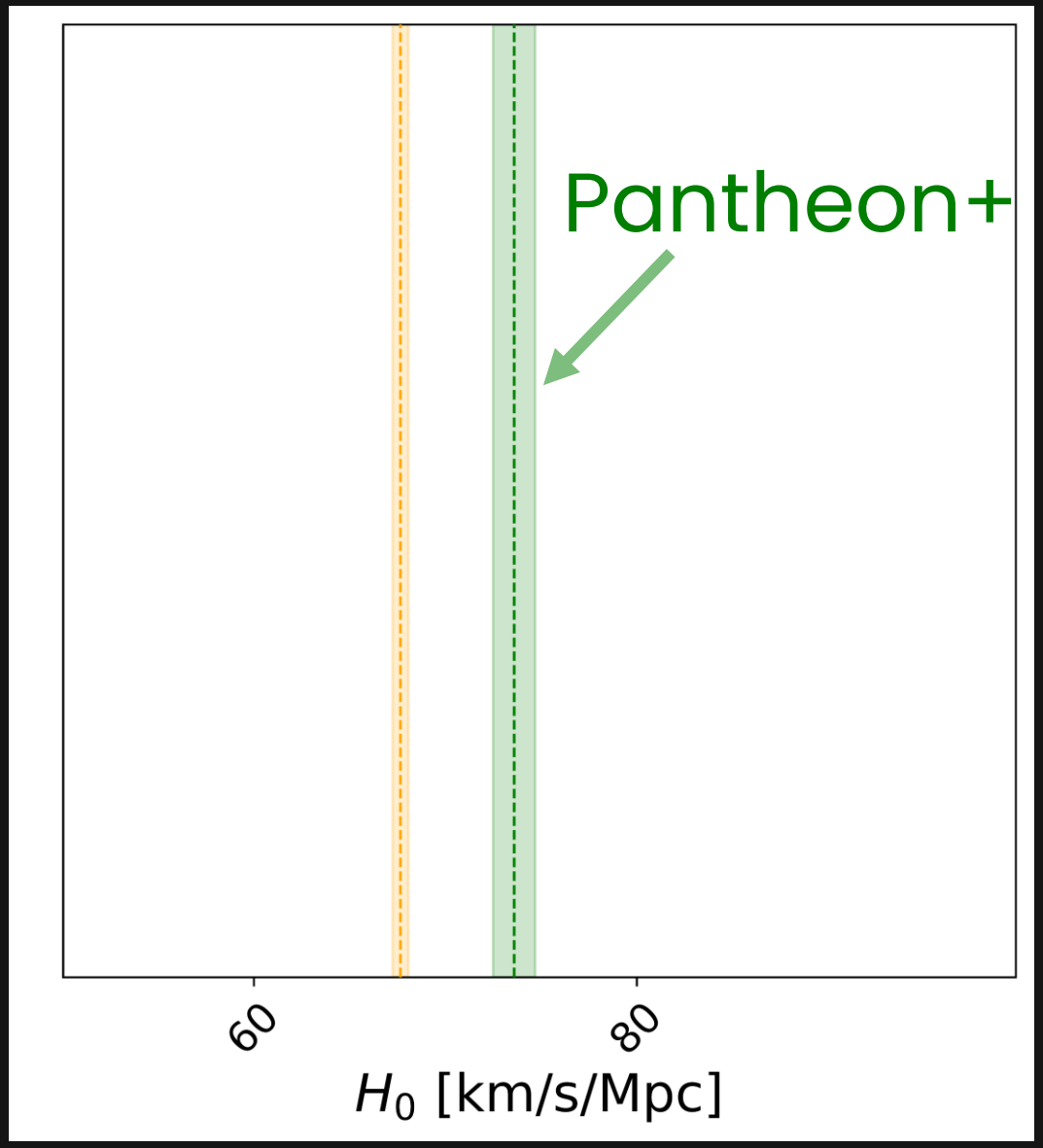
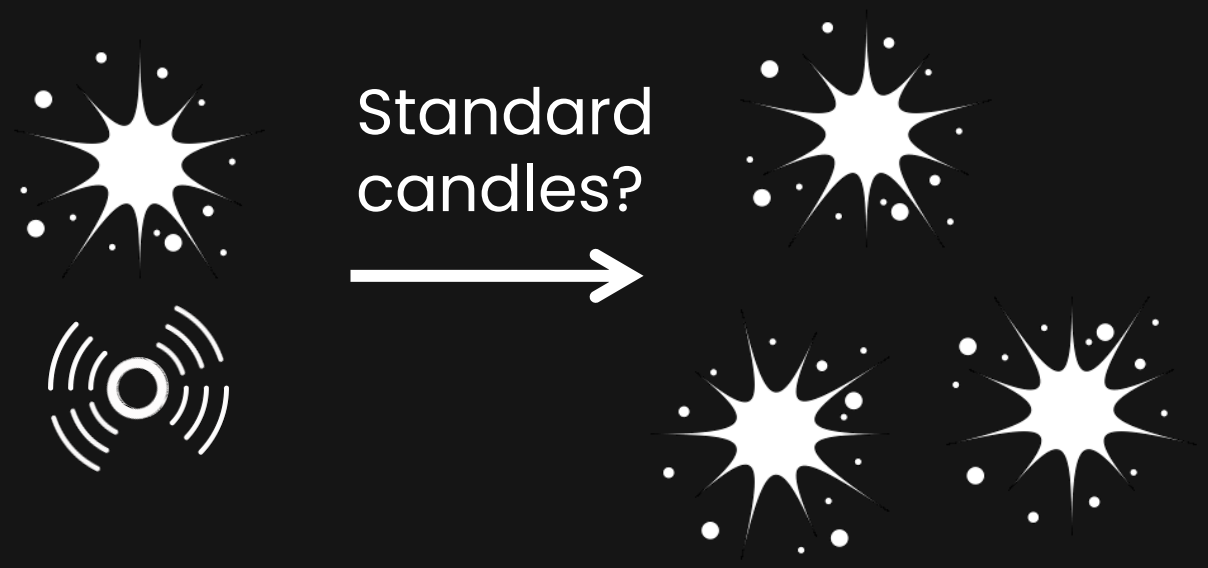


Two problems

1. Supernovae might not have all the same brightness



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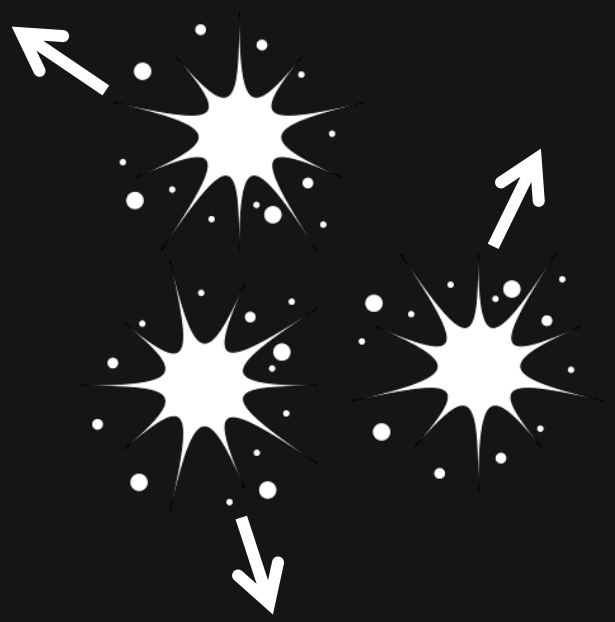
2. Supernovae have peculiar velocities (PV)



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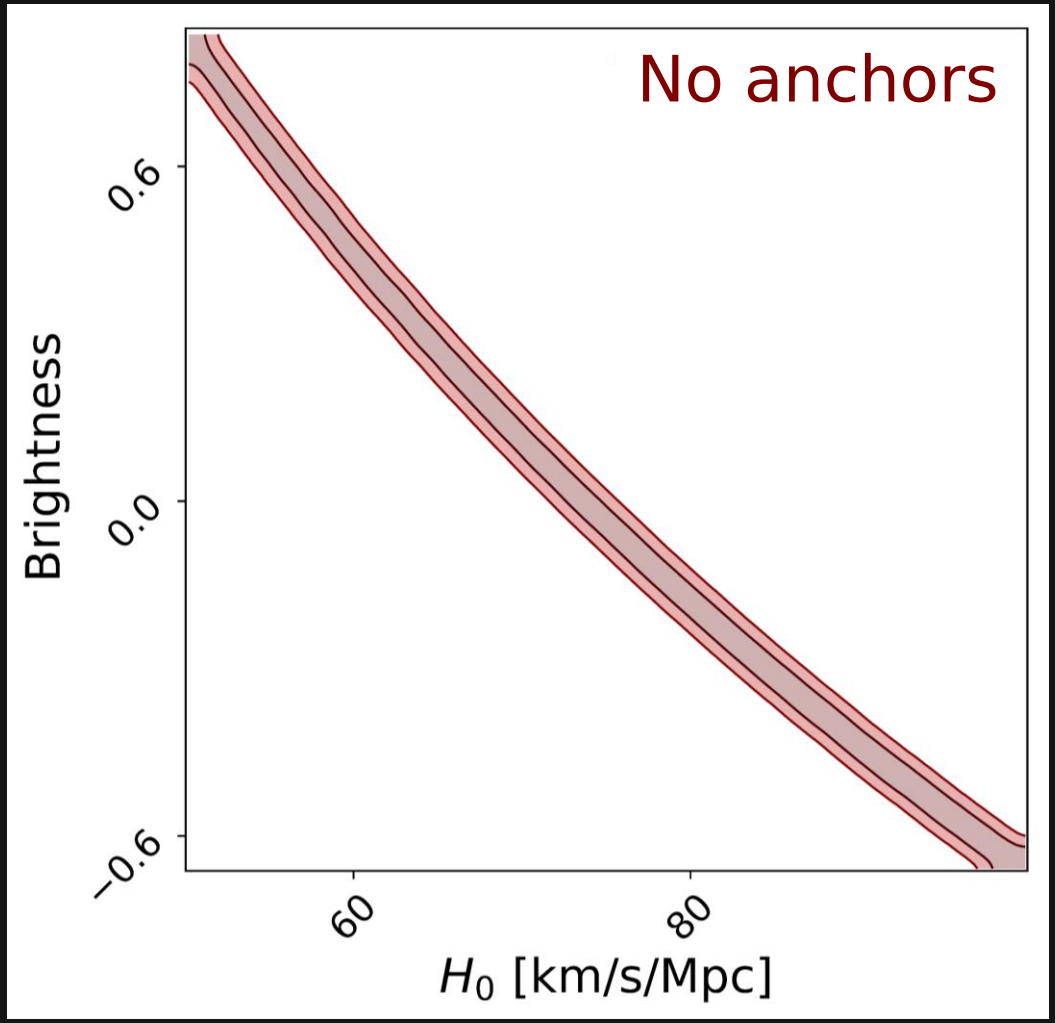
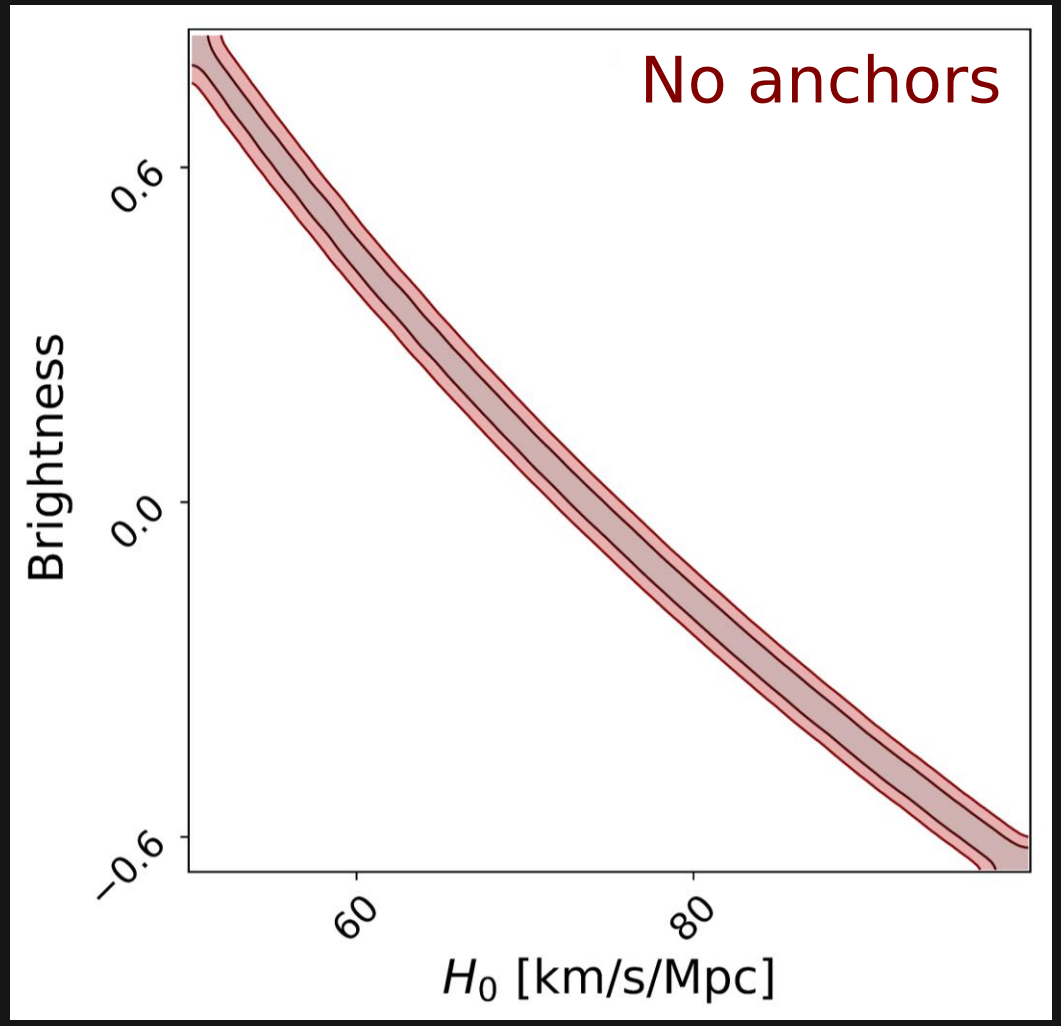


Supernovae might not have all the same brightness

- What if we let it be a free parameter?
- Brightness is perfectly degenerate with H_0!
- H_0 information must come from somewhere else…



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$$C = C_{photo} + C_{lensing} + \dots + C_{PV}$$

- C_{PV} depends on velocity power spectrum P_V
- At linear level, $P_V \propto$ matter power spectrum
- We also include nonlinear corrections

How we model peculiar velocities (PV)

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constant

$$C^{(\mathrm{v})}_{mn} = \frac{B_{mn}}{2\pi^2} \frac{D_1(z_m)\ D_1(z_n)}{D_1^2(0)} \left[\frac{H(z_m) f(z_m)}{(1+z_m)}\right] \left[\frac{H(z_n) f(z_n)}{(1+z_n)}\right]$$

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DEPENDS ON COSMOLOGY

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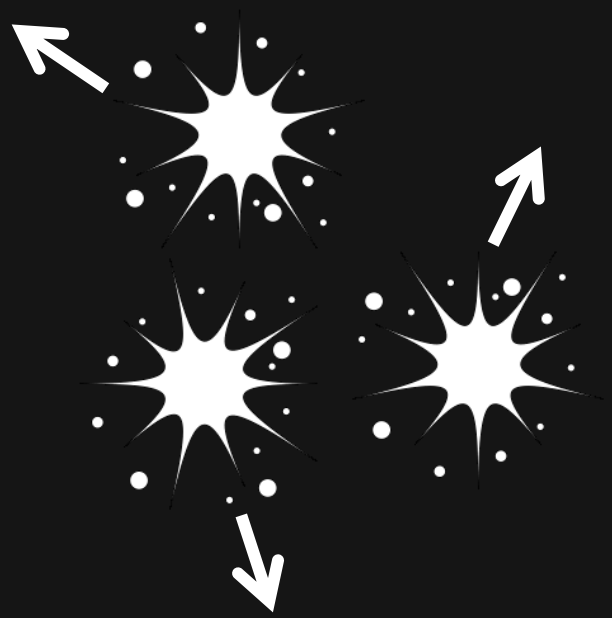

Supernovae velocities are a cosmological probe!

Did someone say computationally intractable?

$$C_{mn}^{(\mathrm{v})} = \frac{B_{mn}}{2\pi^2} \frac{D_1(z_m)\ D_1(z_n)}{D_1^2(0)} \left[\frac{H(z_m) f(z_m)}{(1+z_m)}\right] \left[\frac{H(z_n) f(z_n)}{(1+z_n)}\right]$$
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- Perform Markov chain Monte Carlo (MCMC) sampling
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- Would take 25 years to run…

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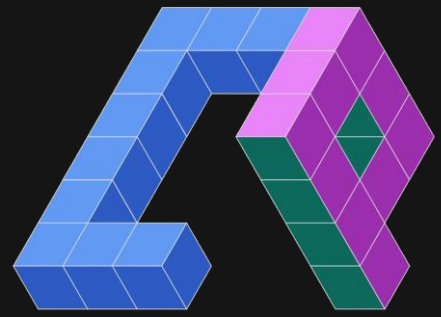
- We train an emulator based on CosmPower-JAX



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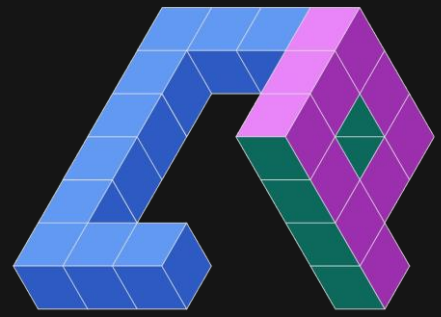

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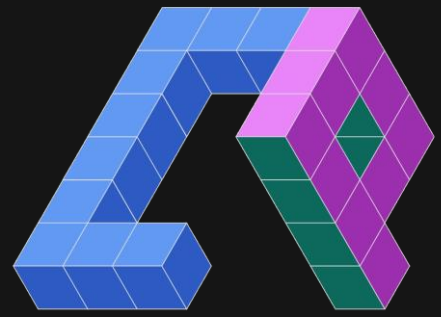
- **From 25 years on CPU to 1 hour on GPU**



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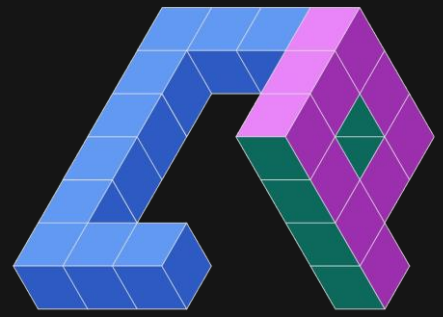
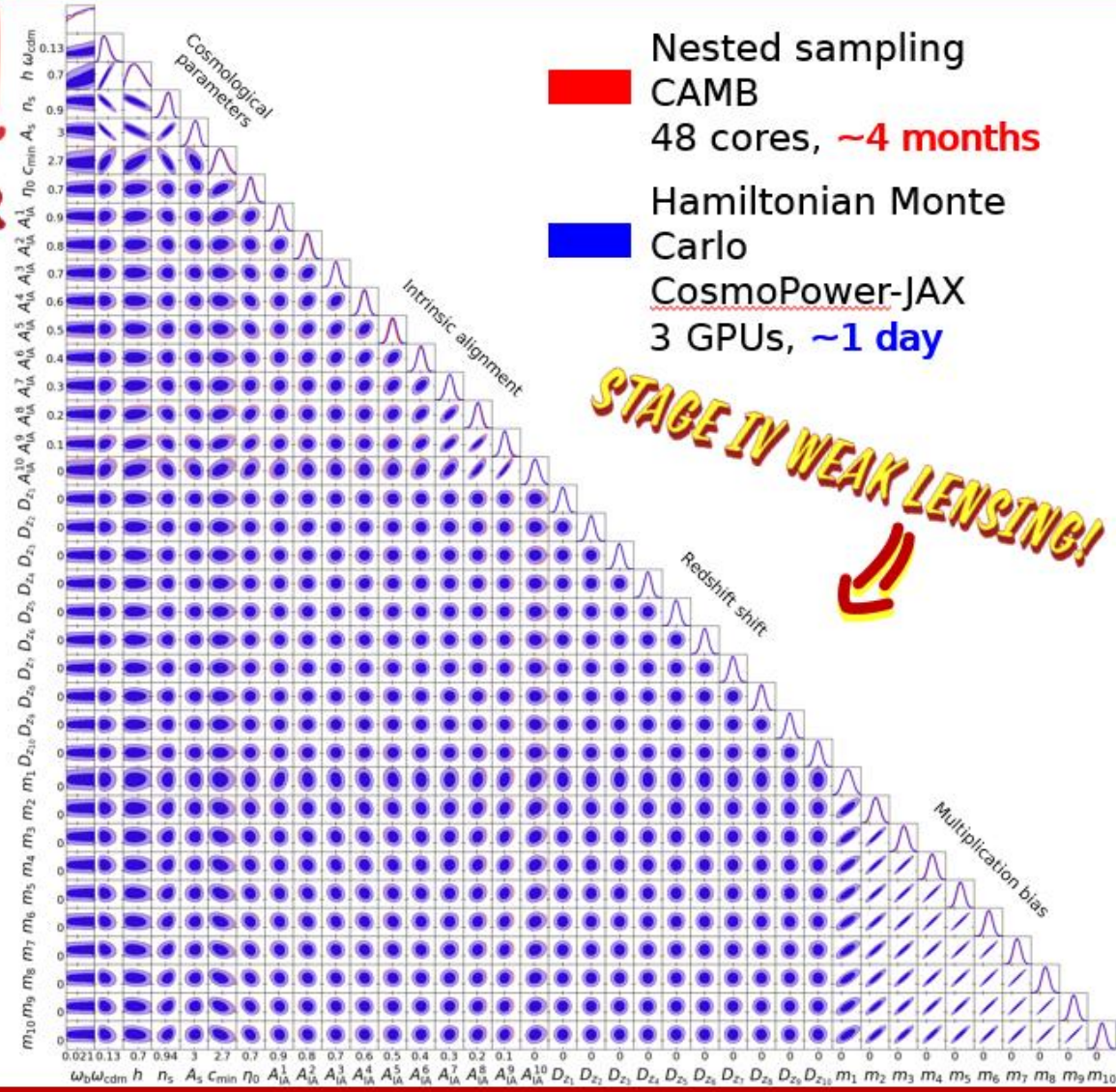


LIKELIHOOD CALL TOO SLOW? • TOO MANY PARAMETERS TO SAMPLE? • RUNNING OUT OF EXCUSES WITH YOUR SUPERVISOR?


DAVIDE PIRAS
davide.piras@unige.ch
ALESSIO SPURIO MANCINI

Better Use CosmoPower-JAX!

THE JAX VERSION OF COSMOPOWER



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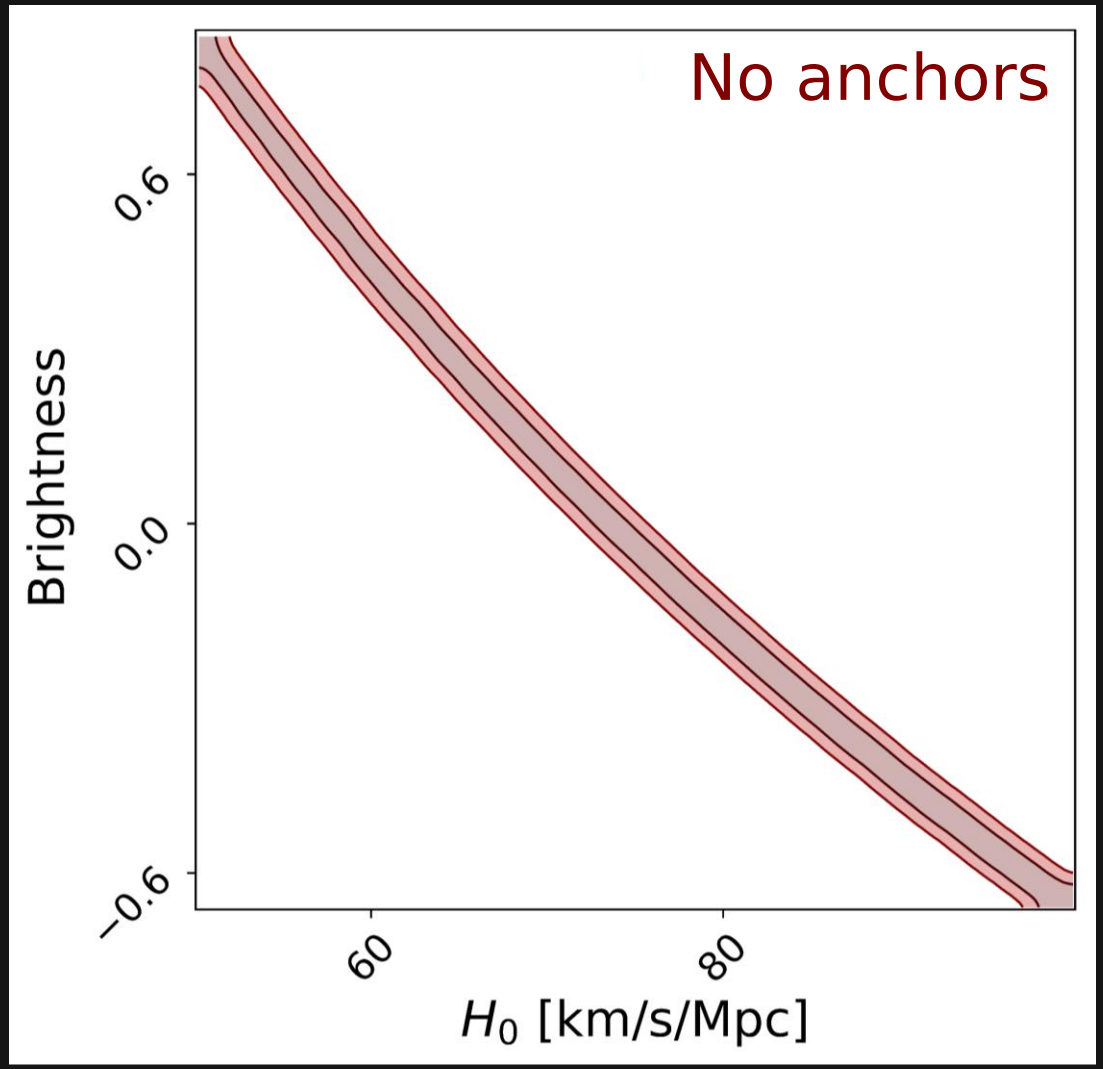
Results

- Validation on mocks and *N*-body simulation

[ask me later if interested]

Results

- Results on Pantheon+ data



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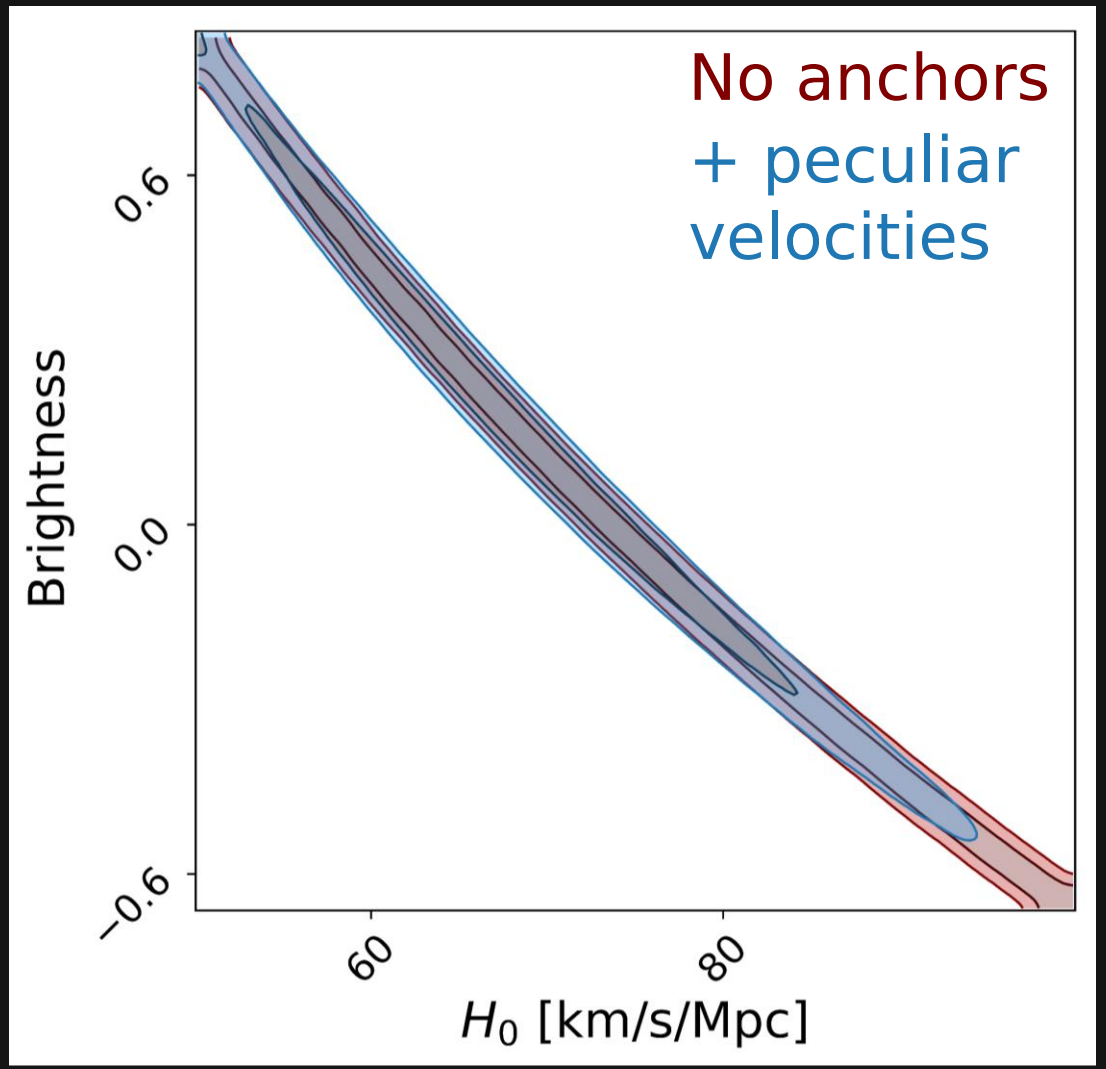
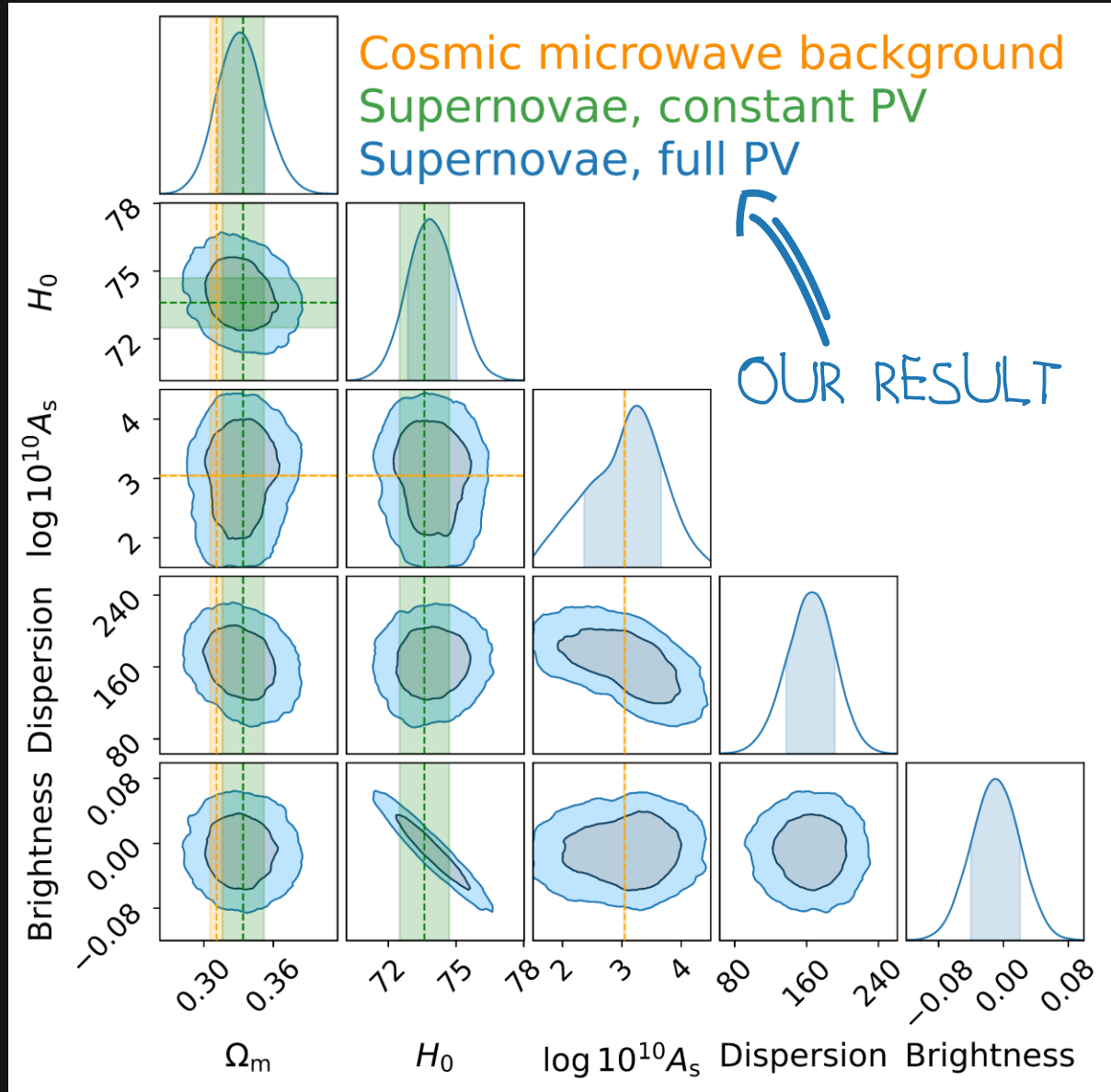
- Results on Pantheon+ data: we find ~68±10



Results

PECULIAR VELOCITIES

- PVs constrain primordial amplitude A_s (with anchors)



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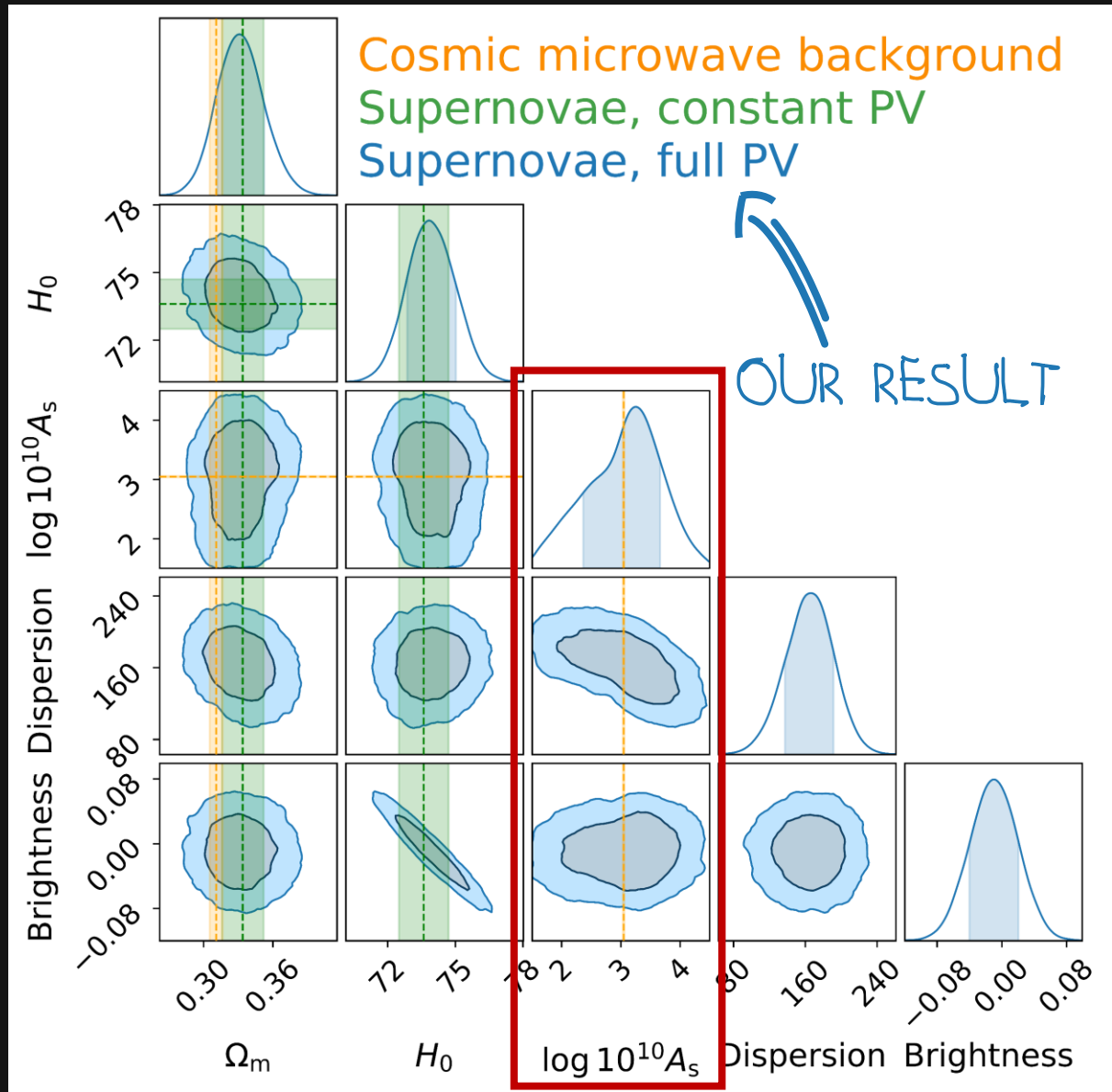

Conclusions

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- Working on Zwicky Transient Facility data next

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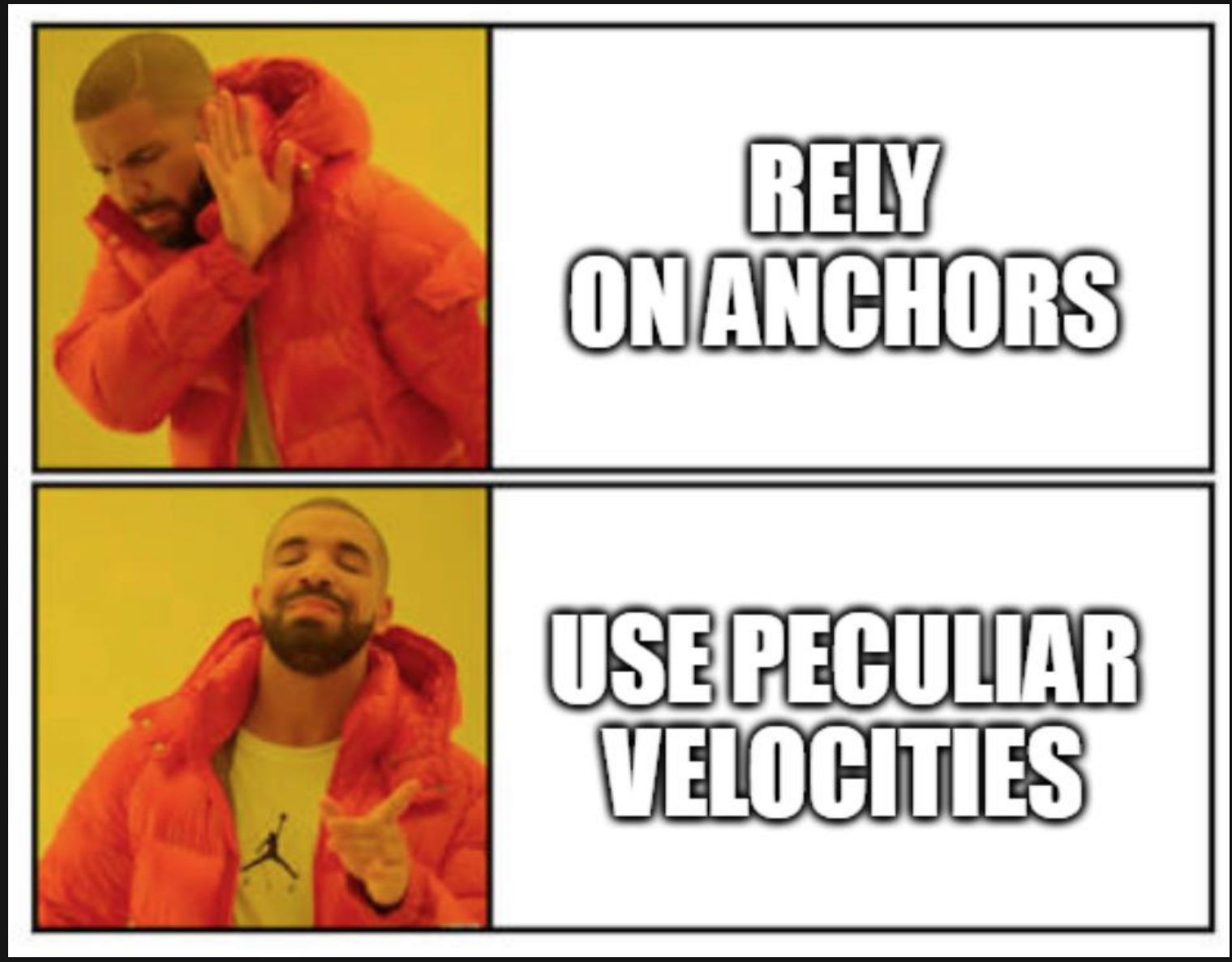
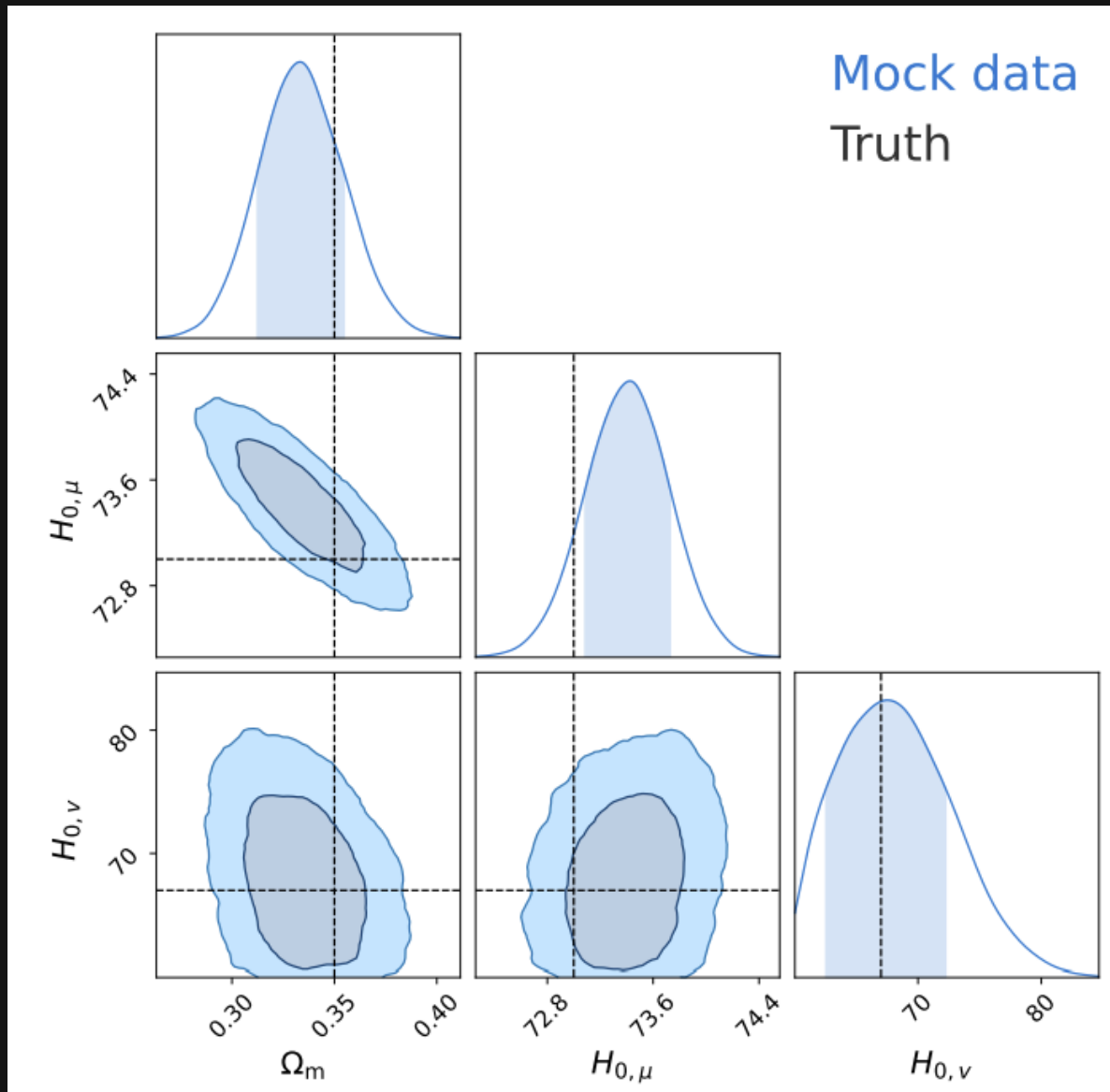
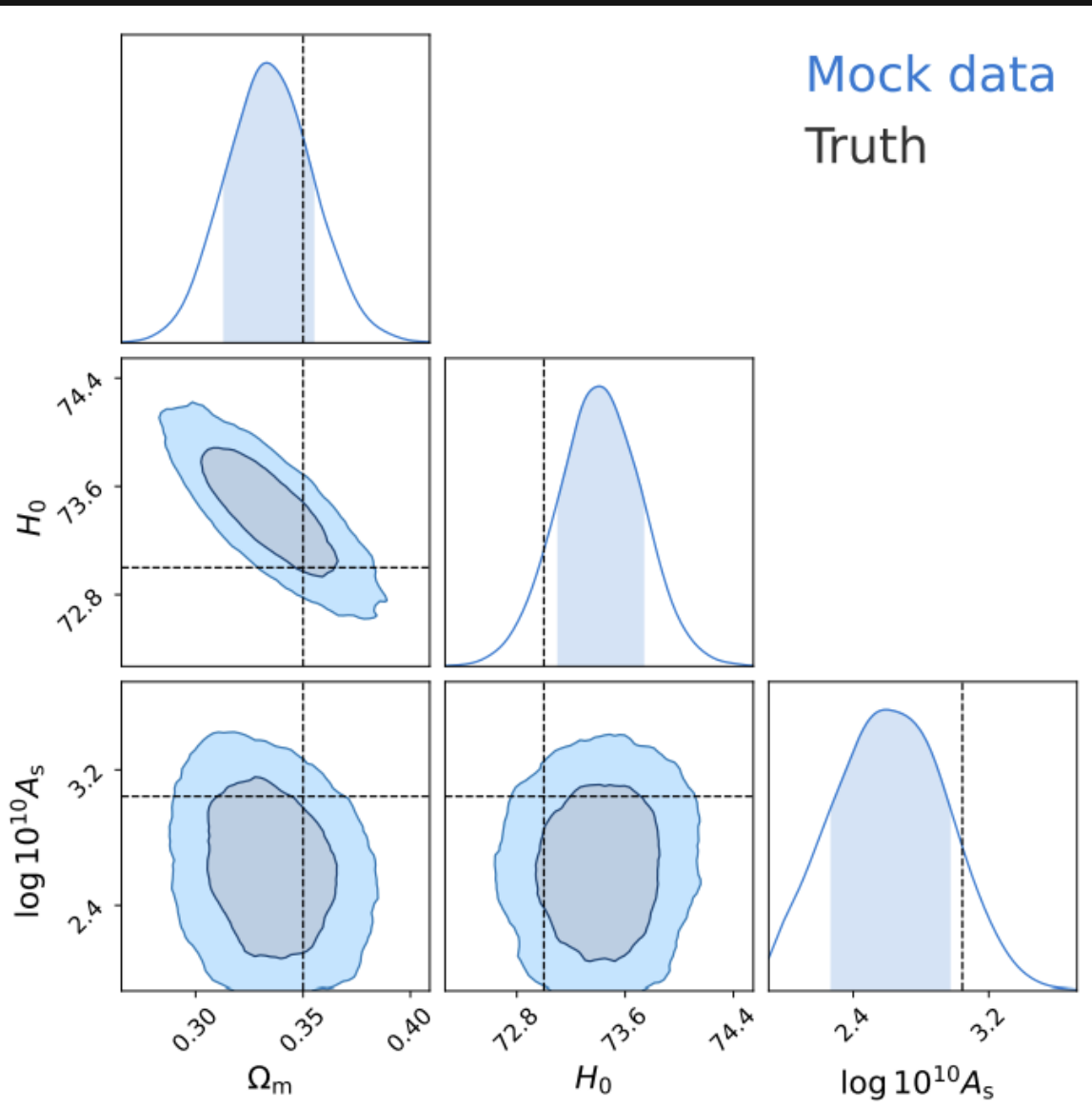


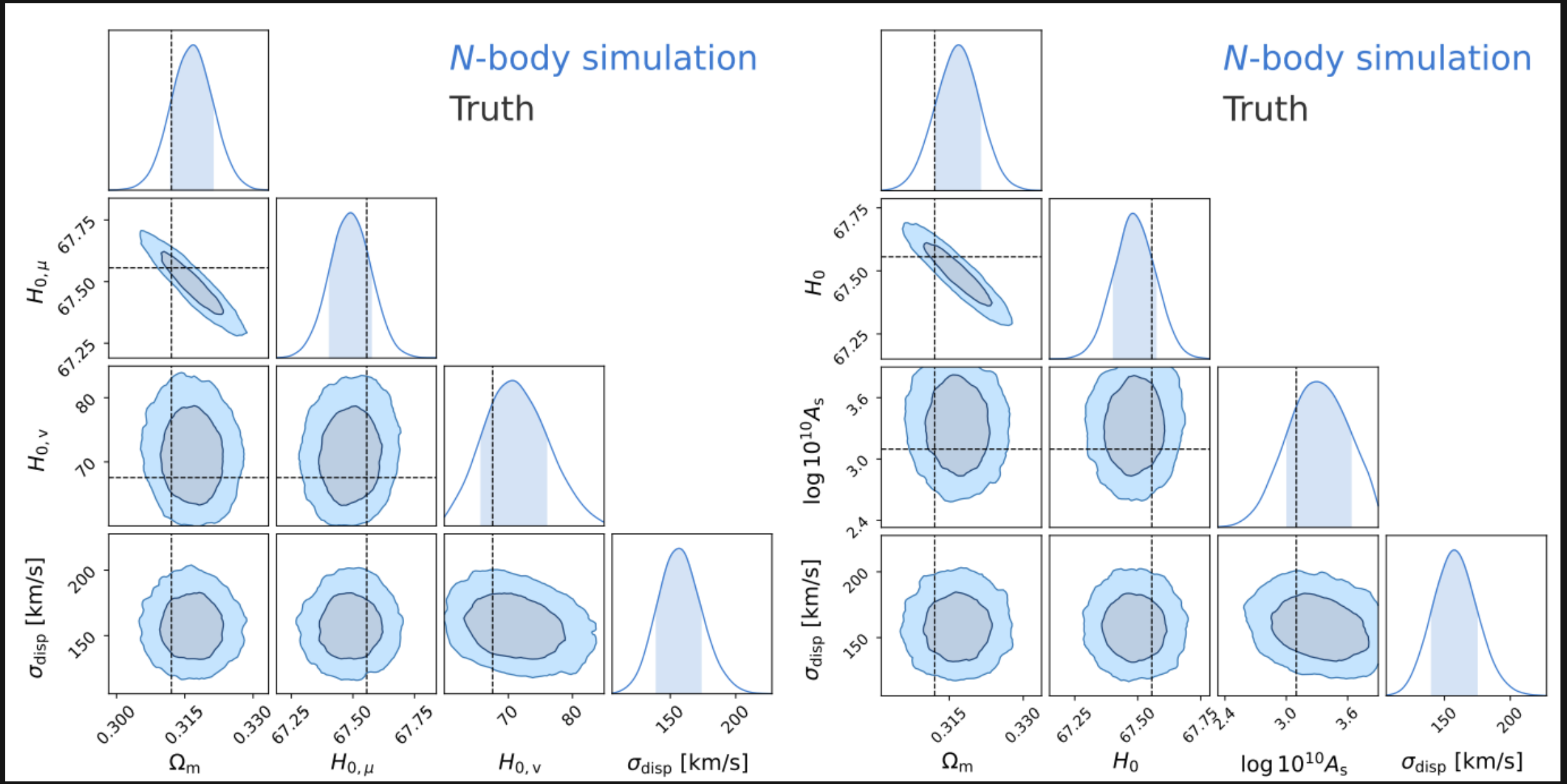
Extra slides

Mock results





N-body simulation results



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