



Dark Energy Survey (DES) and projections for LSST and DESI

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Fermilab Schramm postdoctoral fellow



Dark Energy *Survey* (DES) and projections for LSST and DESI

A gigantic sky
“photography”
project.





Dark Energy *Survey* (DES) and projections for LSST and DESI

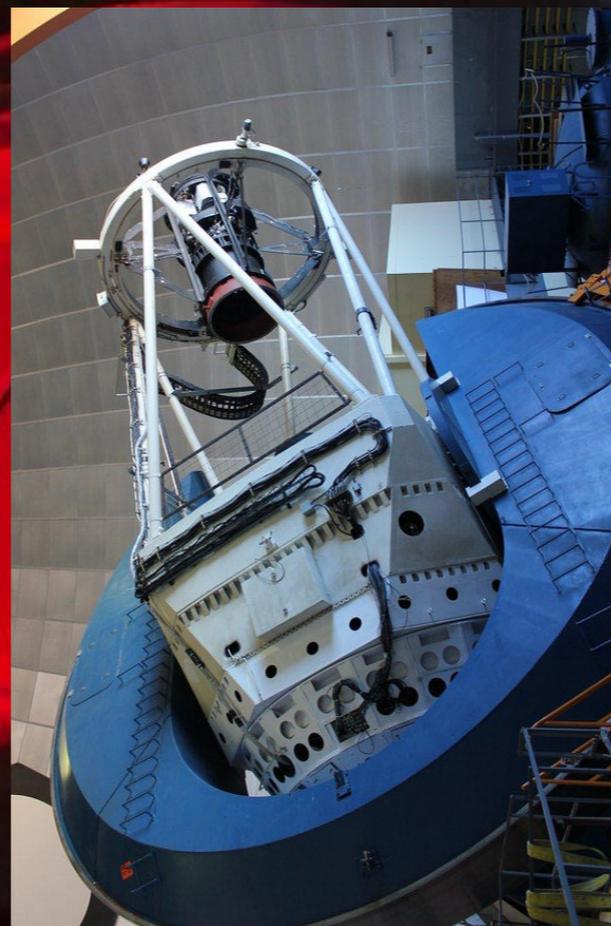


Our “photographers”: ~ 600 collaborators on 4 continents.



Dark Energy *Survey* (DES) and projections for LSST and DESI

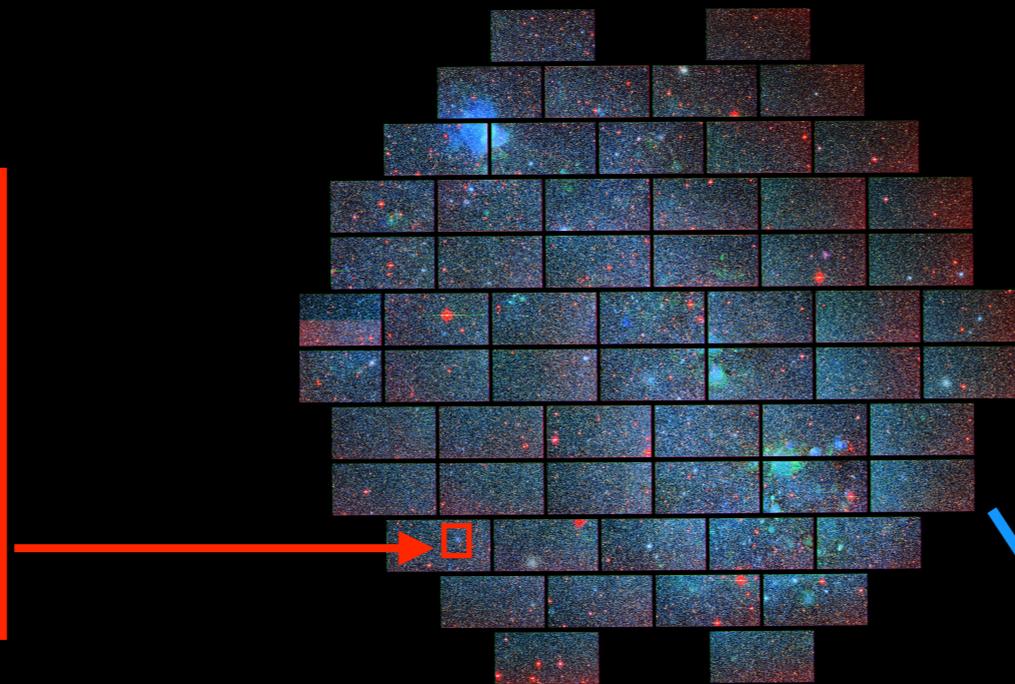
A gigantic sky
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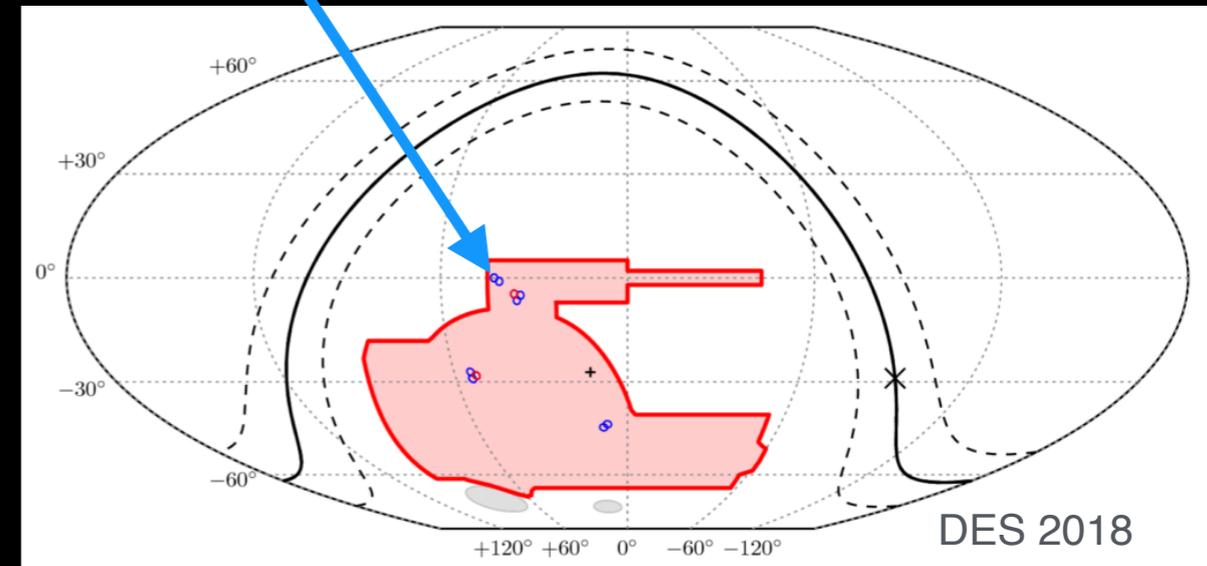
Our instrument: the **Dark Energy Camera**
and the **Blanco telescope**.



Dark Energy *Survey* (DES) and projections for LSST and DESI



DES observes $5,000 \text{ deg}^2$,
 $1/8$ of the sky.

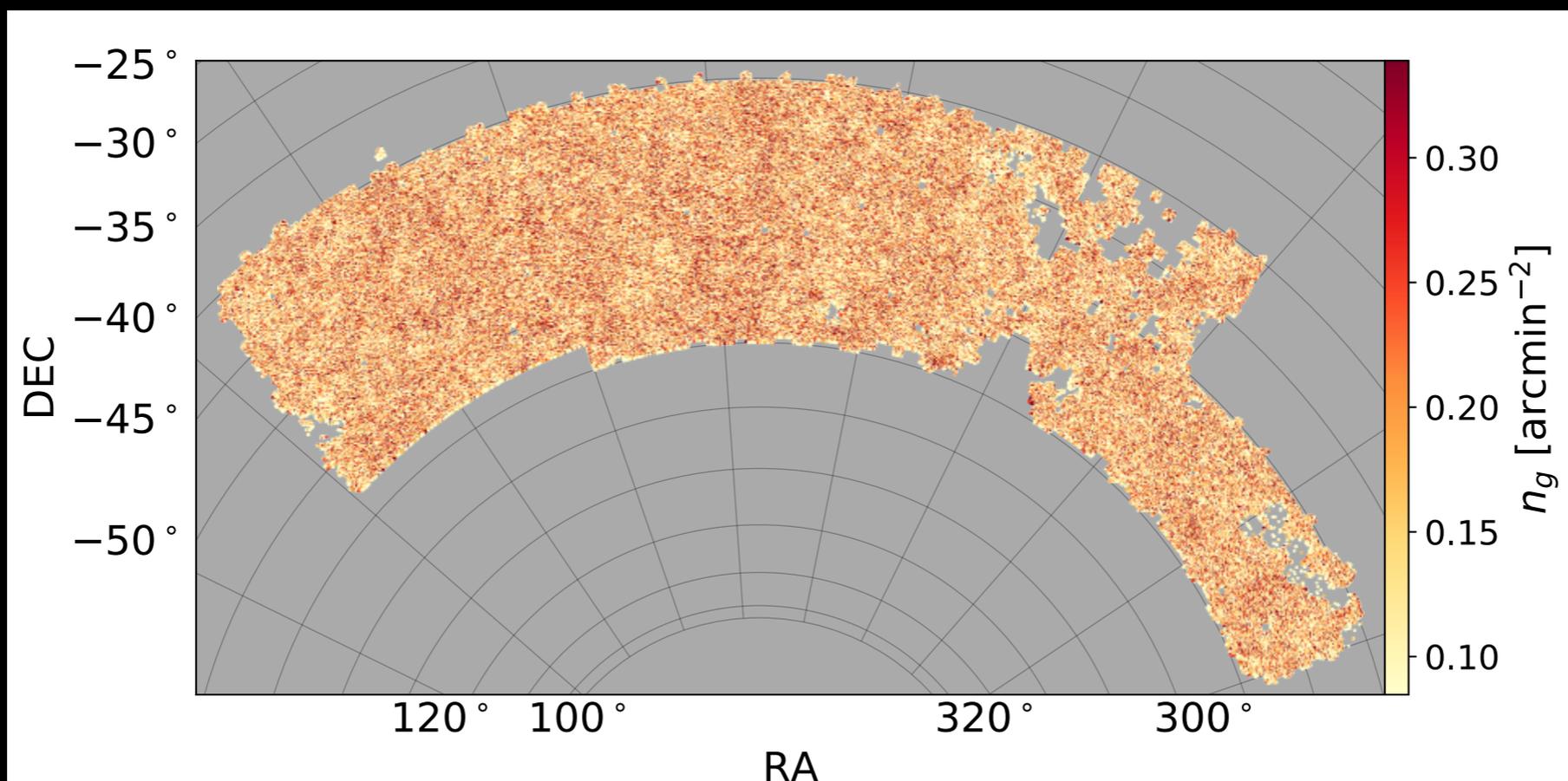


“An **extremely wide-field** deep optical imaging survey.”



Dark Energy *Survey* (DES) and projections for LSST and DESI

- **Year 1 2013~2014: half of the footprint.**
Publishing Y1 data analyses.
- Year 3 ~2016: whole footprint.
Beginning Y3 data analysis.
- Year 6 ~2019: Final year of DES data taking.
Final results ~2021





Dark Energy Survey (DES) and projections for LSST and DESI

Dark energy affects the universe expansion history,

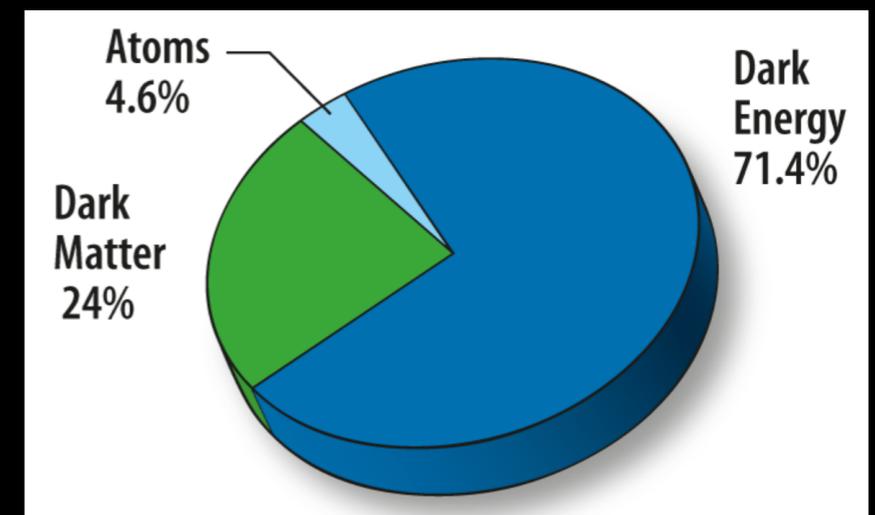
which is quantifiable through:

- (1) type Ia supernovae,
- (2) baryon acoustic oscillation.

Dark energy affects cosmic structure growth,

which is quantifiable through:

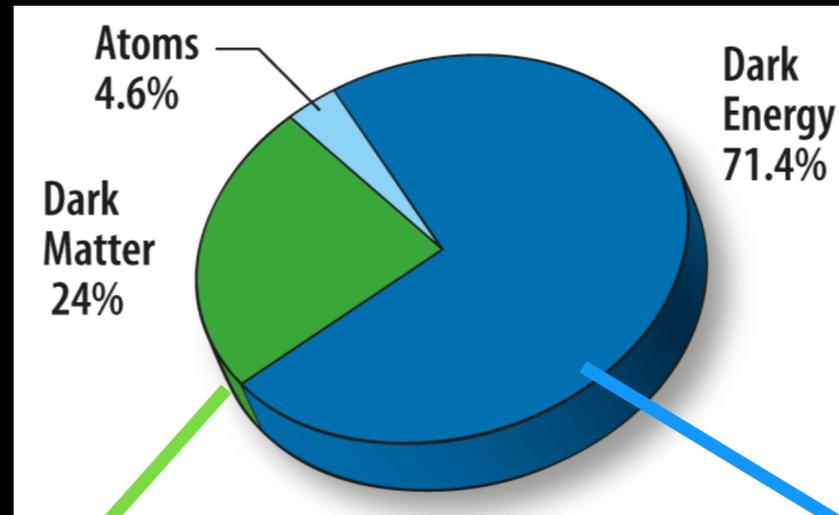
- (3) **weak lensing**,
- (4) galaxy clusters.



Credit: nasa.gov

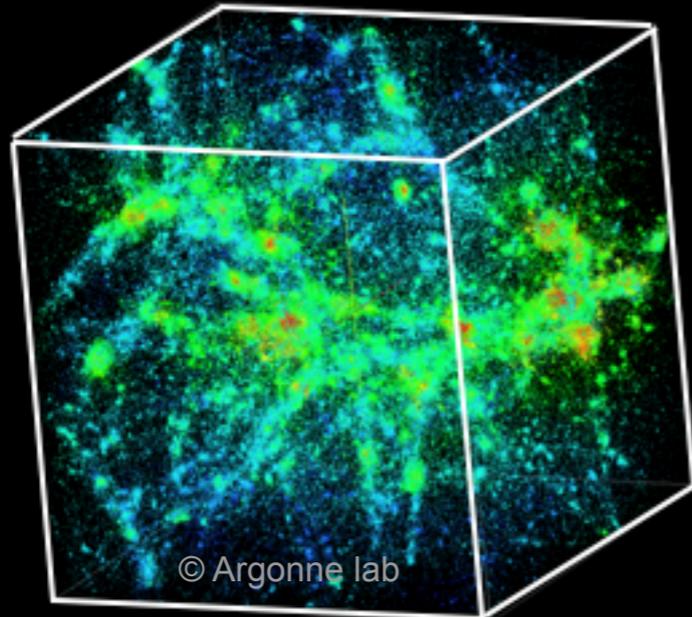


Dark Energy affects cosmic structure formation.

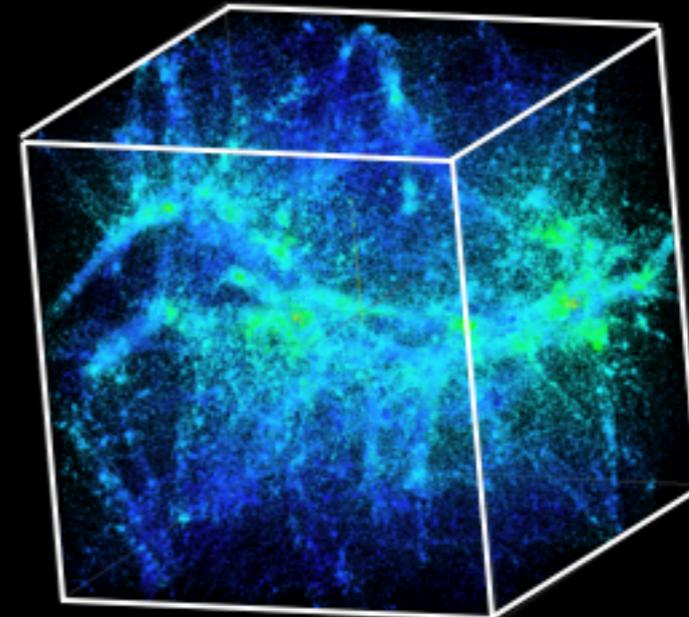


Credit: nasa.gov

No dark energy



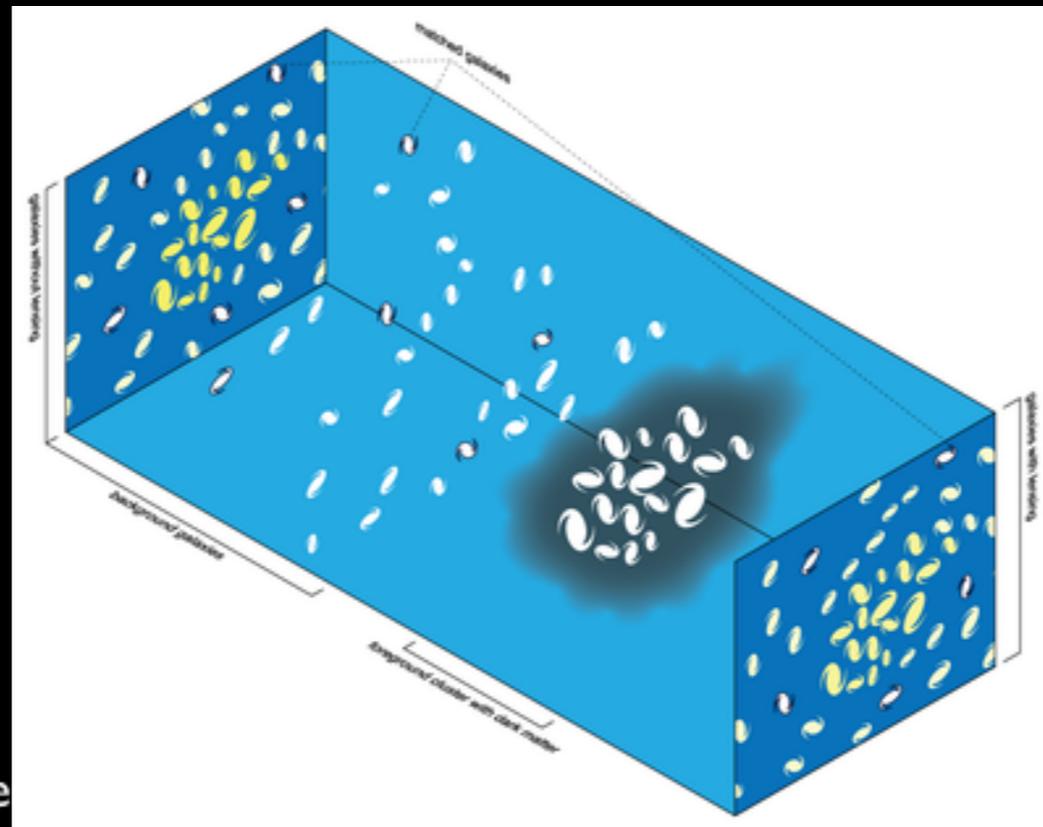
Standard Model





Dark Energy affects cosmic structure formation.

DES quantifies the structure formation clumpiness with **weak lensing**.

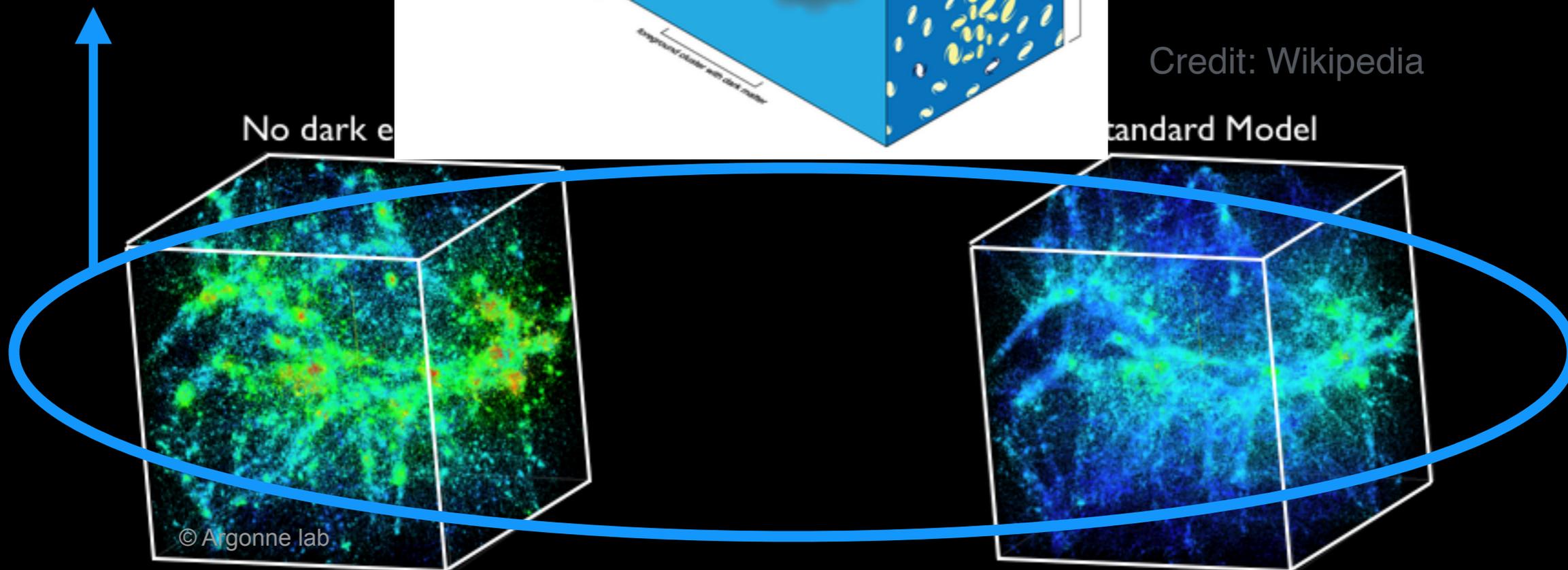


Credit: Wikipedia

Observable via WL

No dark e

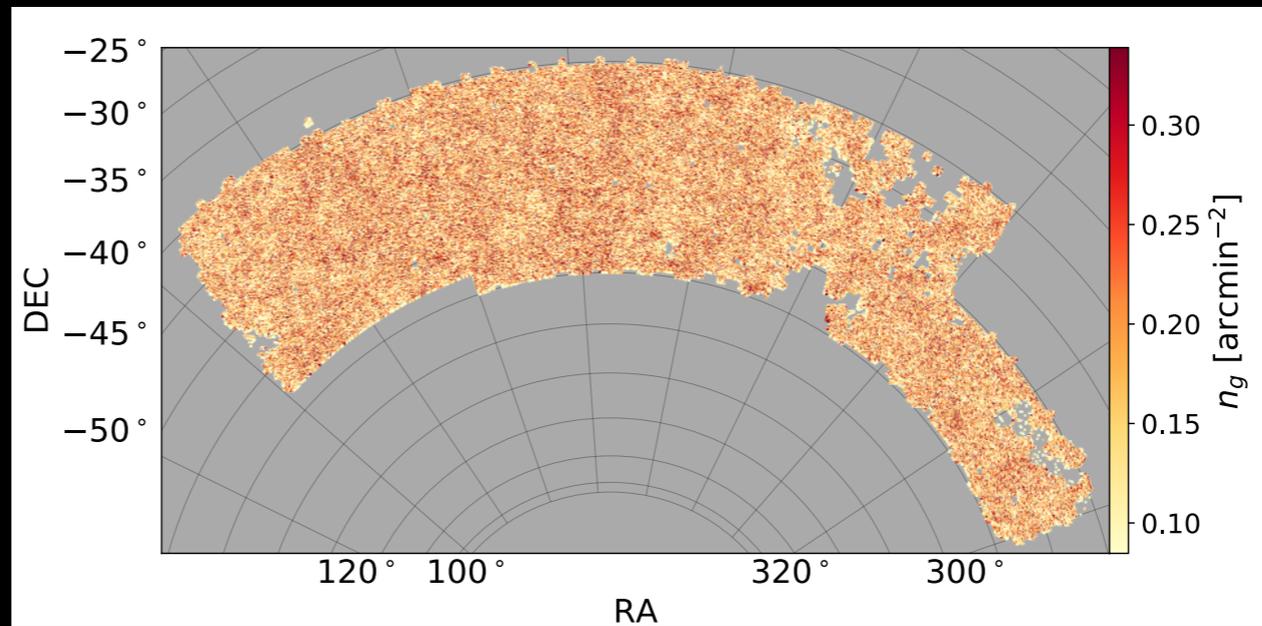
Standard Model



© Argonne lab

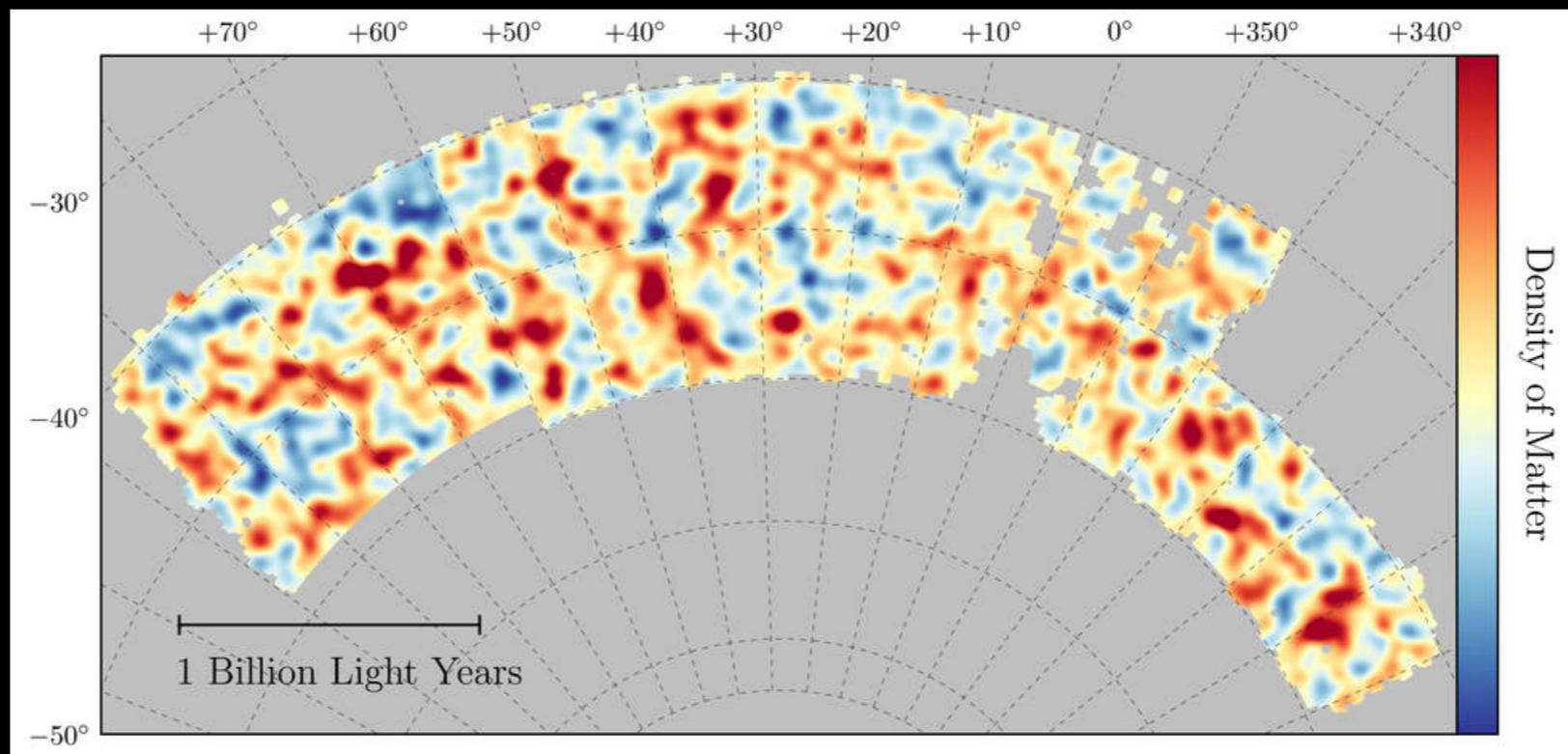
DES quantifies the structure formation clumpiness with **weak lensing**.

Galaxy map



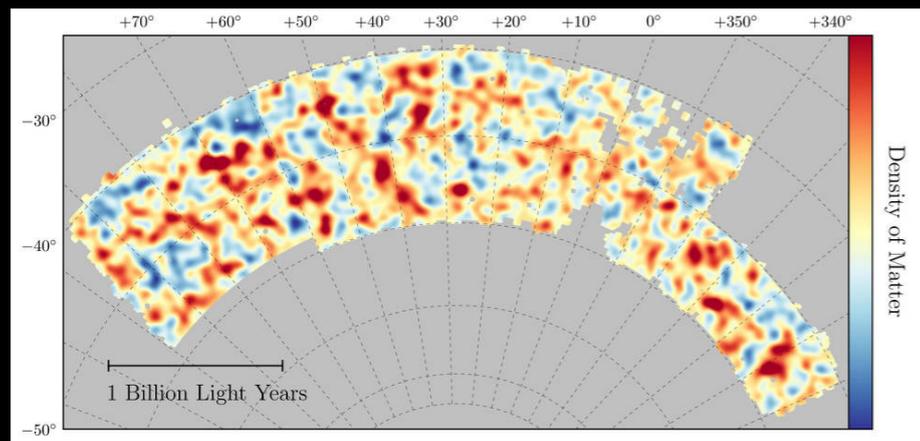
Elvin-Poole 2017

Matter map

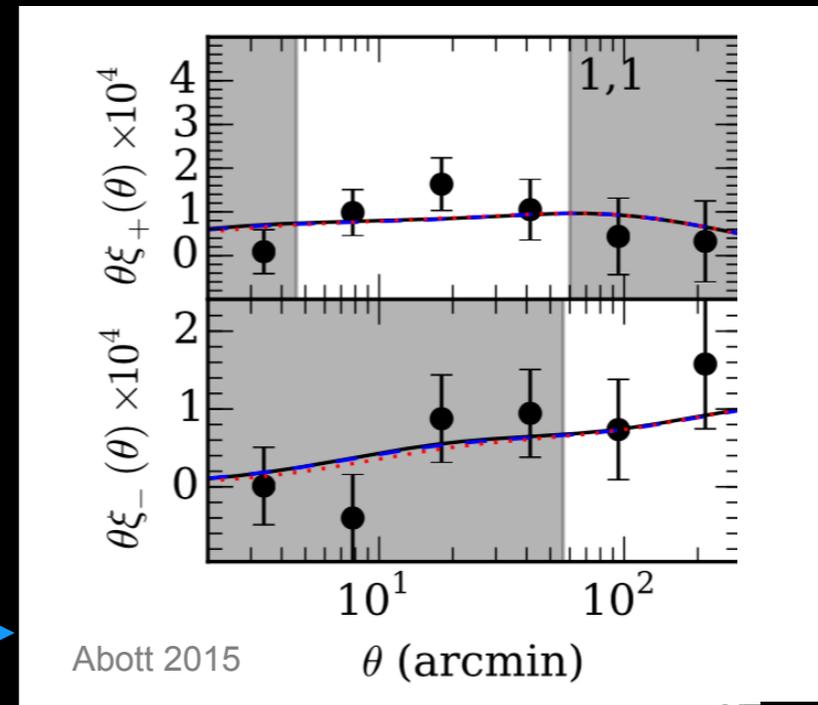


Chang 2017

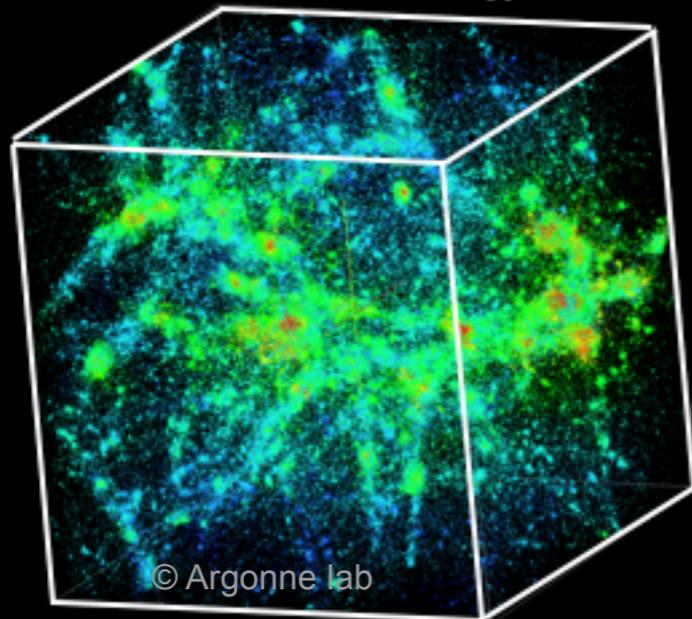
DES quantifies the structure formation clumpiness with **weak lensing**.



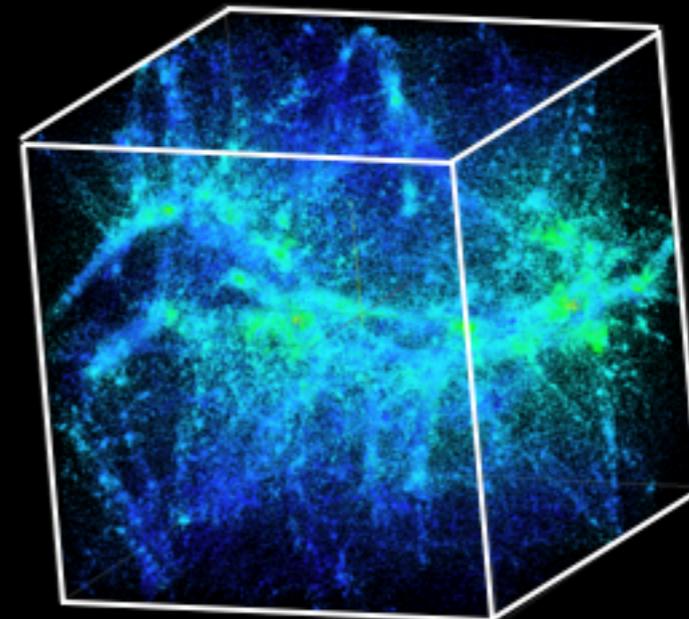
Cosmology parameters inferred from 2 point correlation analysis.



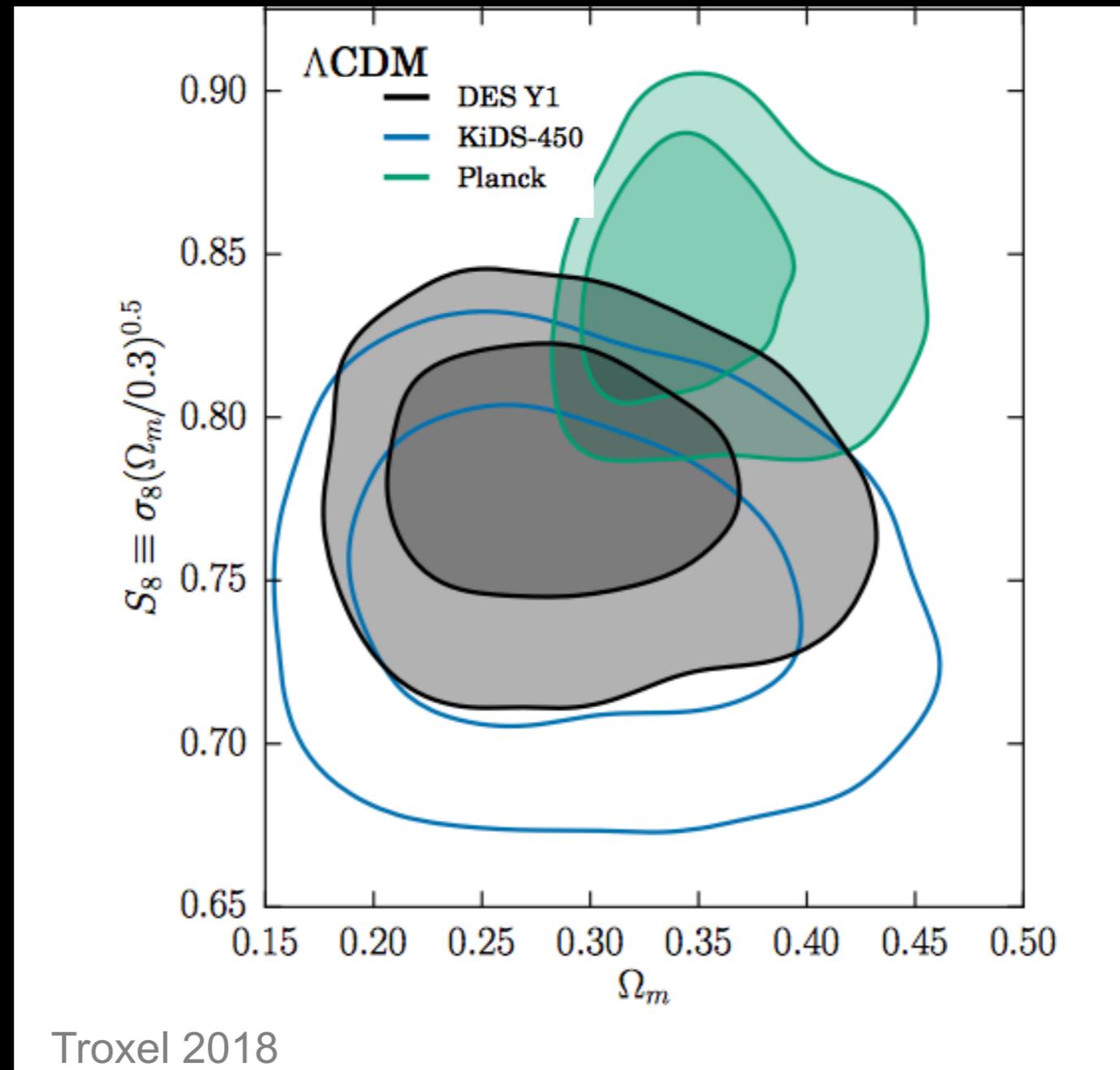
No dark energy



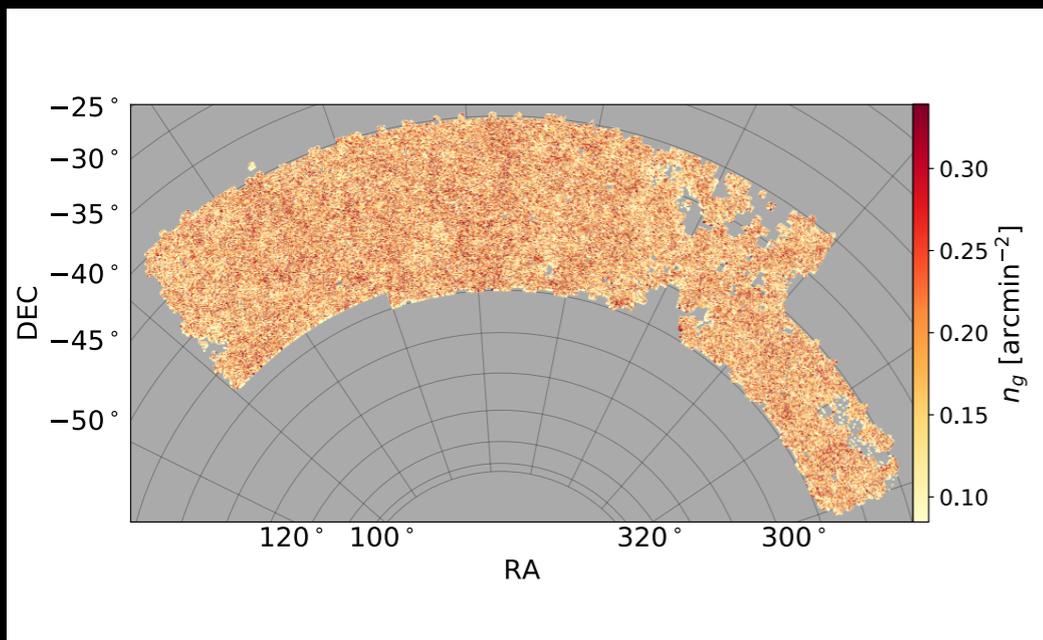
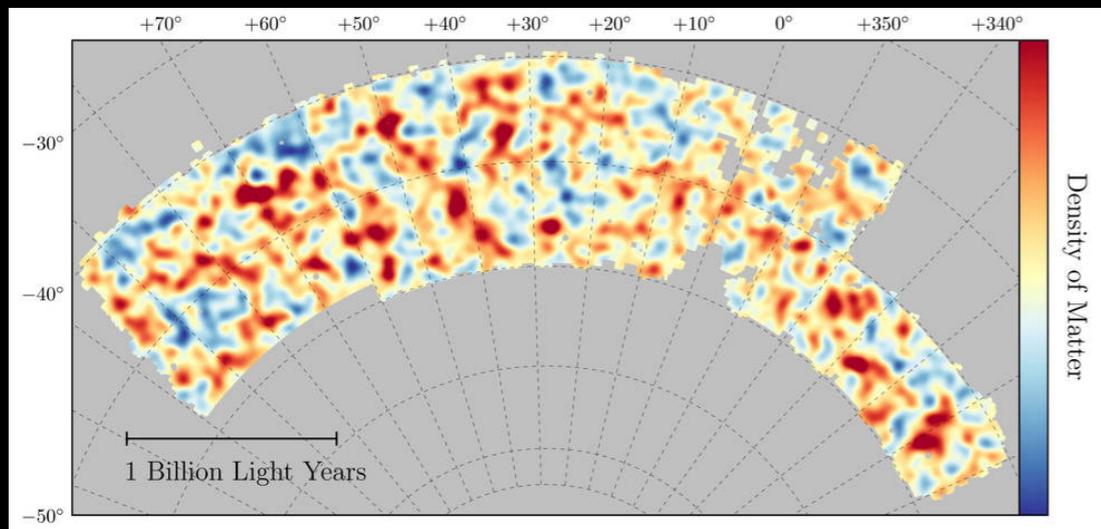
Standard Model



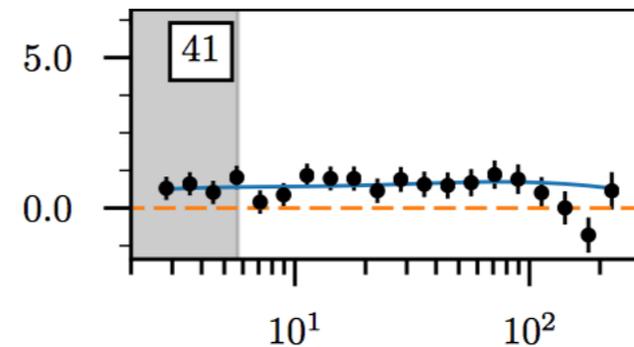
DES quantifies the structure formation clumpiness with **weak lensing**.



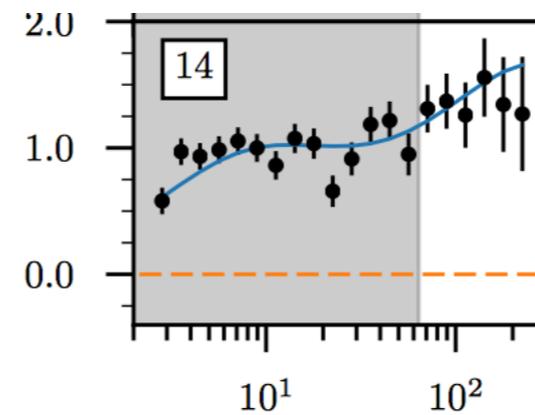
DES quantifies the cosmic clumpiness with **weak lensing** and **galaxies**.



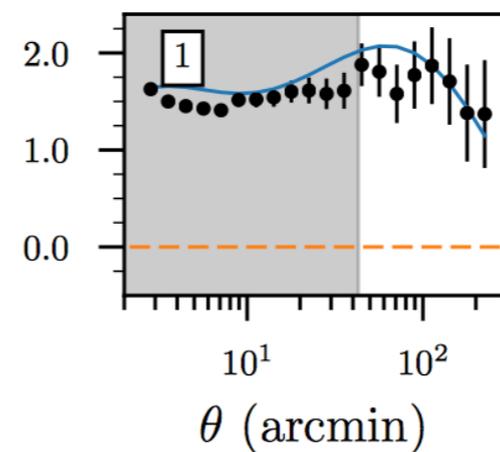
“3 x 2”



shear-shear



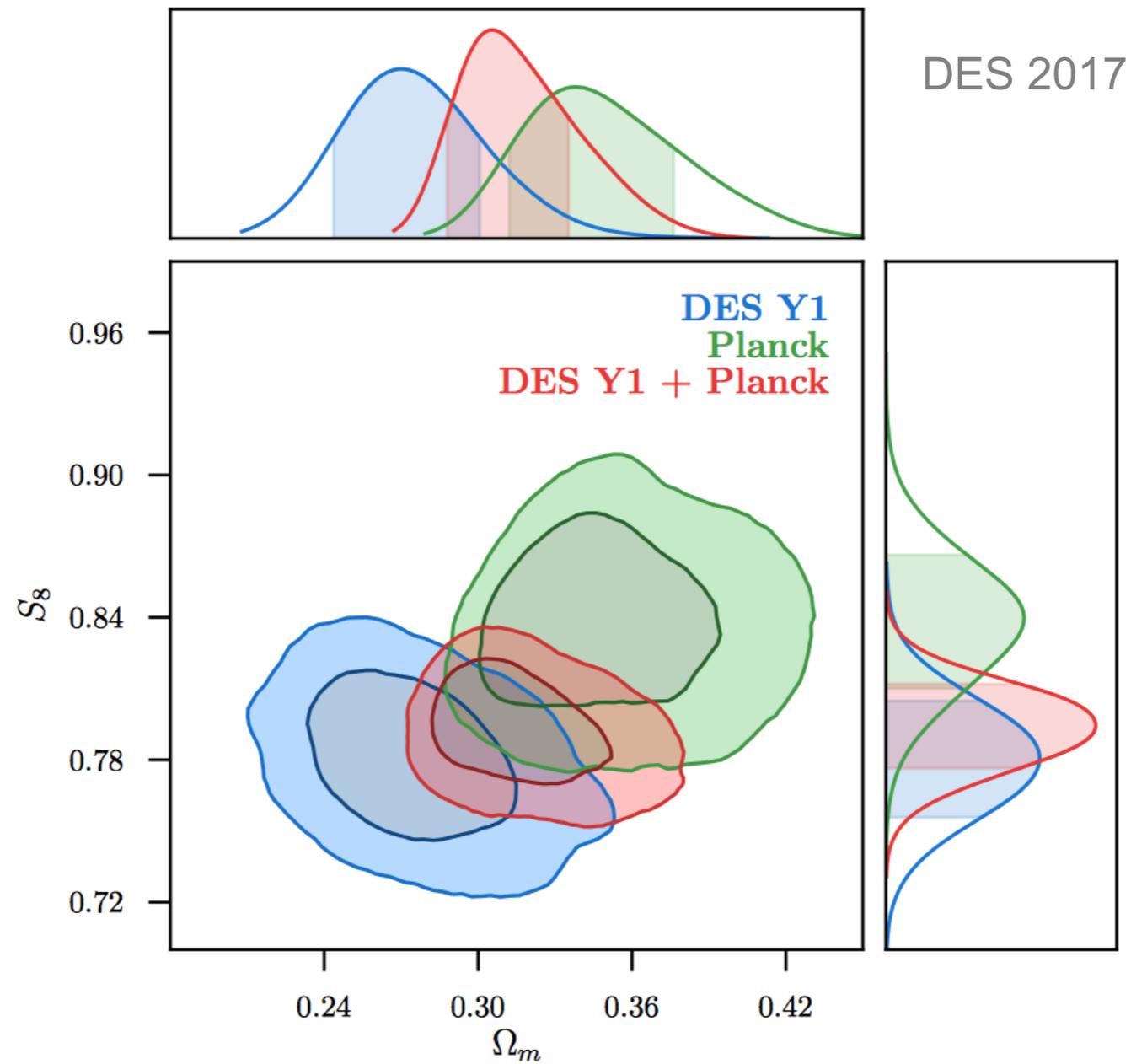
galaxy-shear



galaxy-galaxy



Dark Energy Survey (DES) and projections for LSST and DESI





Dark Energy Survey (DES) and projections for LSST and DESI

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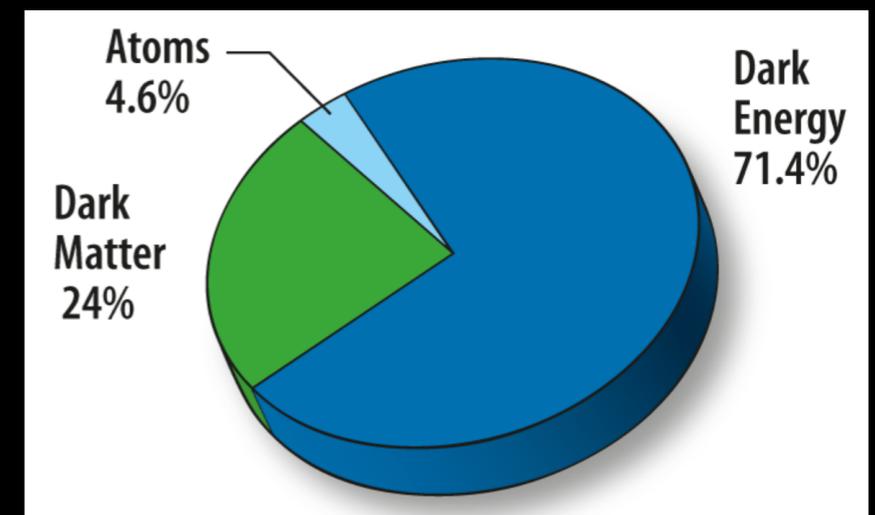
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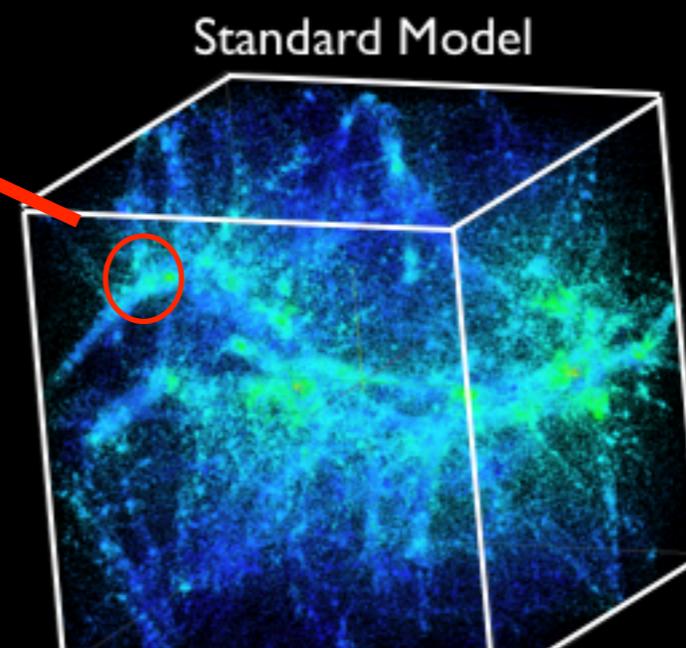
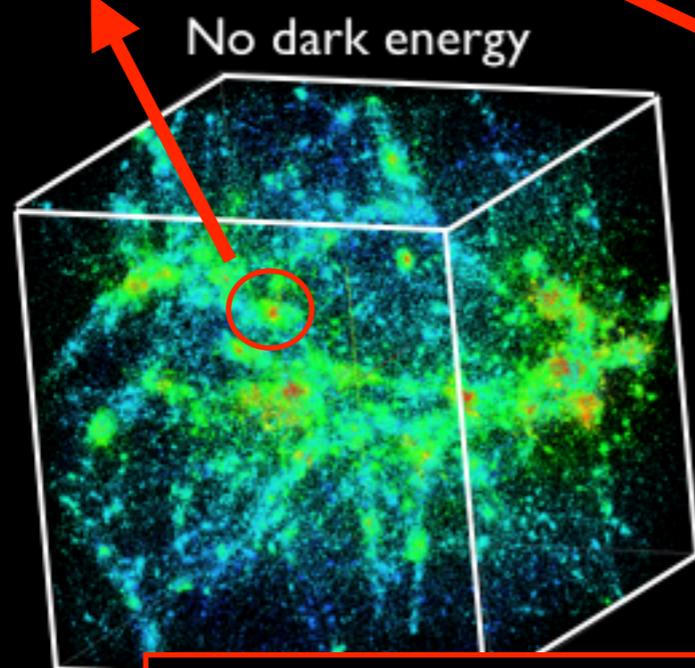


Credit: nasa.gov



Dark Energy affects cosmic structure formation.

DES quantifies the structure formation clumpiness with **galaxy clusters**.

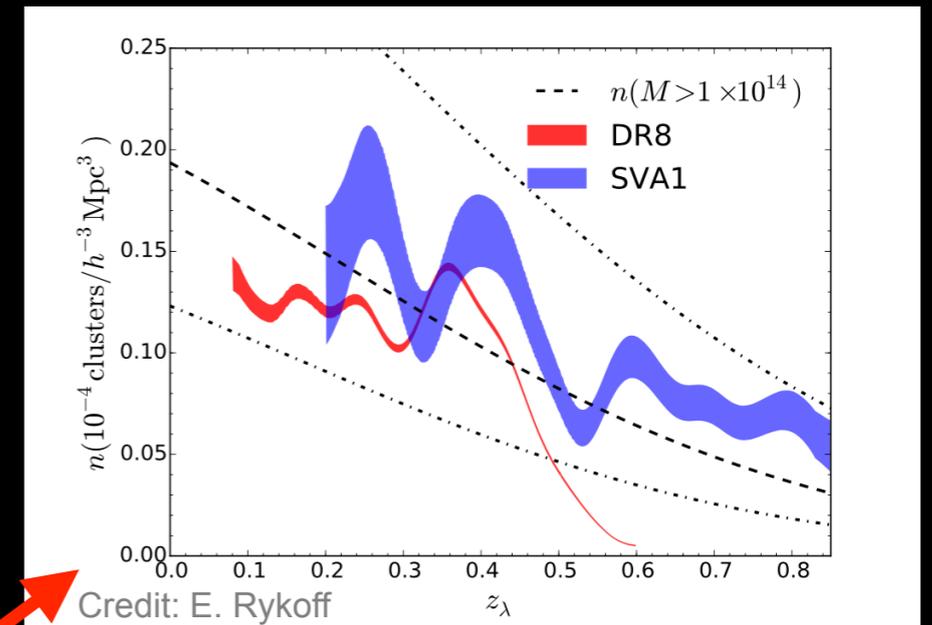
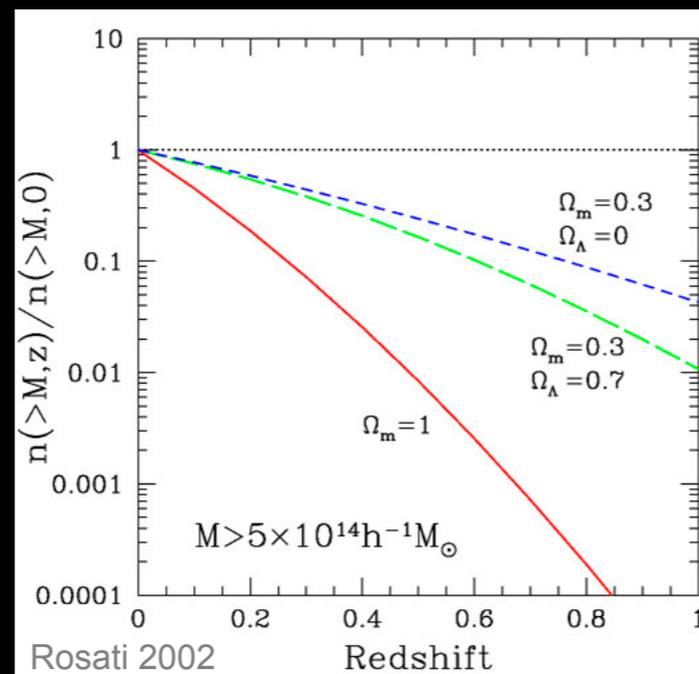


Galaxy Clusters are the peaks of the clumpy density field.

DES quantifies the structure formation clumpiness with **galaxy clusters**.

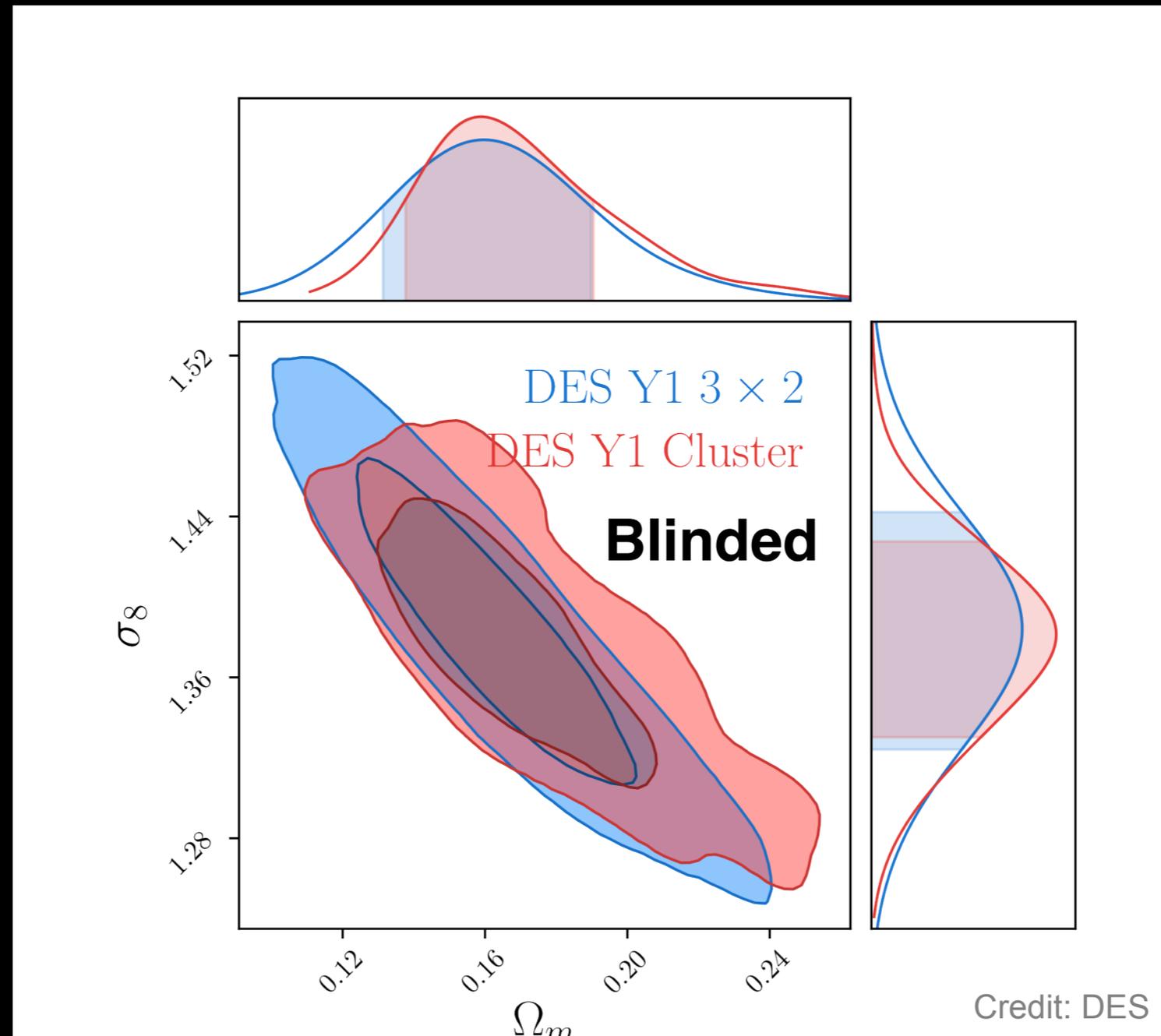


Number densities sensitive to cosmology models.





Dark Energy affects cosmic structure formation.

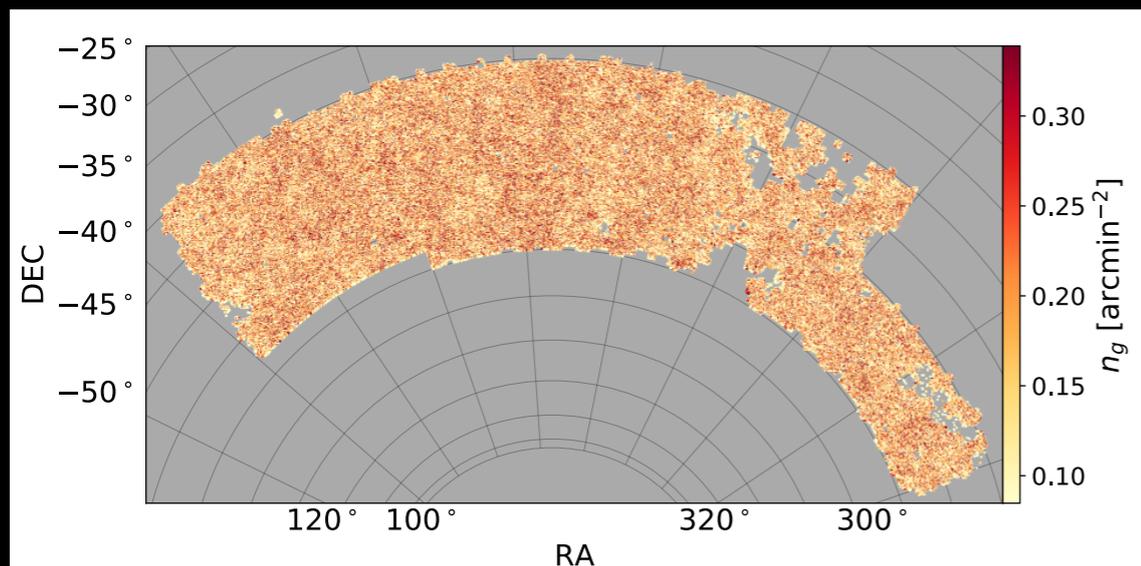




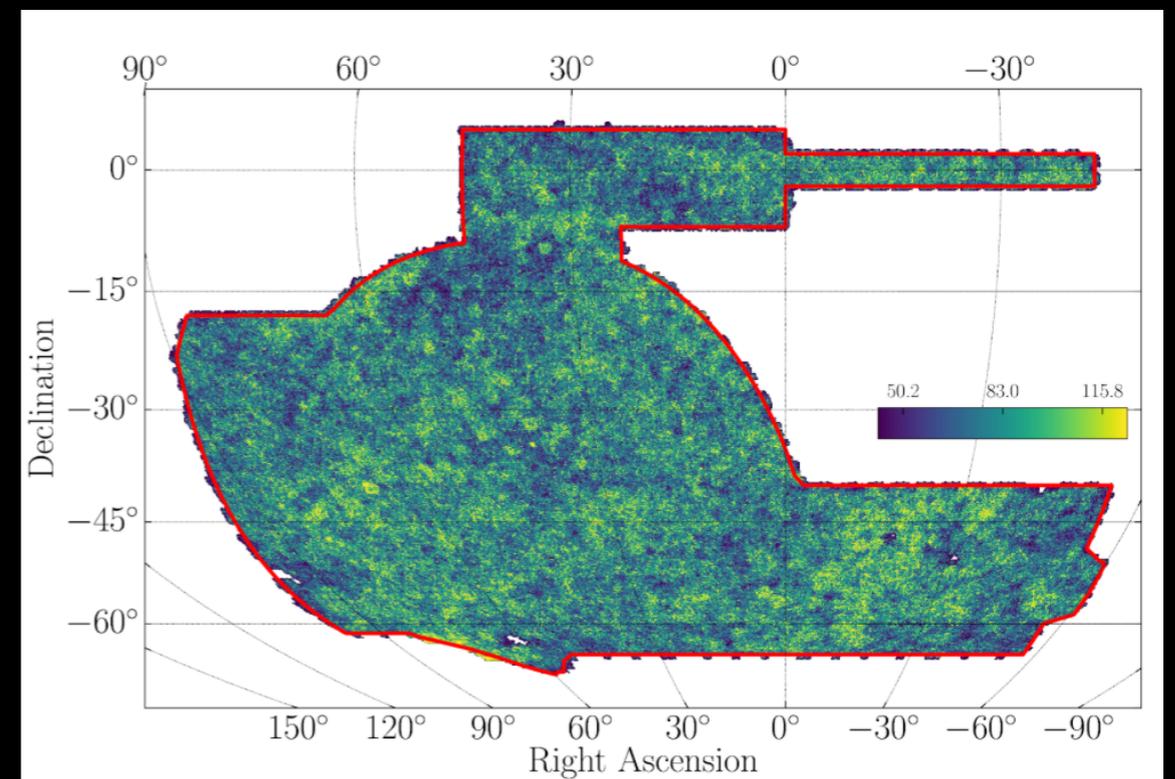
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Y1

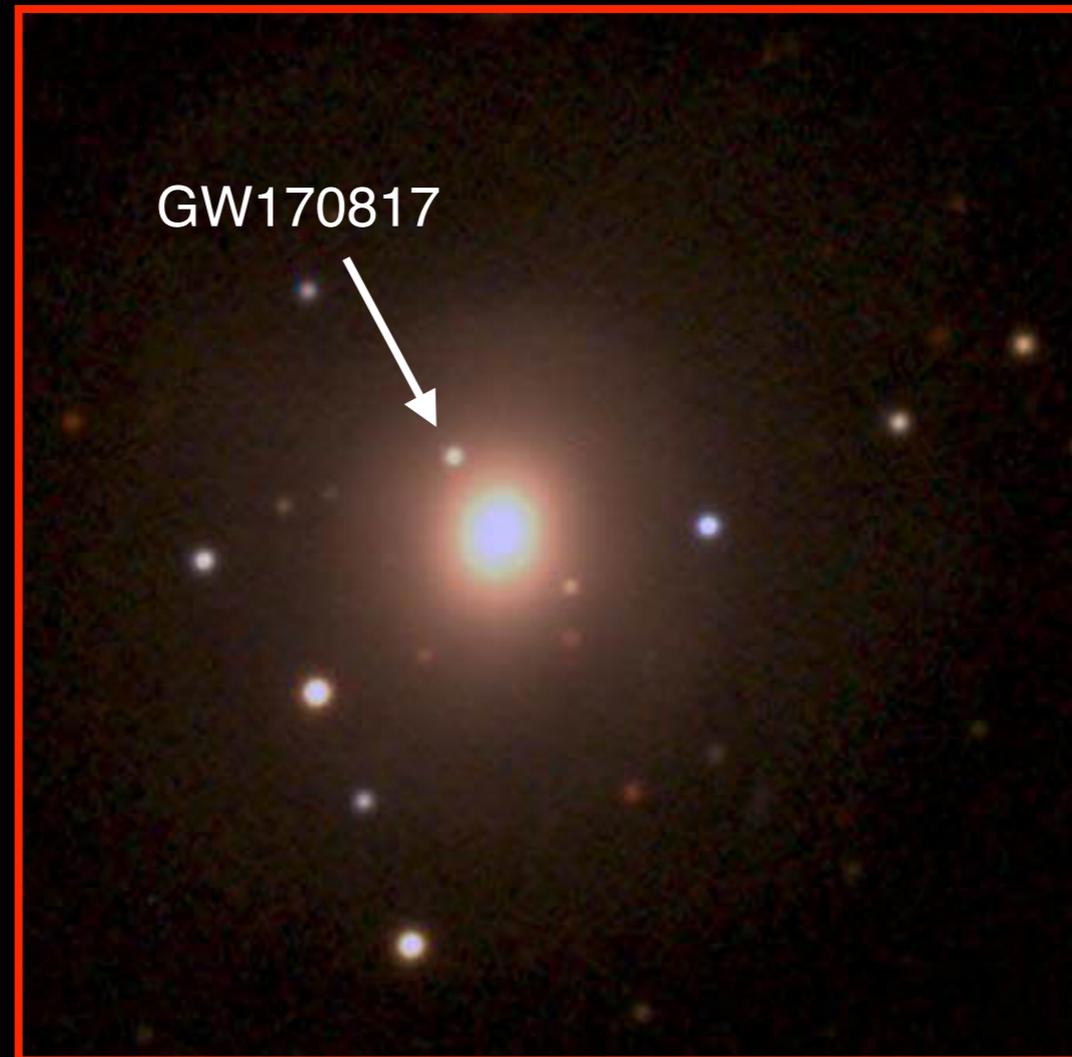


Y3



Dark Energy Survey (DES)

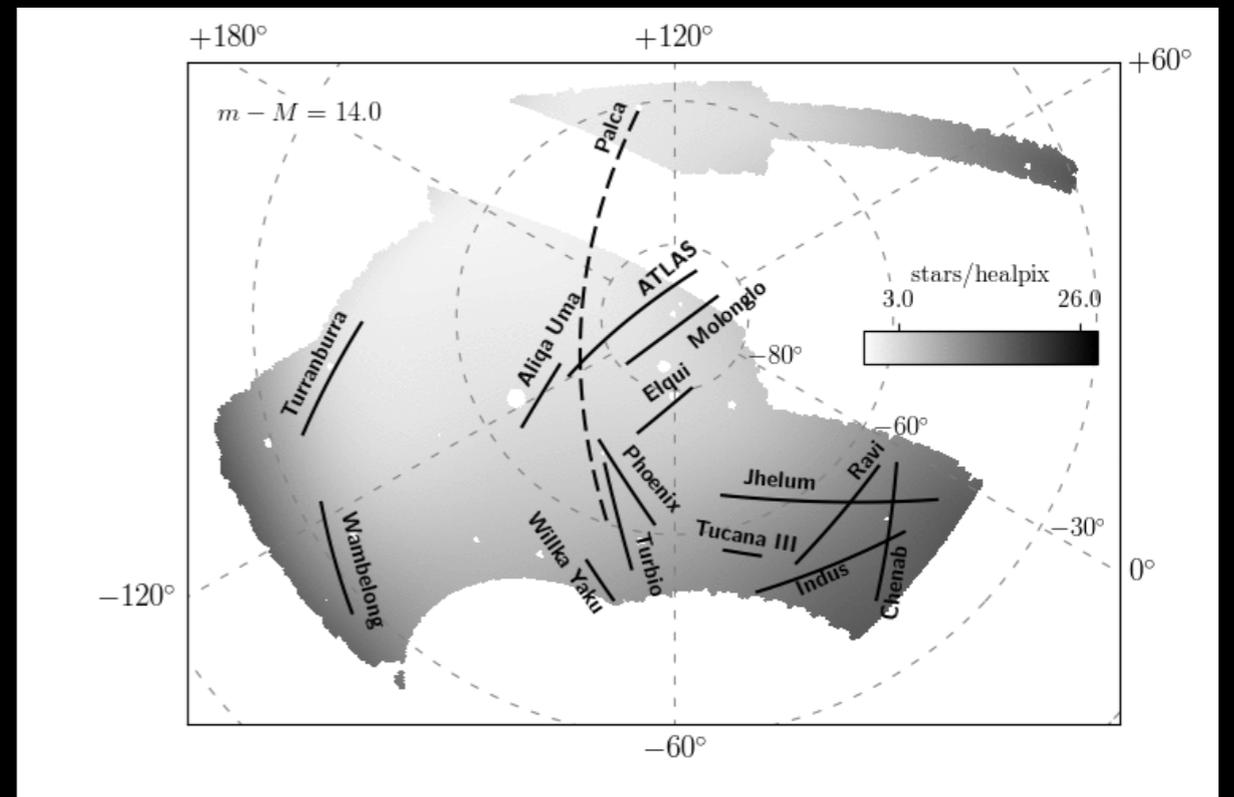
is not just dark energy



Independent discovery of a binary neutron star event
— a gravitational wave source with electromagnetic counterpart.



Dark Energy Survey (DES) is not just dark energy



Discovery of a few milky way streams, relics of tidal stripping.
Named by children in Chile and Australia.

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Design



The Large Synoptic Survey
Telescope —
building an 8.4 meter
telescope in Chile.

Construction



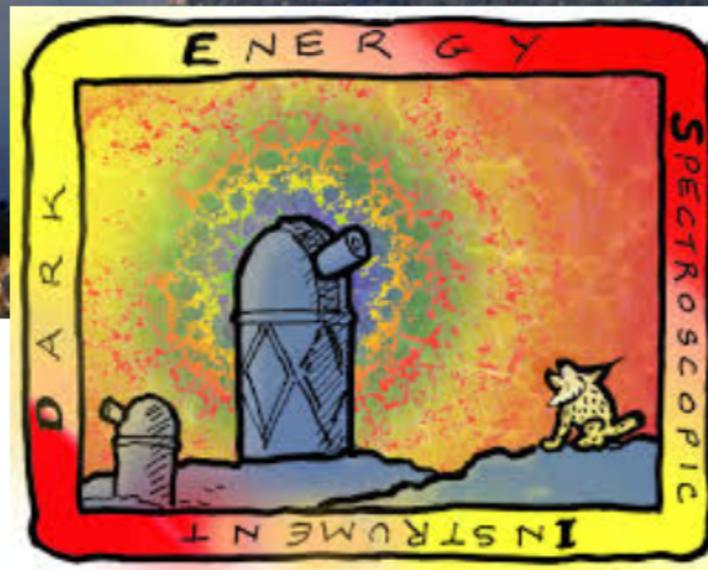
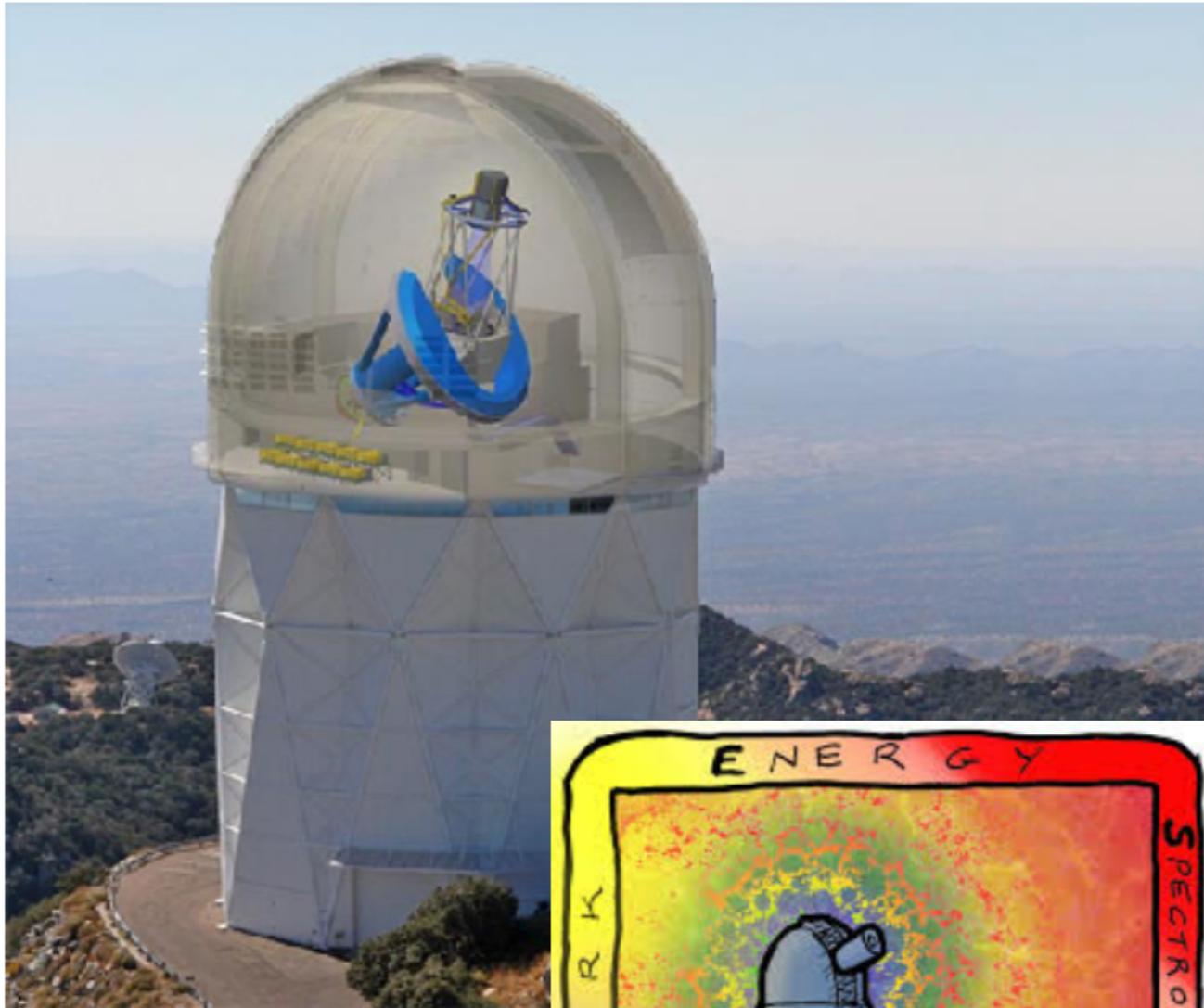
First light expected in 2020.

(1) Full DES depth in 15 s.

(2) Image half of the sky in 3 nights

(3) 10x sensitivity to dark energy
parameters over DES.

Dark Energy Survey (DES) and projections for LSST and *DESI*



The Dark Energy Spectroscopic Instrument — with a 4m telescope in Arizona.

Installation started in Feb 2018.
First light expected in May 2019.

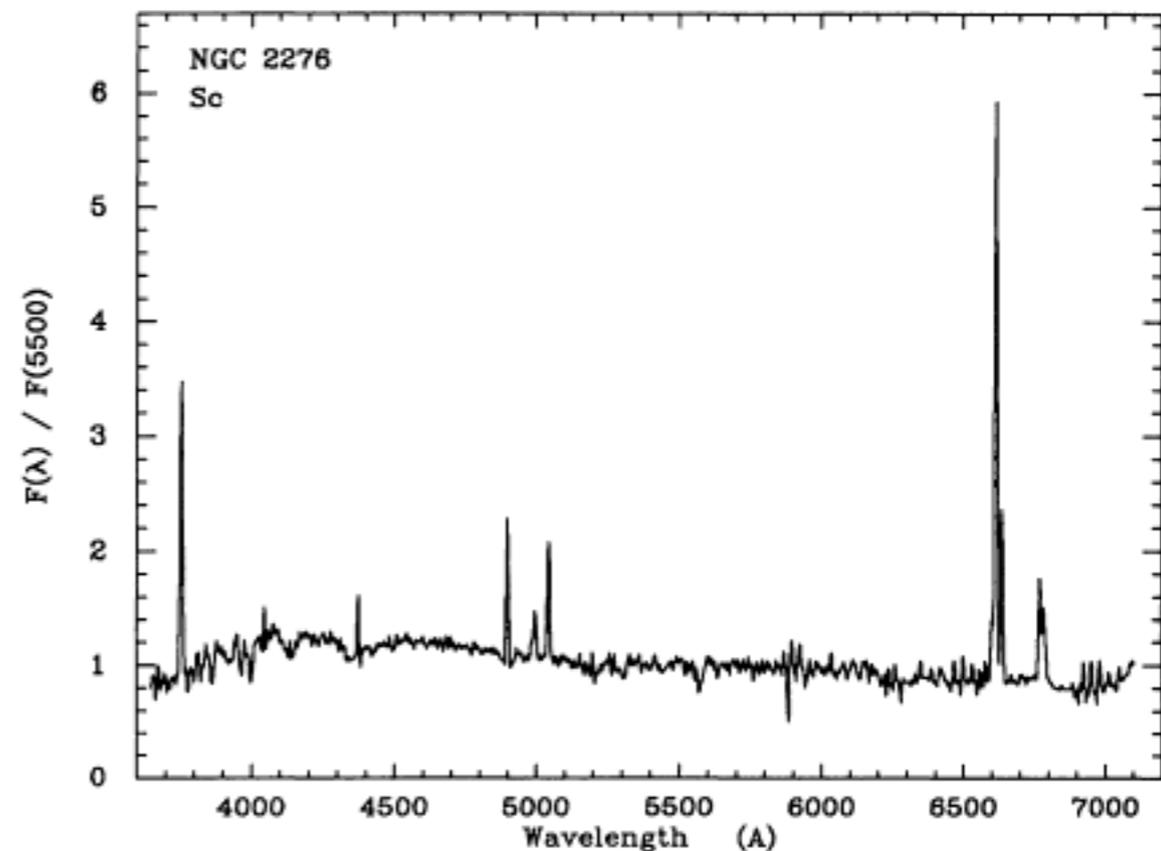
Dark Energy Survey (DES) and projections for LSST and *DESI*

DESI is a **spectroscopic survey** that measures both
(1) the universe expansion history and
(2) cosmic structure growth.

DES/LSST data...



DESI data...



[Credit: R. Kennicutt](#)

Dark Energy Survey (DES) and projections for LSST and *DESI*

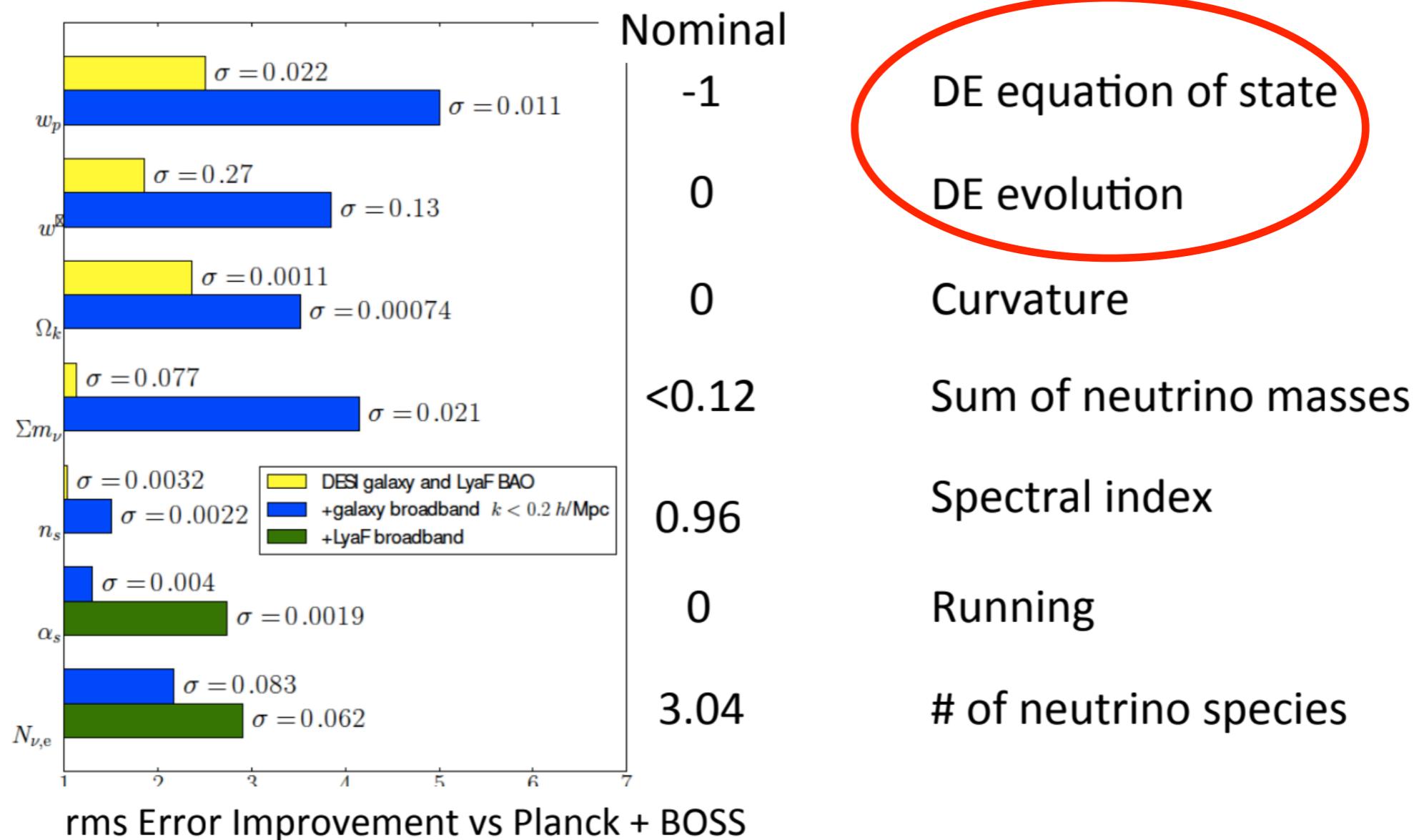
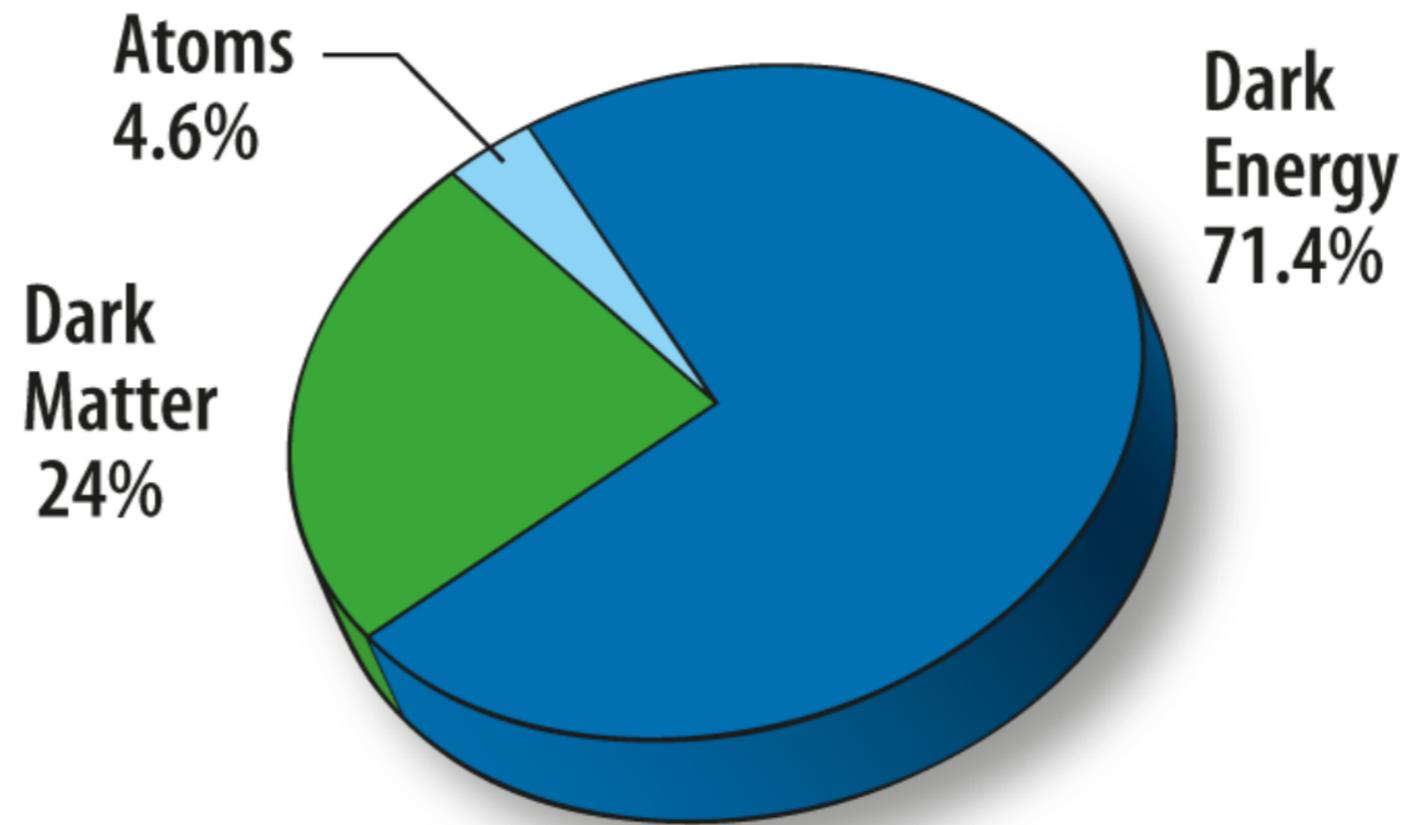


Figure Credit: DESI Collaboration (2016)



Questions?