

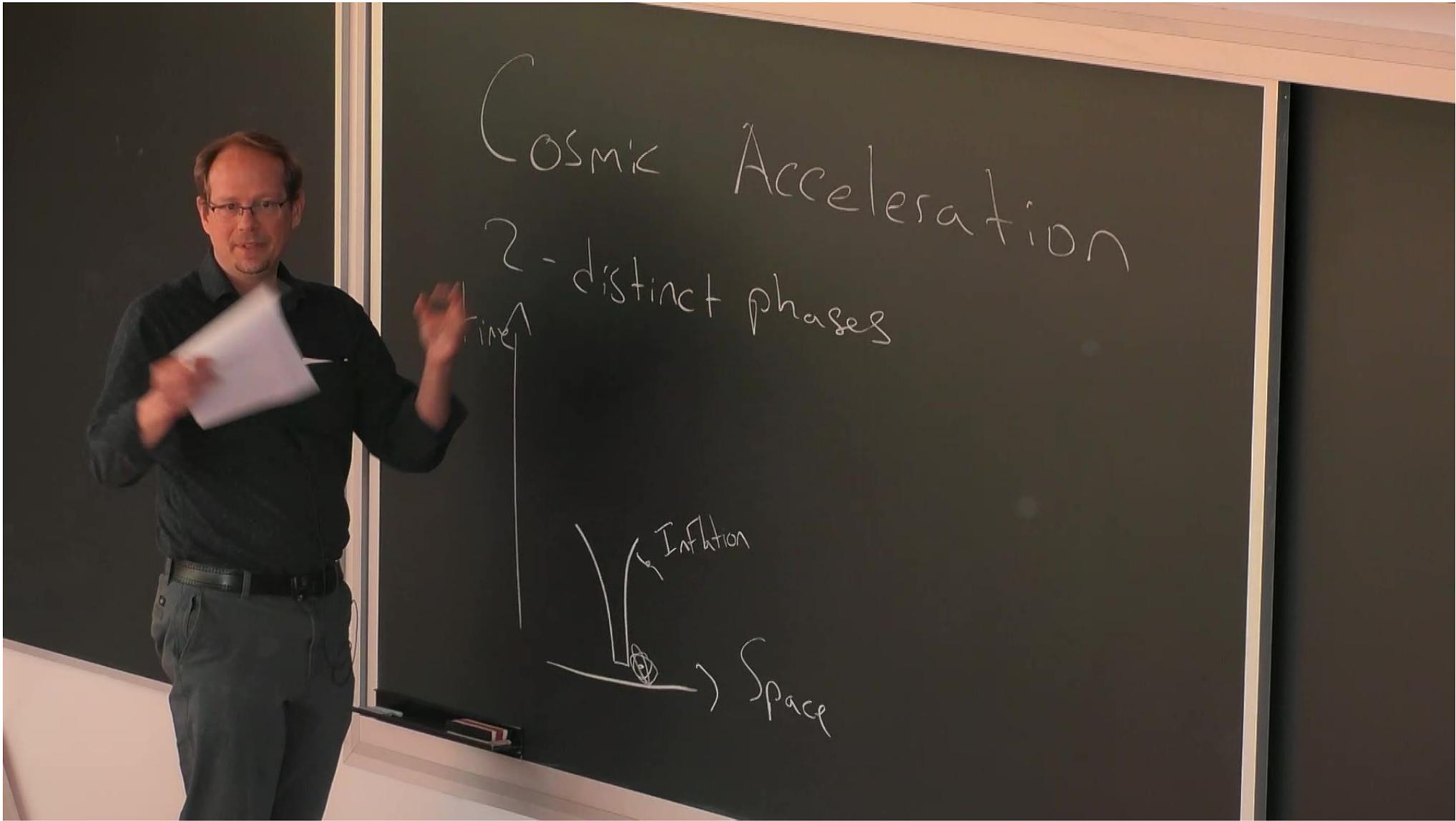
Title: Cosmology

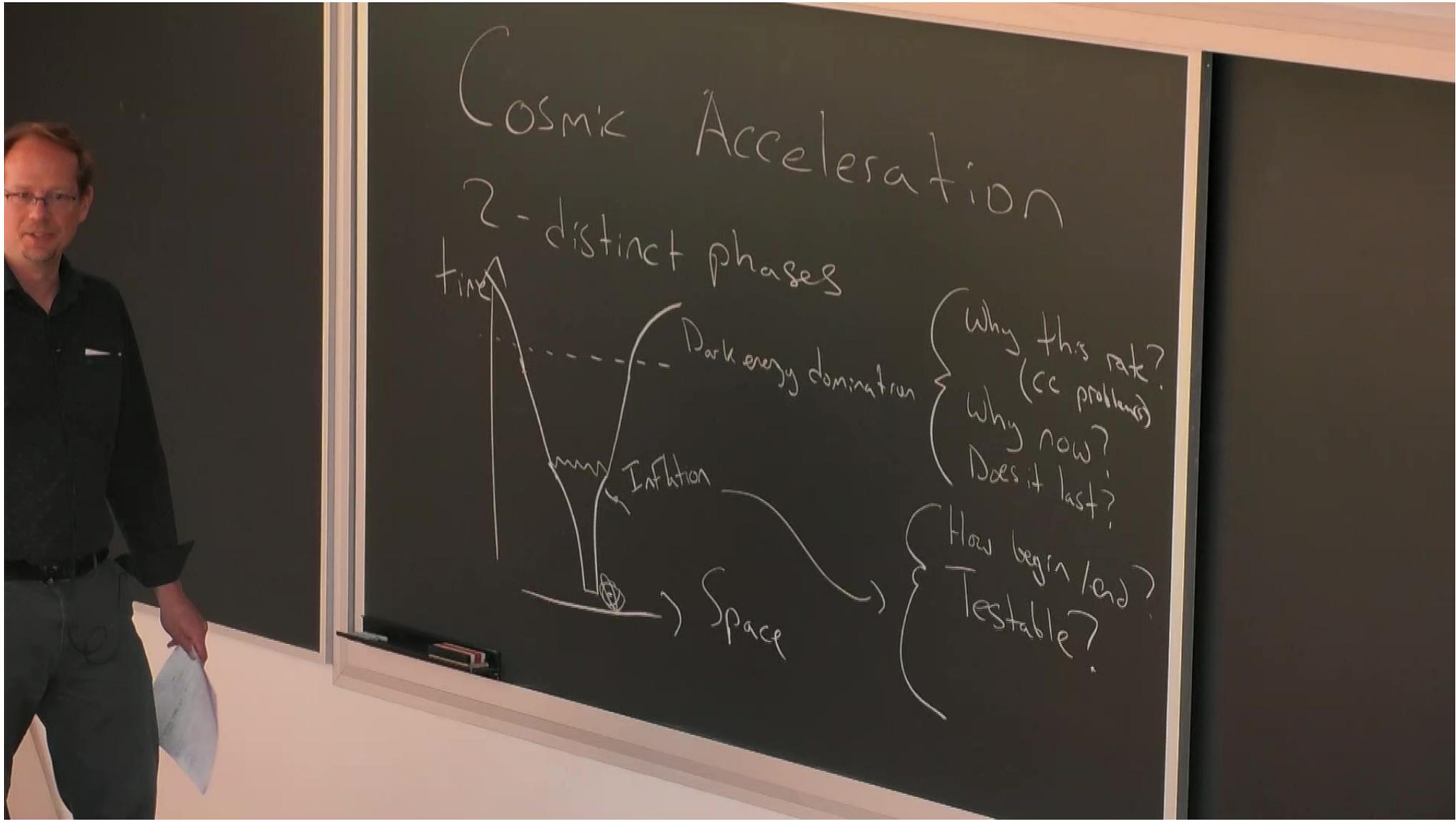
Speakers: Matthew Johnson, Jessica Muir

Collection: Scicomm Collider

Date: April 13, 2023 - 2:00 PM

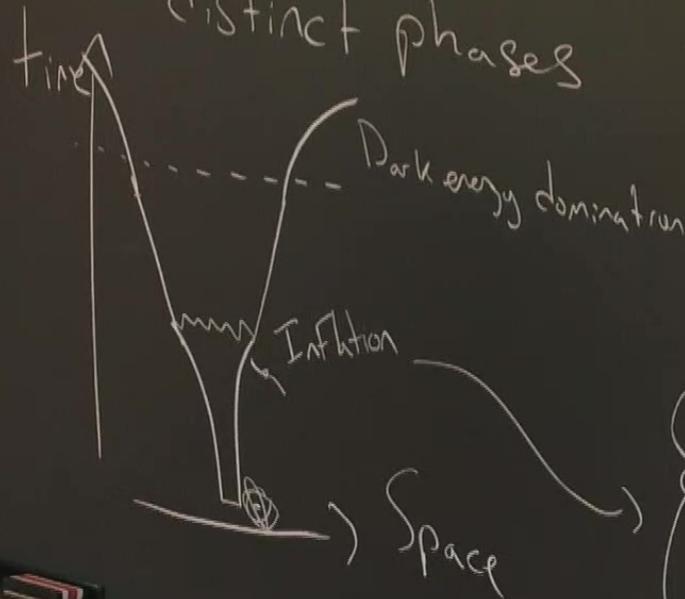
URL: <https://pirsa.org/23040098>





Cosmic Acceleration

2 - distinct phases

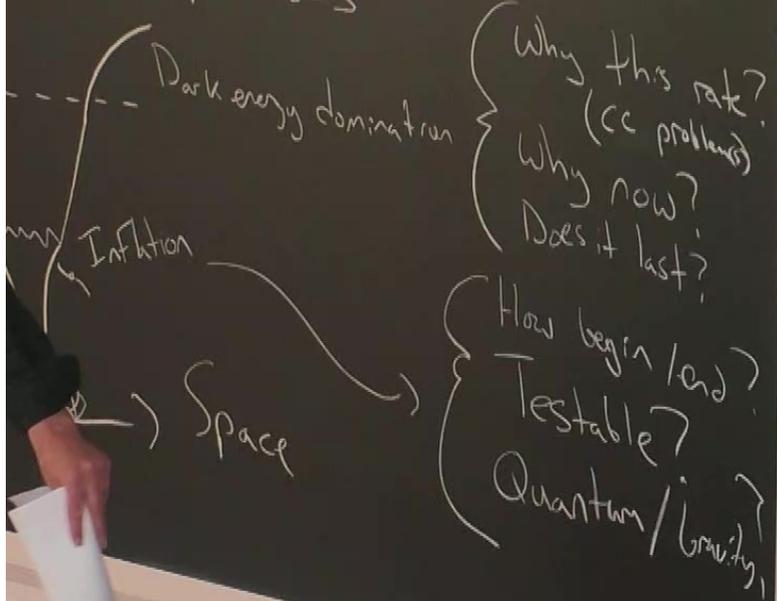


Why this rate?
(cc problems)
Why now?
Does it last?

How begin/end?
Testable?

Dark Energy Acceleration

distinct phases



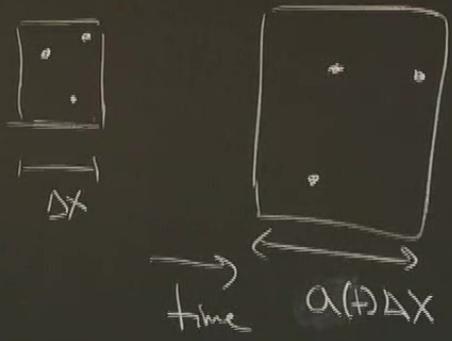
① What causes it?

② Begin/end?

③ Implications/Puzzles.

④ Model - $\Omega_{\text{ML}} = 8\pi G_N T_{\text{ML}}$
↑
Curvature
(how universe expands)

uses it?
 end?
 ans/Puzzles.

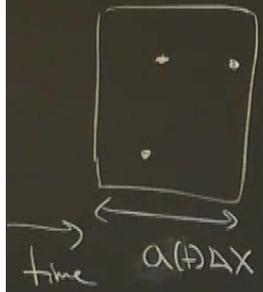


$$G_{MD} = 8\pi G_N T_{MD}$$

\uparrow Curvature
 (how universe expands)
 Symmetric

\leftarrow Matter + Energy
 \leftarrow Newton's Constant

Normal stuff dilutes
 \rightarrow Decelerating (universes)
 Acceleration \rightarrow Non-diluting



Normal stuff
 → Decelerating
 acceleration → Non-d
 $a(t) = e^{Ht}$

Non-dynamical Stuff

2	2	2	2
2	2	2	2
2	2	2	
2	2	2	

Not GR.

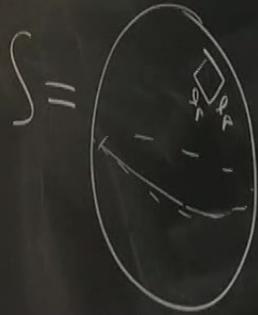
Scalar field
 Non-dynamical
 Λ - Cosm. Const.
 Dynamical - Inflaton
 Quintessence

Quantum \rightarrow Cosmos.

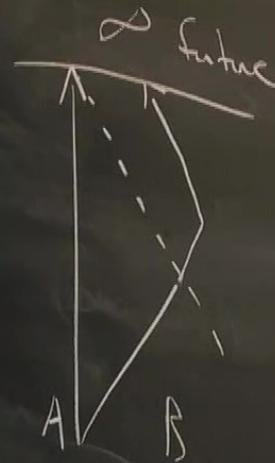
Seeds for structure \rightarrow Inflation.

Event Horizon.

Entropy



$$S =$$



$$\sim \# \text{ DOF}$$

Quantum \rightarrow Cosmos

Seeds for structure \rightarrow Inflation

horizon

\rightarrow # bits

$\sim 100 \text{ Tb}$

$T \sim 10^{25} \text{ K}$

$S_p \sim 1 \text{ ppm}$



DARK ENERGY
SURVEY

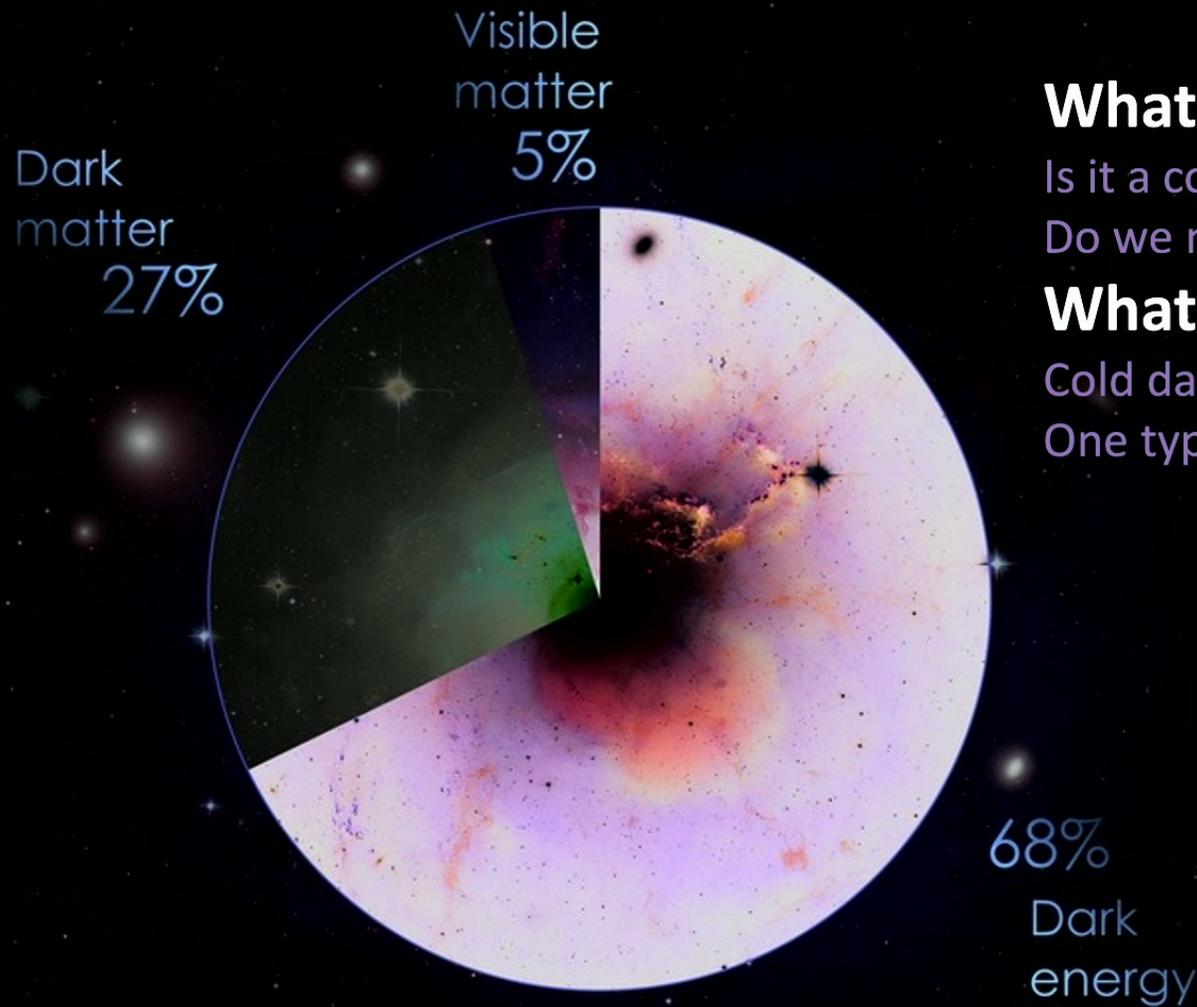
Confronting models with measurements

Researcher talk – Scicomm Collider – Perimeter Institute

Jessie Muir - Postdoctoral Fellow @ Perimeter Institute

April 13, 2023





What is dark energy?

Is it a cosmological constant?

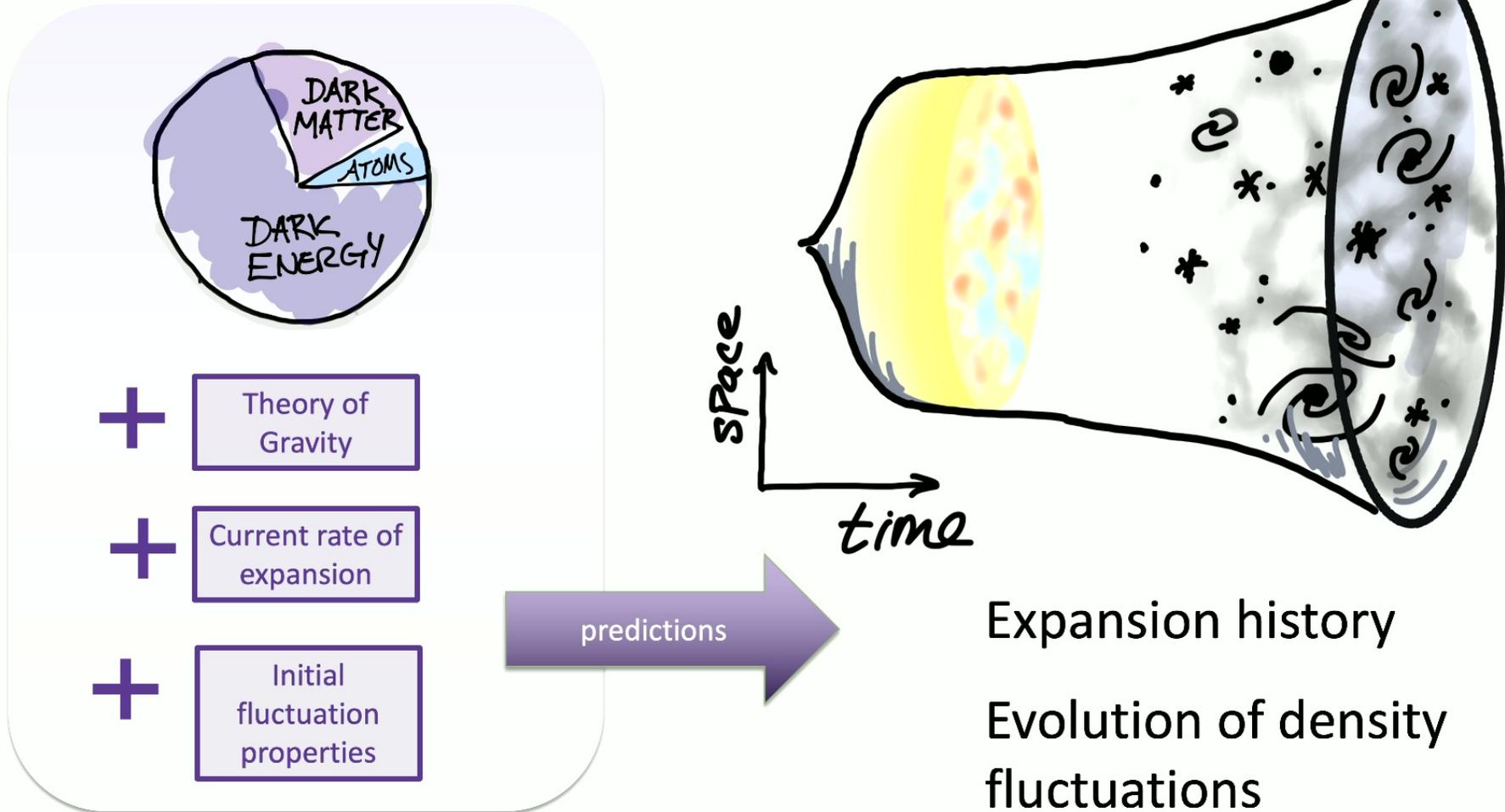
Do we need to extend general relativity?

What is dark matter?

Cold dark matter? Axions?

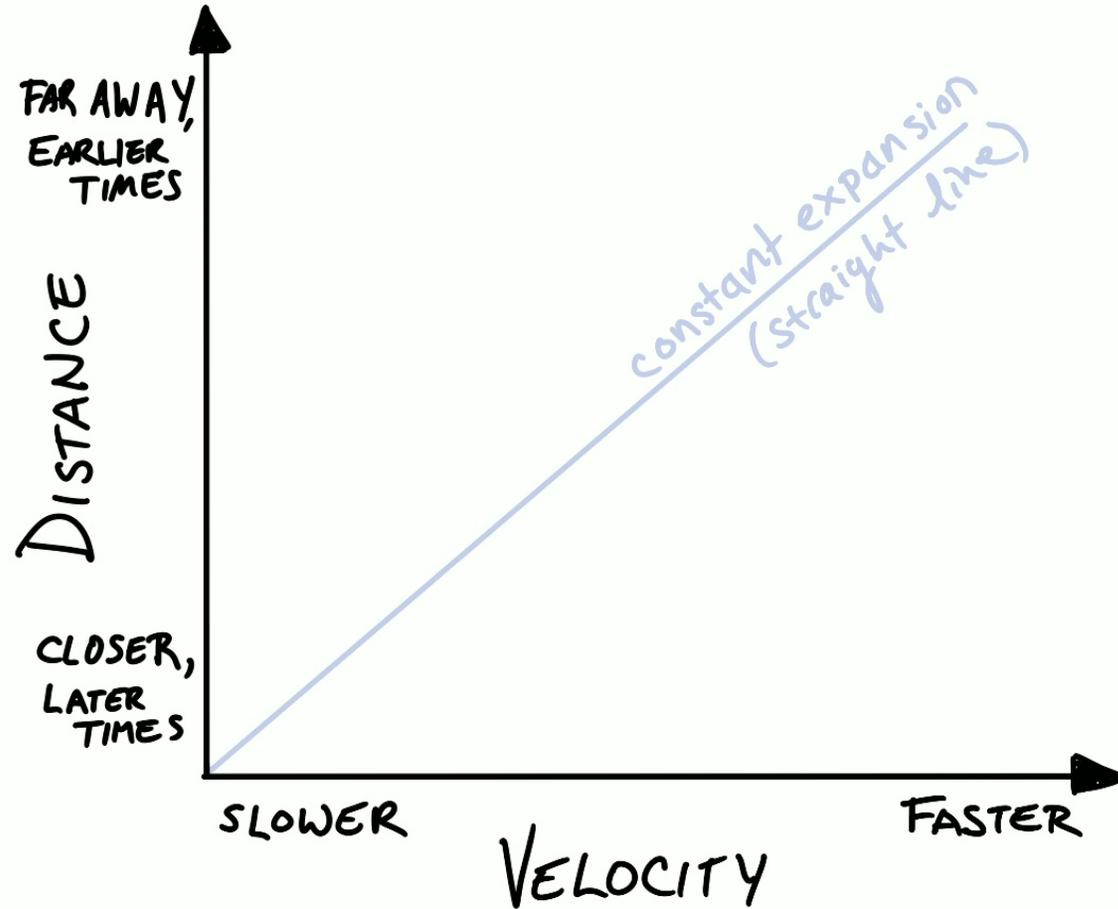
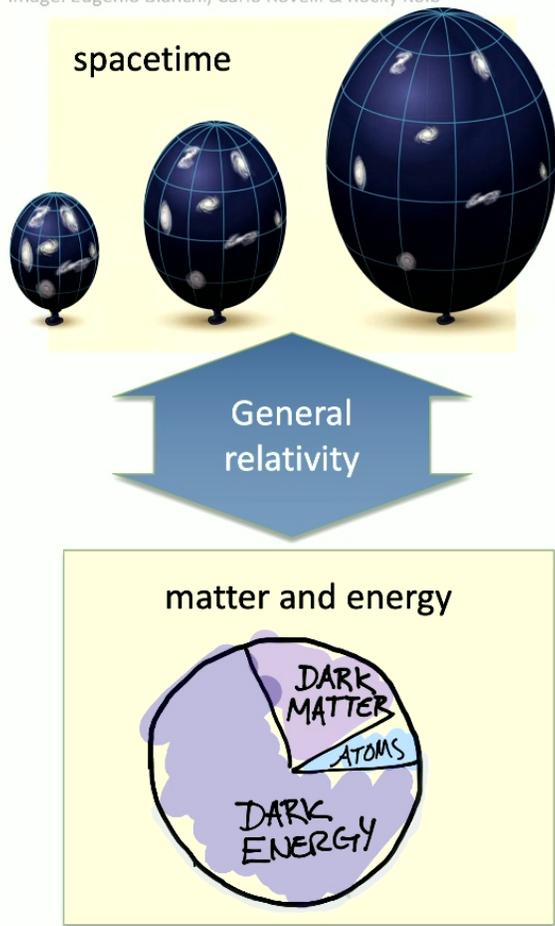
One type of particle? More?

Broadly speaking, we can measure two things.



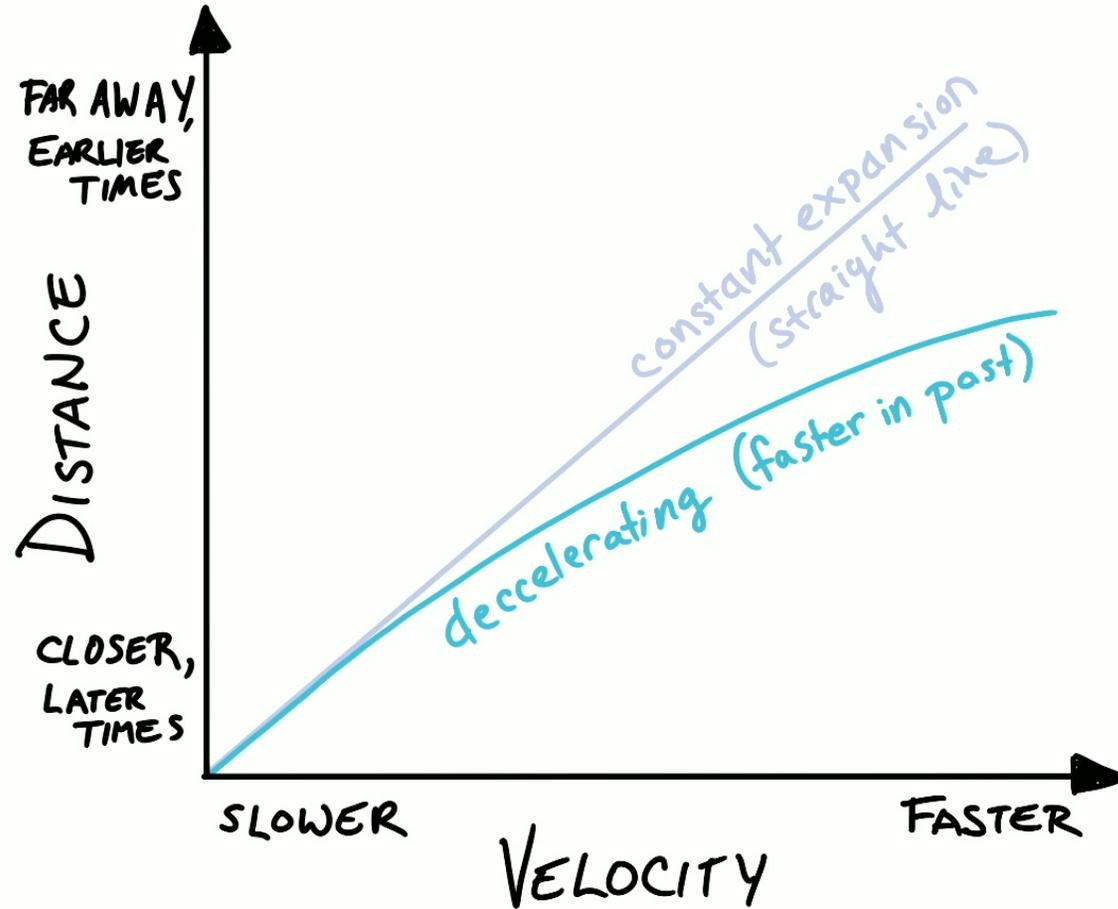
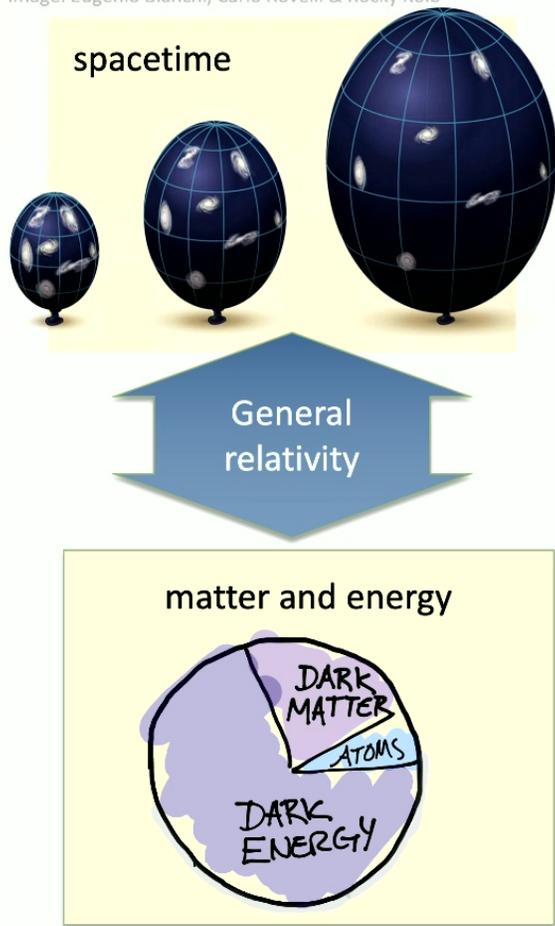
Expansion

Image: Eugenio Bianchi, Carlo Rovelli & Rocky Kolb



Expansion

Image: Eugenio Bianchi, Carlo Rovelli & Rocky Kolb



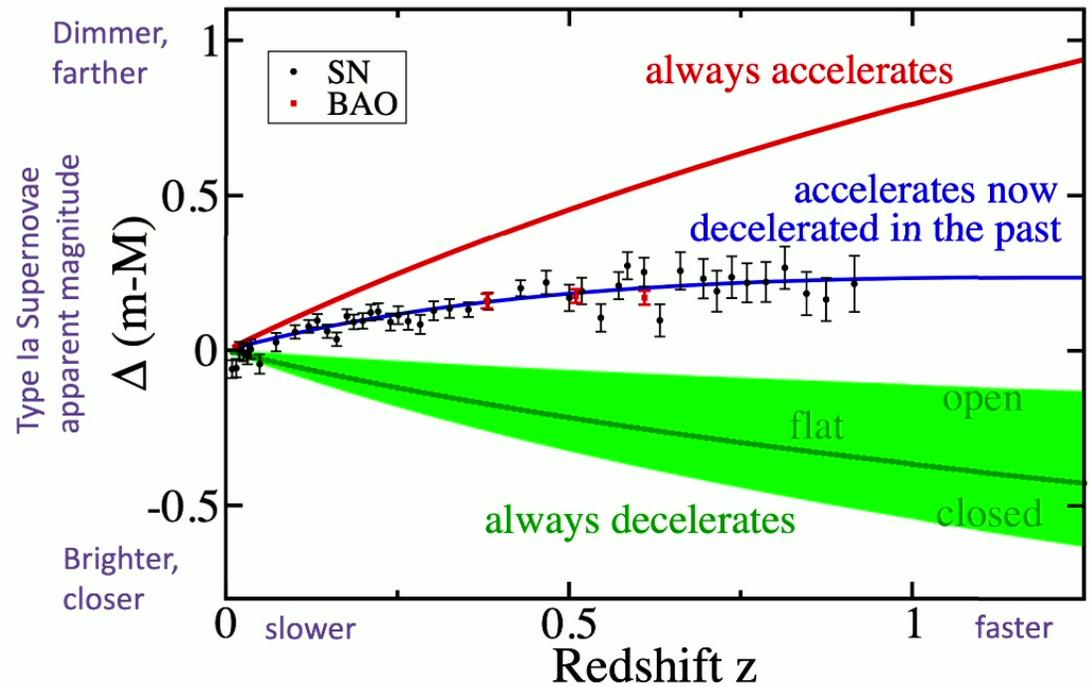
Expansion is probed with distance measurements

Standard(izable) candles: Type Ia Supernovae

Standard ruler: BAO, characteristic size of feature in galaxy distribution



Image: NASA



Huterer & Schafer, Rept.Prog.Phys. 2018, arXiv:1709.01091

Structure Growth

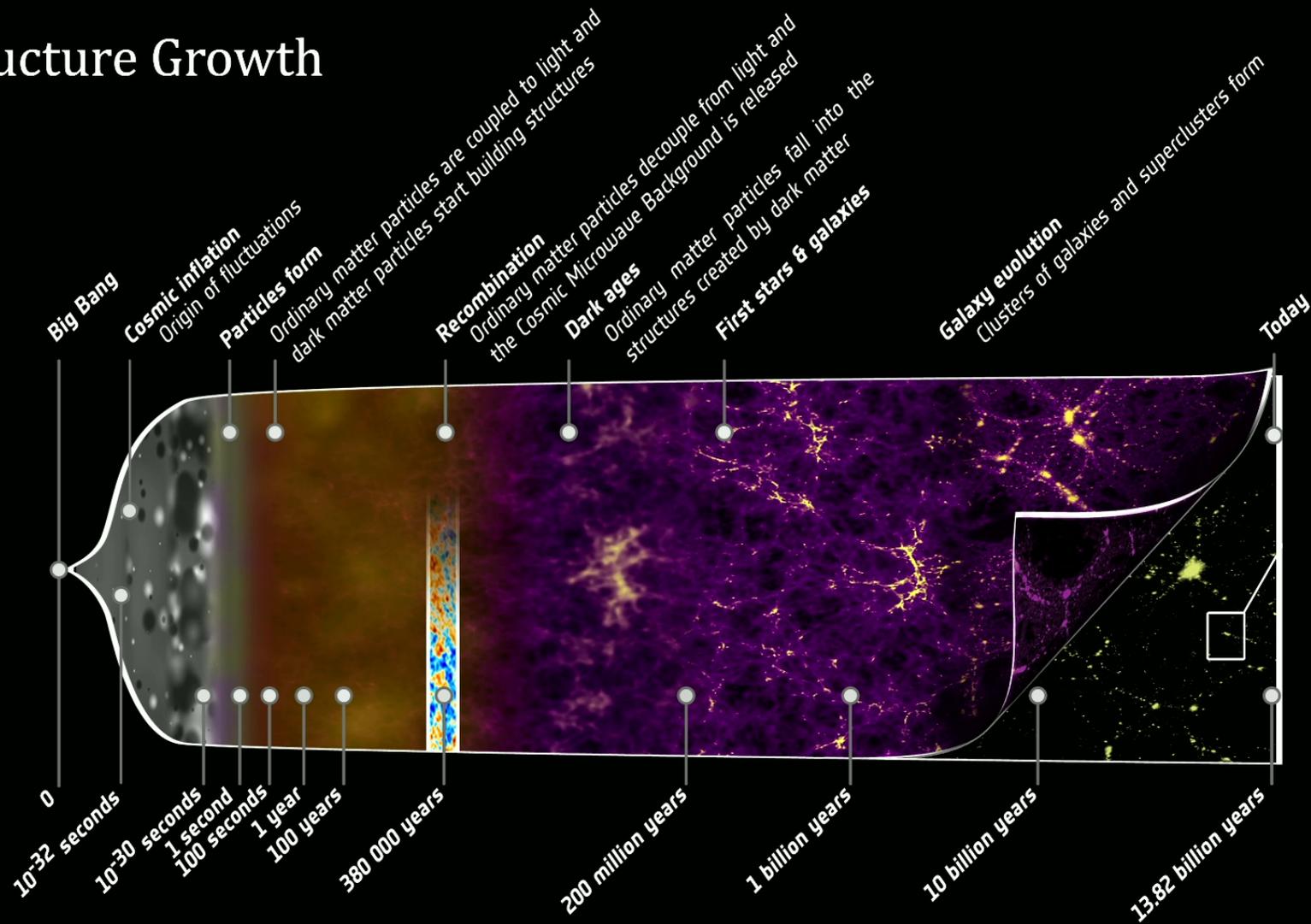
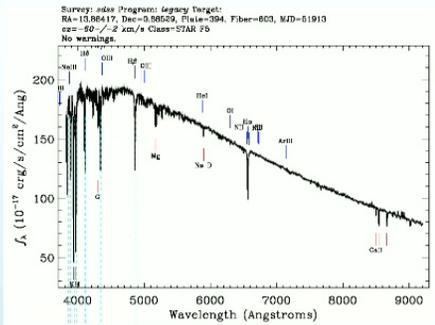


Image : Planck, ESA

Growth measurements with galaxy surveys

Spectroscopic surveys



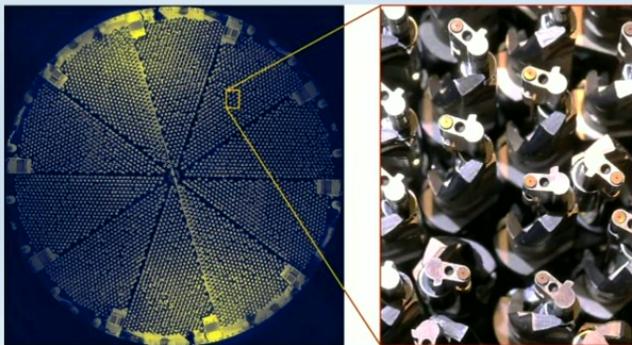
Select galaxies as targets, measure spectra .

Spectra →
redshift →
precise distances

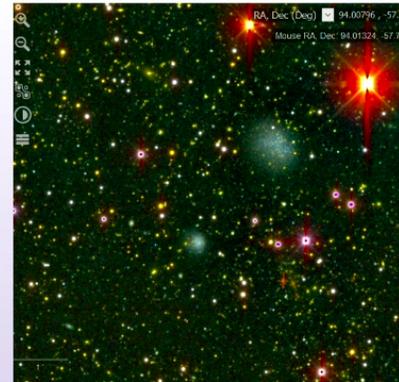
DESI
35M gal. by 2026

BOSS
1.3M gal., done 2014

Euclid
50M gal., planned
2024-2030



Imaging surveys



Find galaxies in images.

Distances from brightness in a few color filters.

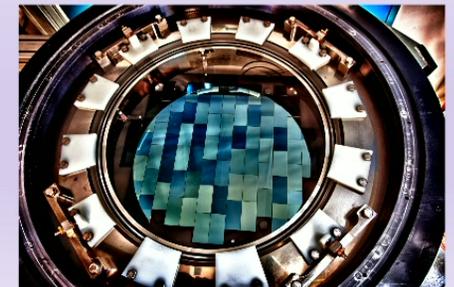
Less time per galaxy →
more galaxies

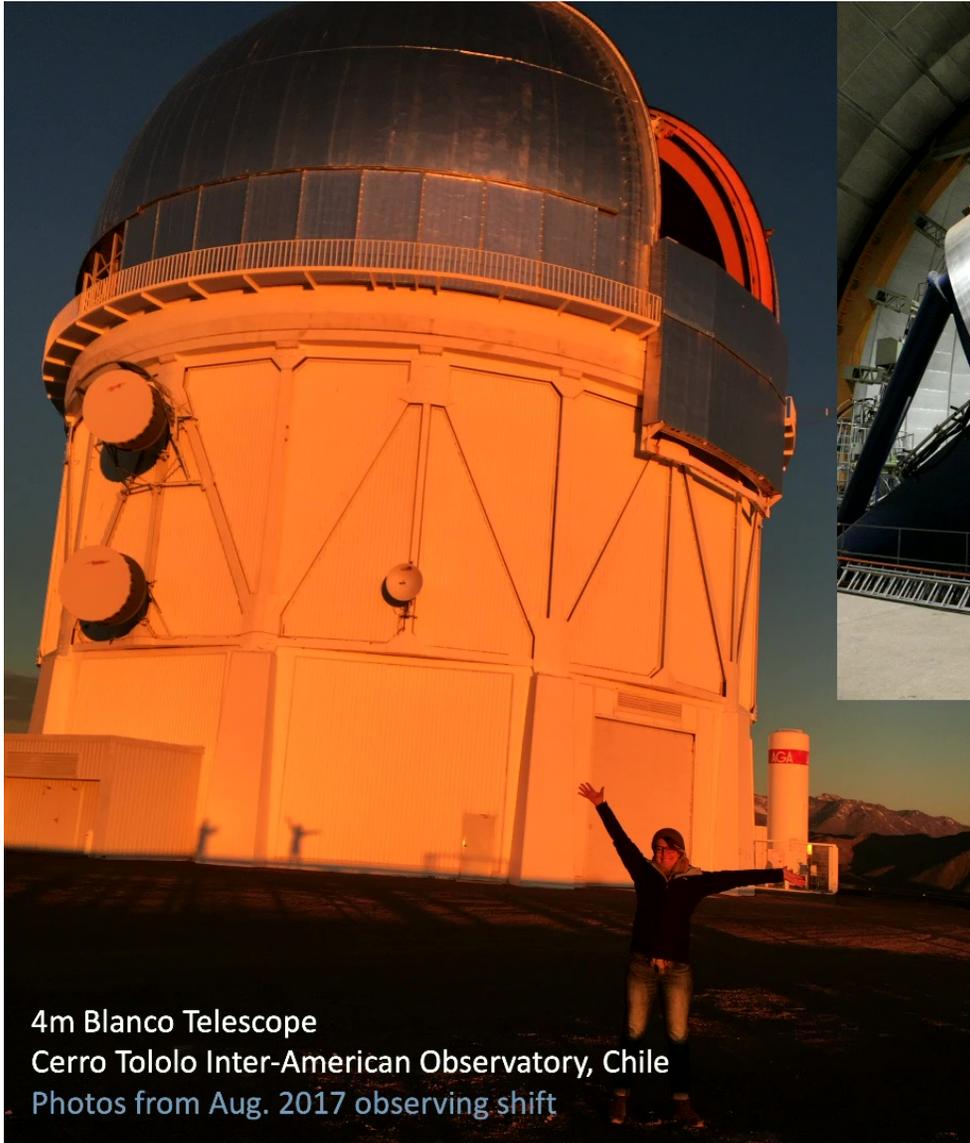
Can measure galaxy shapes

DES - 200M gal. completed 2019

KiDS , HSC, UNIONS

Rubin LSST
20B galaxies, planned 2024-2034





Dark Energy Survey (DES)

DARK ENERGY SURVEY

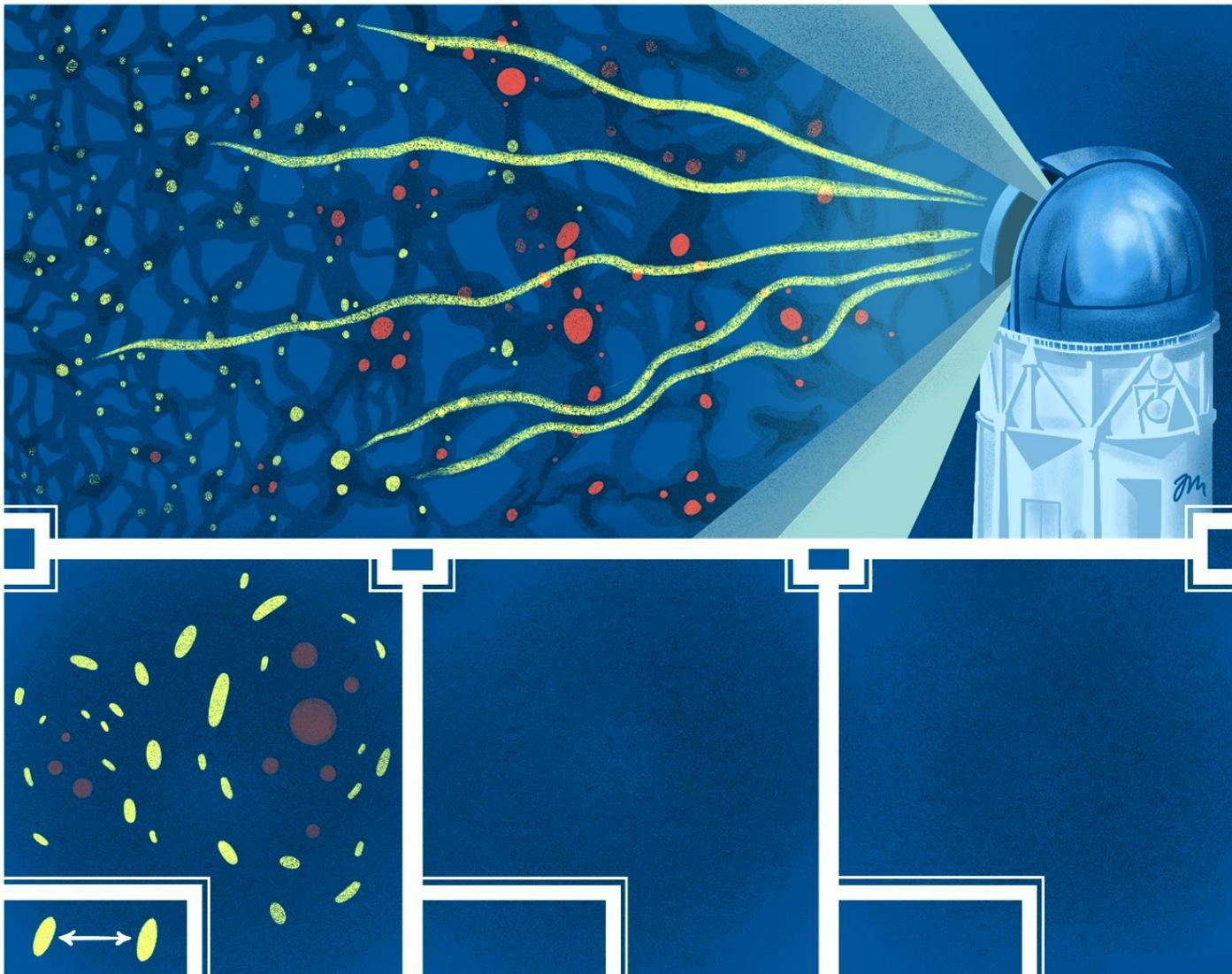
- Imaging survey 2013-2019
 - 758 nights observing
 - 5000 deg², ~10% of sky
- 400+ participants
- Cosmology analysis still underway!

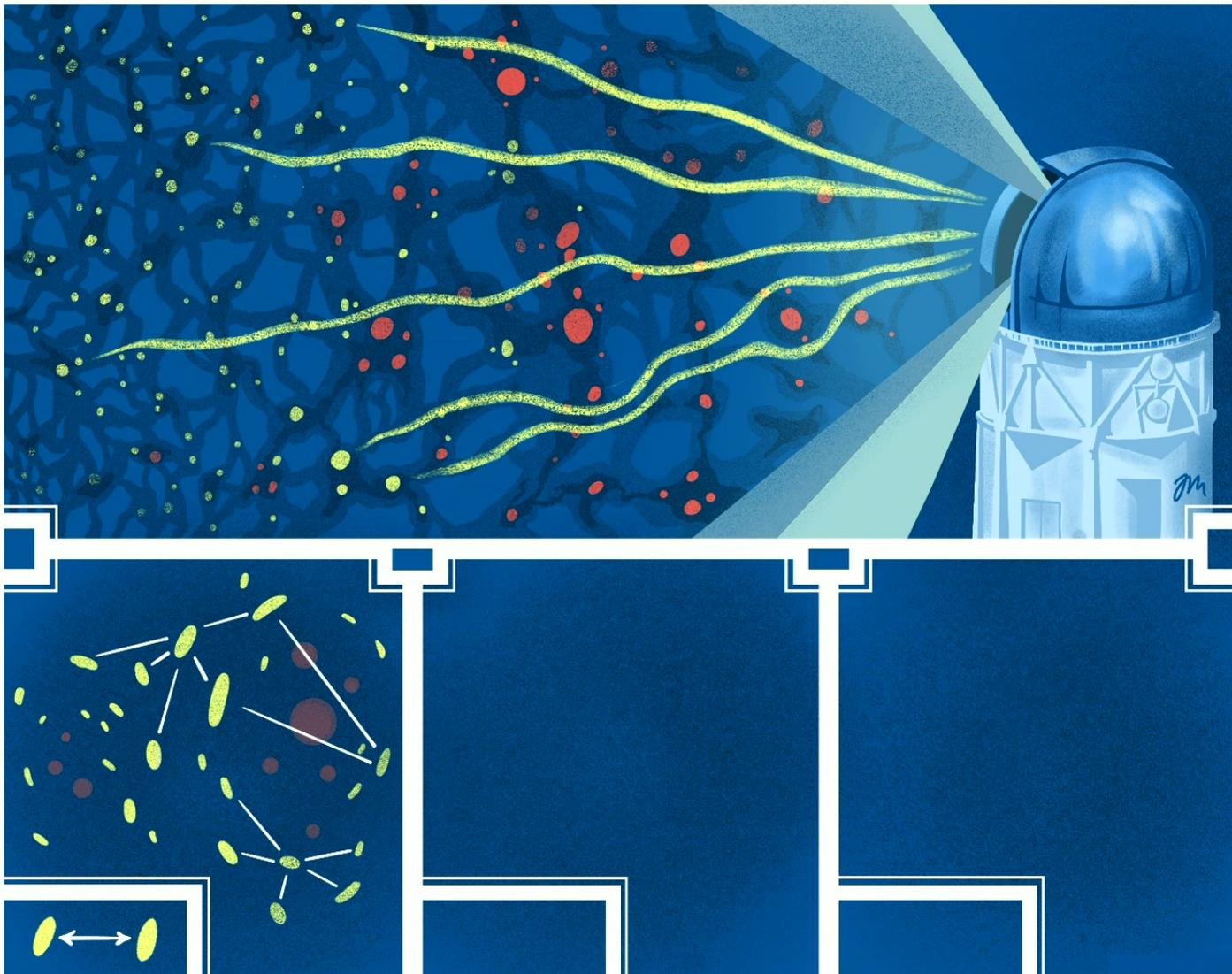
Funding

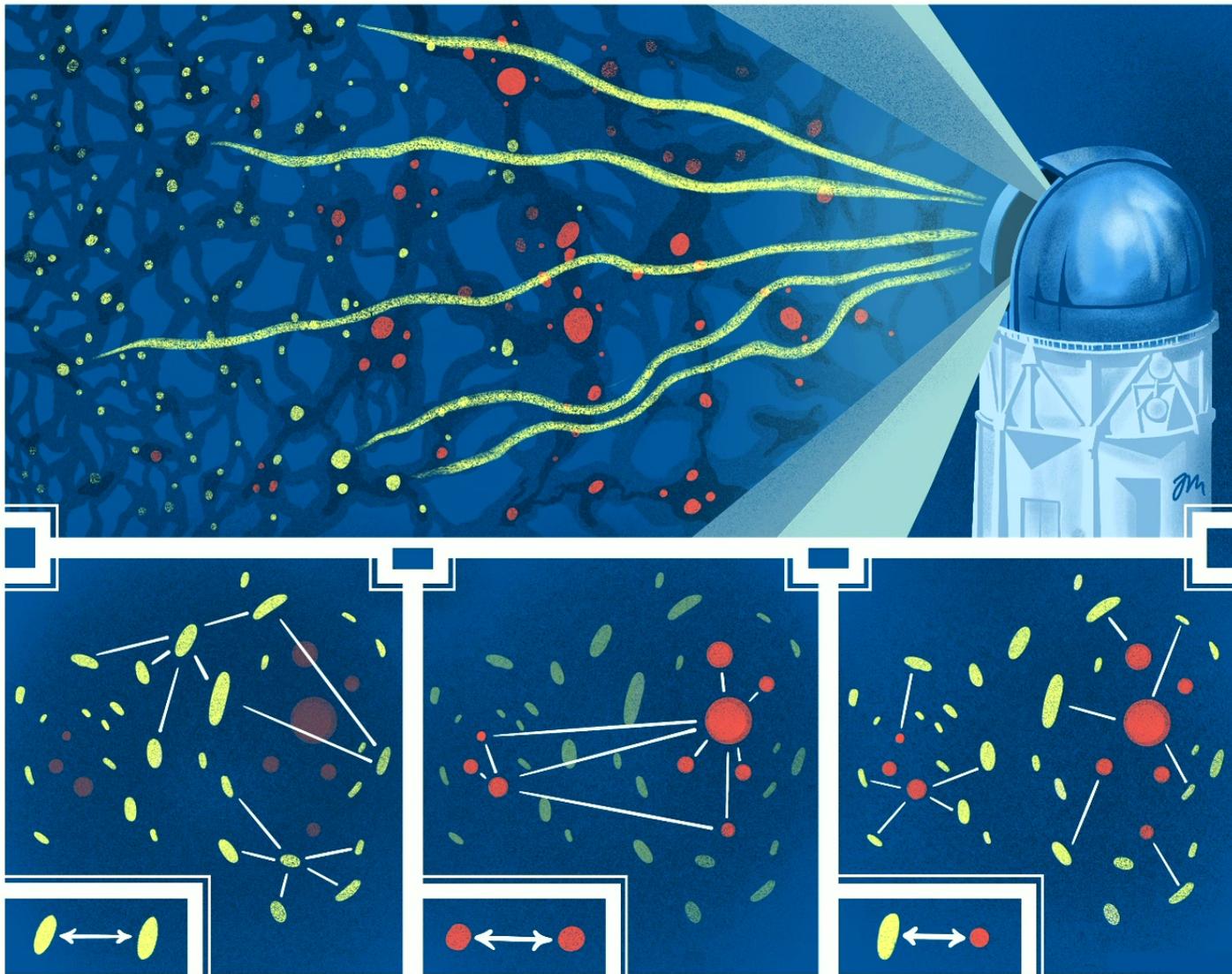


Member institutions







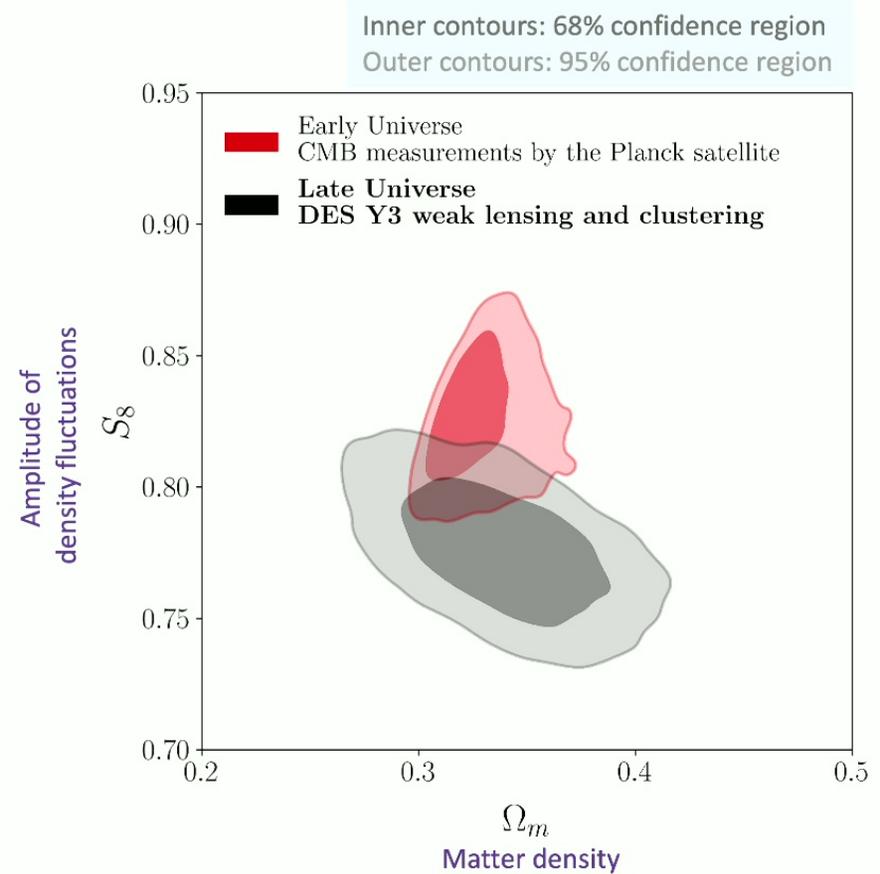


Constraining model parameters

Λ CDM

Cosmological standard model

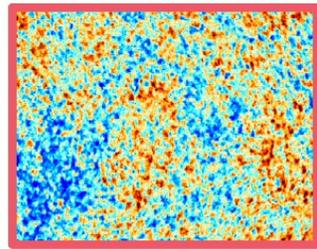
- Λ - cosmological constant dark energy
- CDM – cold dark matter



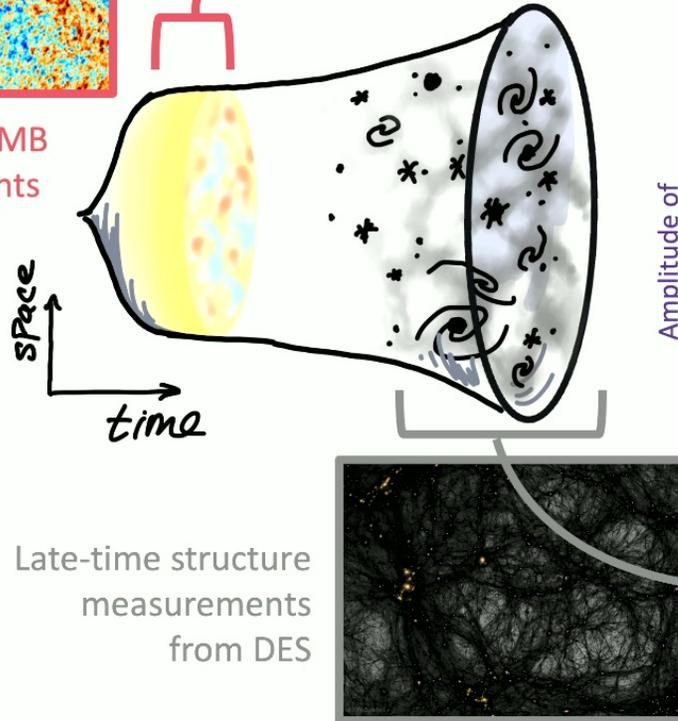
DES Collaboration 2022, arXiv:2105.13549

10

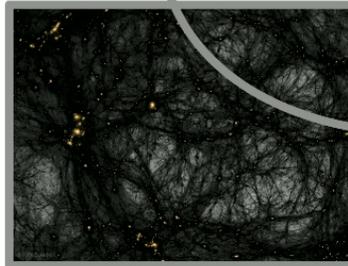
Constraining model parameters



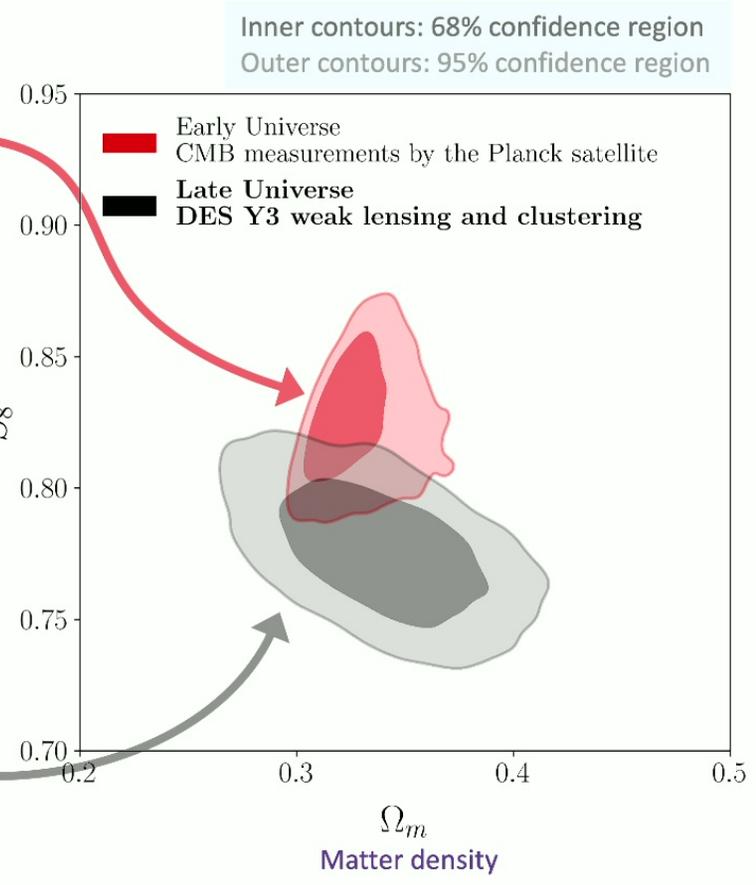
Early-time CMB measurements from Planck



Late-time structure measurements from DES

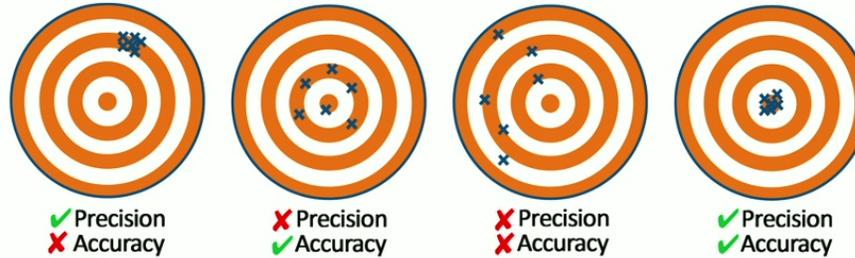


Amplitude of density fluctuations S_8



DES Collaboration 2022, arXiv:2105.13549

PRECISION VS ACCURACY



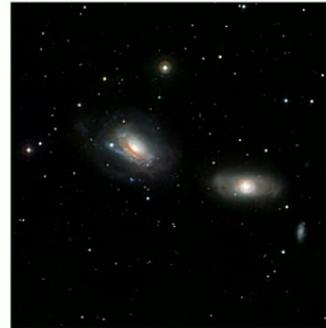
Baryon feedback: Scale cuts

Don't include data where we know theoretical predictions aren't reliable.



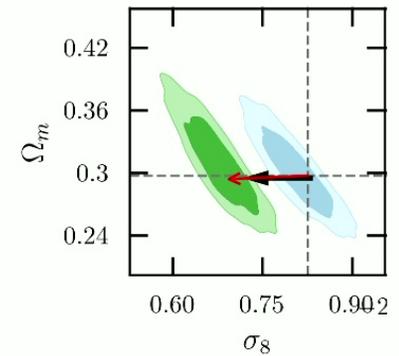
Intrinsic alignments: modeling

Model how tidal interactions contaminate weak lensing signals.



Experimenter bias: Blinding

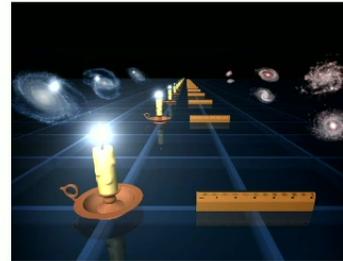
Hide results until decisions, validation checks are finalized.



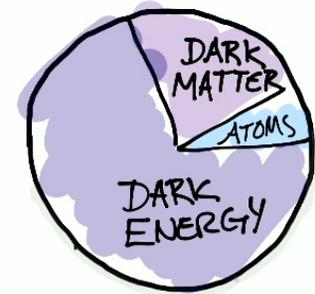


Conclusion

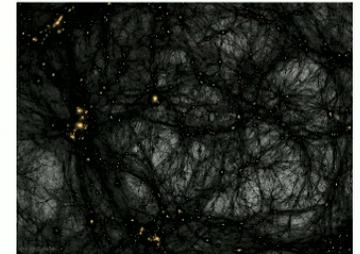
We test cosmological model predictions for...



Growth of structure via CMB, galaxy surveys.



Expansion history via distance measurements,



The combination/comparison of constraints can provide clues towards more fundamental descriptions of dark matter & energy.

- Collaborative effort
- Care needed to avoid biased results
- Exciting data on the horizon from ongoing & future galaxy surveys.