An Introduction to the Dark Energy Survey

Justin Myles
on behalf of many collaborators in DES

Outline

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   - Telescope and Instrument
   - Survey Strategy
2. Science Probes
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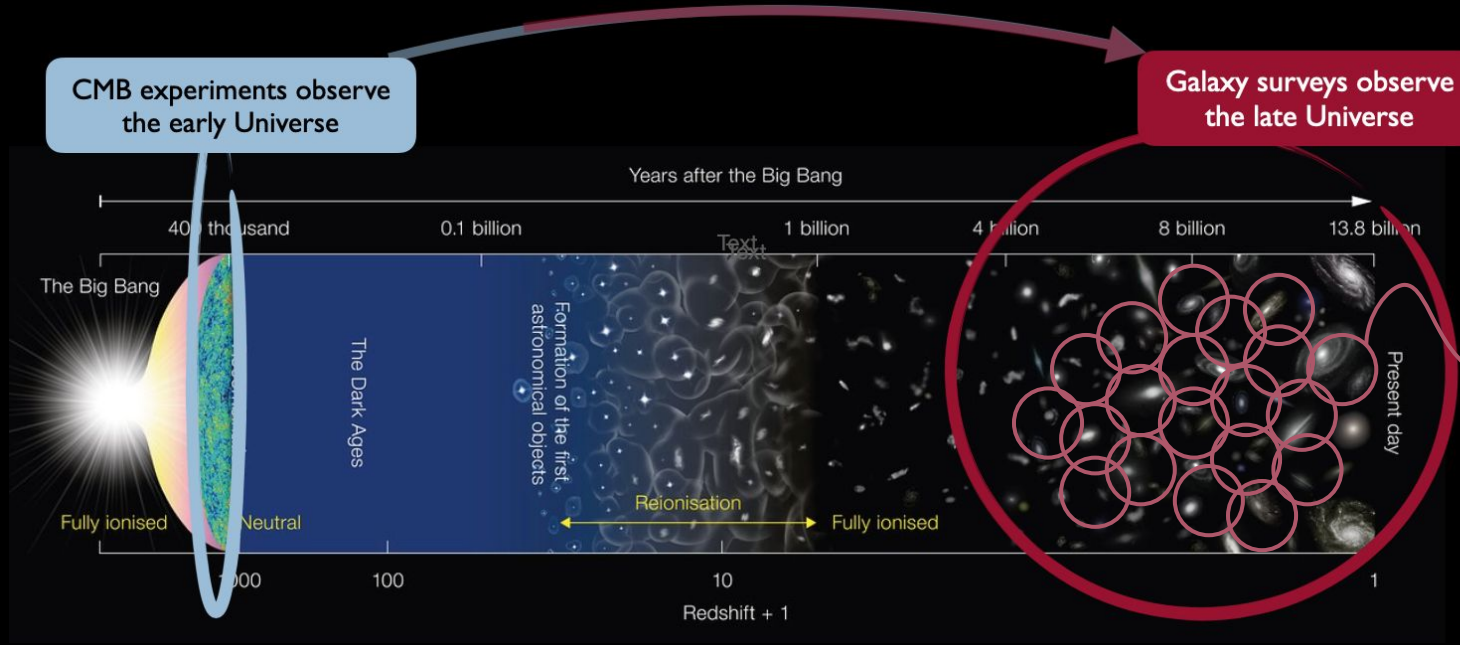
   - Example of additional science opportunities
3. Science Results and Project Status
   - Year 3 Cosmology Results
   - Getting involved

Background

The burning question: Is the late time matter clustering compatible with the ΛCDM prediction assuming initial conditions from the CMB?

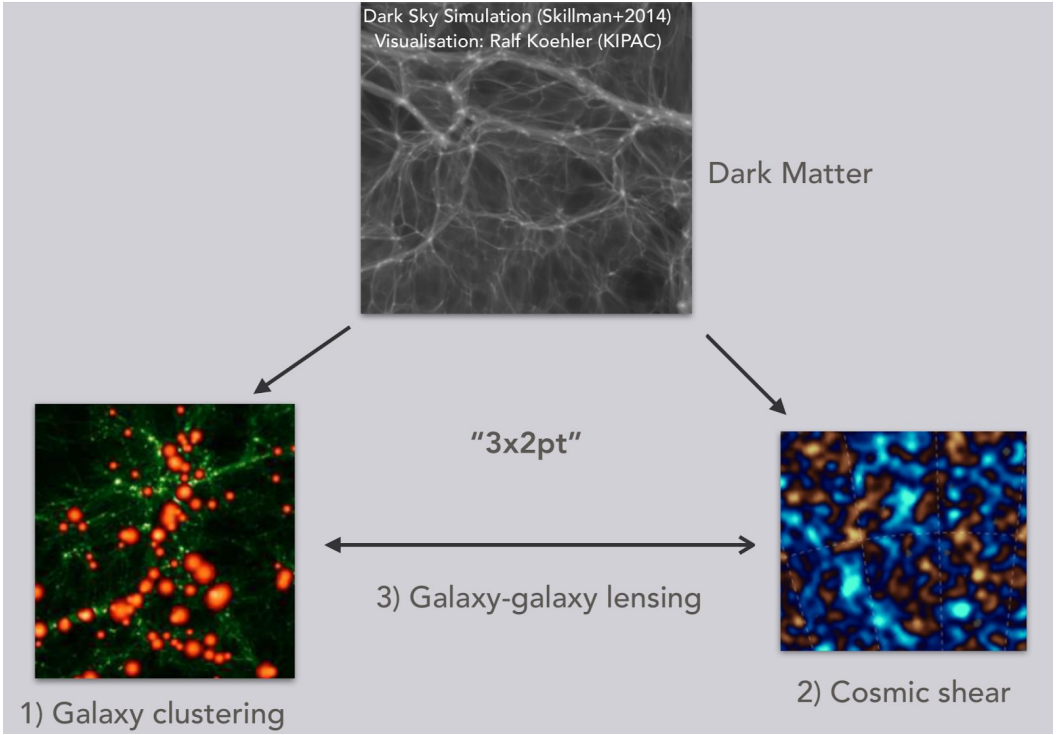


Spheres with radius 8 Mpc/h

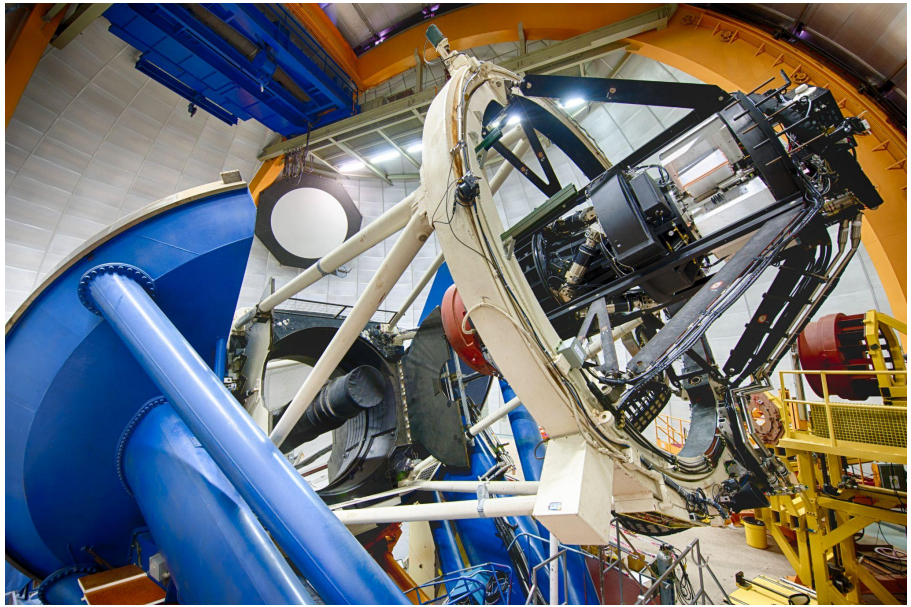
A_s: Amplitude of primordial scalar density fluctuations.

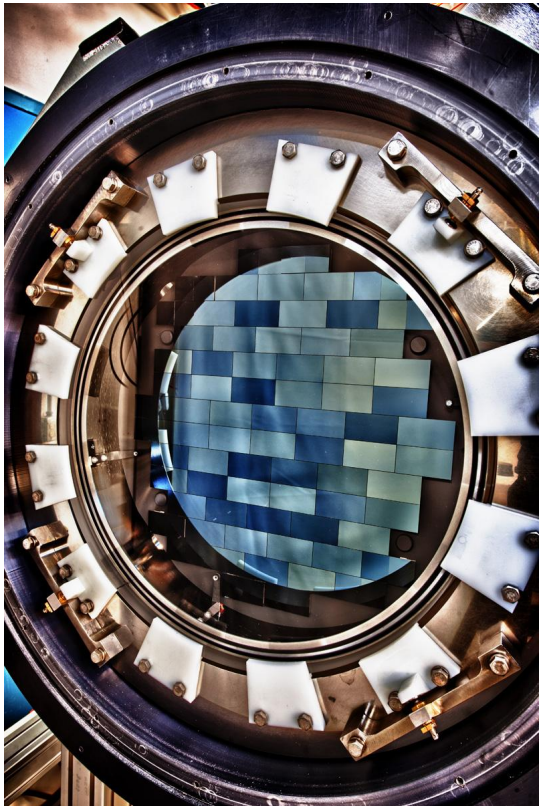
σ_8: Amplitude of mass fluctuations today.

The primary science goal of DES is to study the accelerated expansion of the Universe. DES probes this and other questions with statistical measures of structure in the Universe measured by taking images of galaxies.

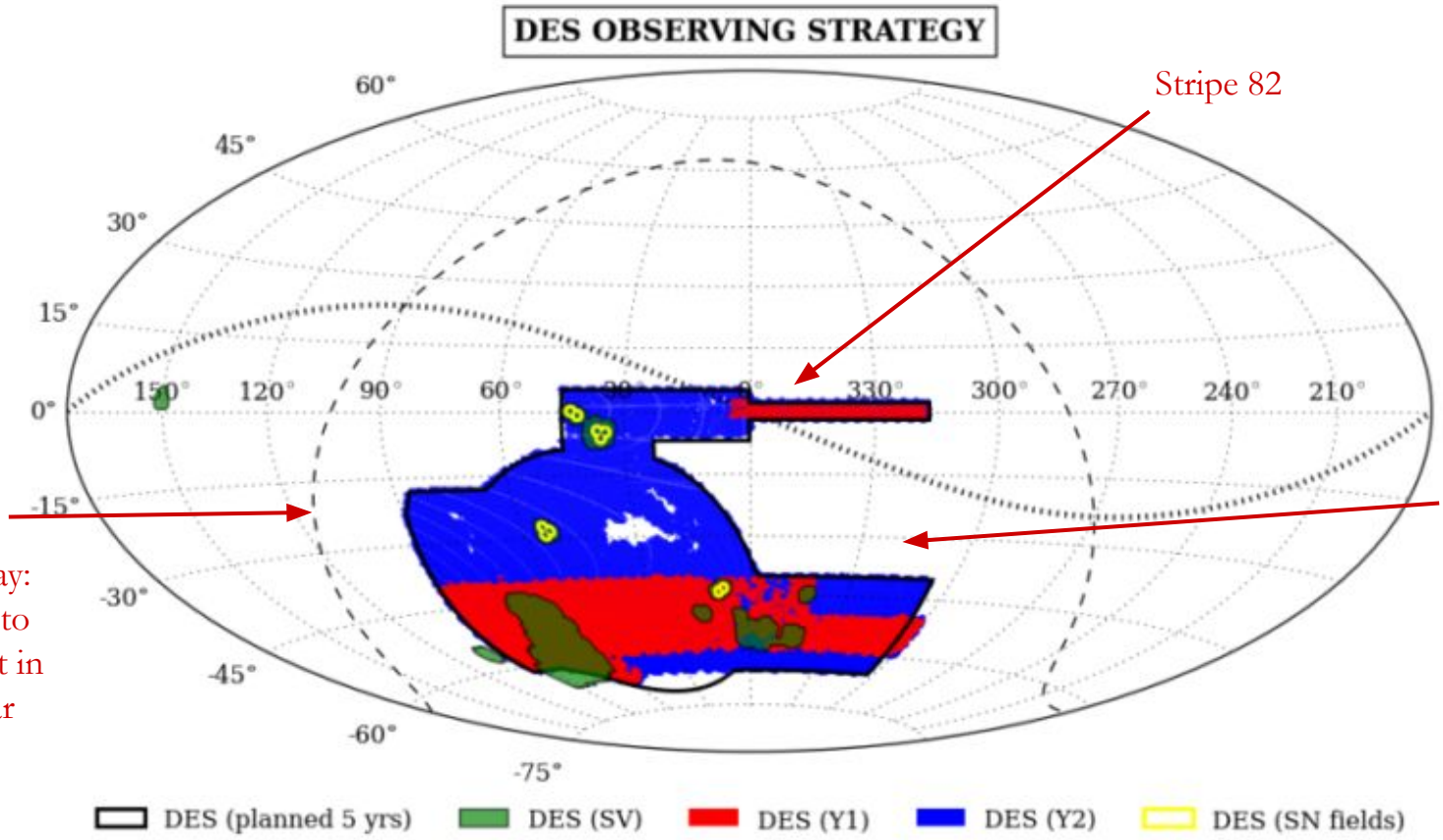


The project is made possible by the state-of-the-art 570 megapixel Dark Energy Camera mounted on the 4m Blanco telescope at CTIO in Chile. Among many innovative features of DECam are the thick CCDs optimized for the red light of galaxies DES targets.





The survey strategy consists of a 5000 sq. deg. wide field to measure statistics of Large Scale Structure of the Universe and an array of 10 smaller deep fields to observe supernovae and other transient phenomena.



Stripe 82

Overlap with South Pole Telescope CMB survey

- - - Milky Way: Avoided due to stars and dust in the interstellar medium

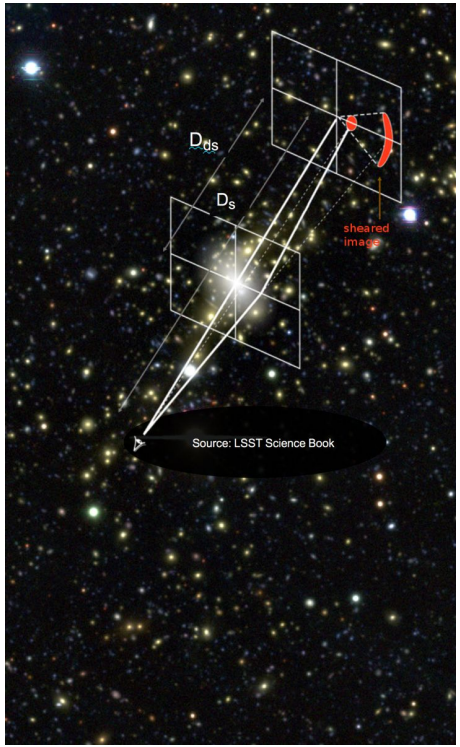
Science Probes

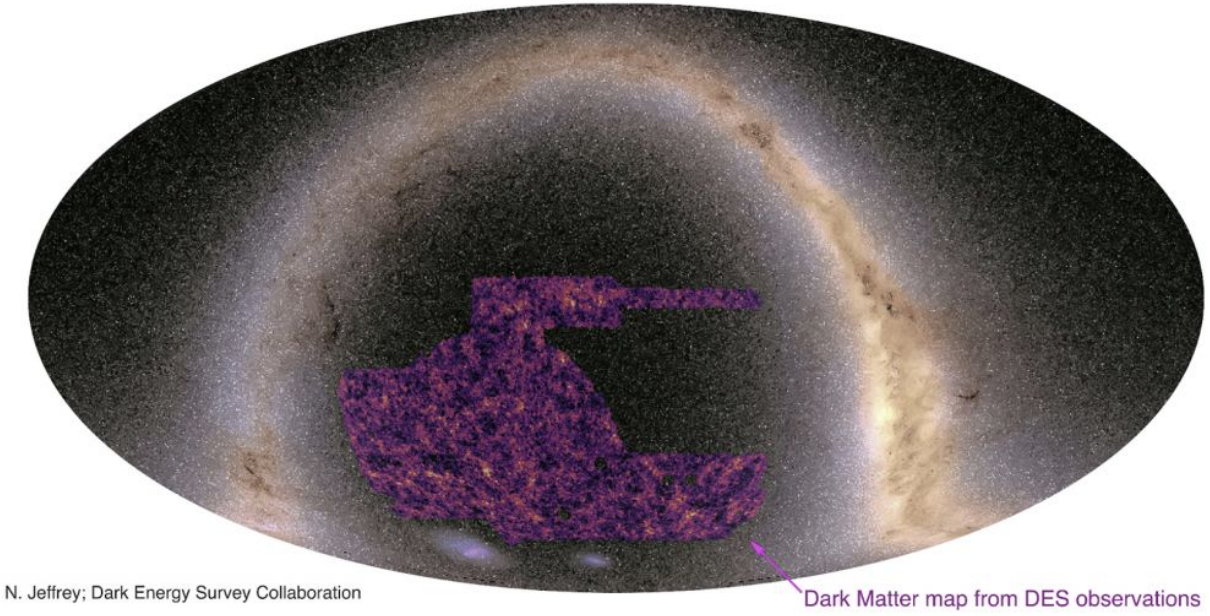
Science Probes

I. Weak Gravitational Lensing
II. Supernovae
III. Galaxy Clusters
IV. Baryon Acoustic Oscillations

and many more...

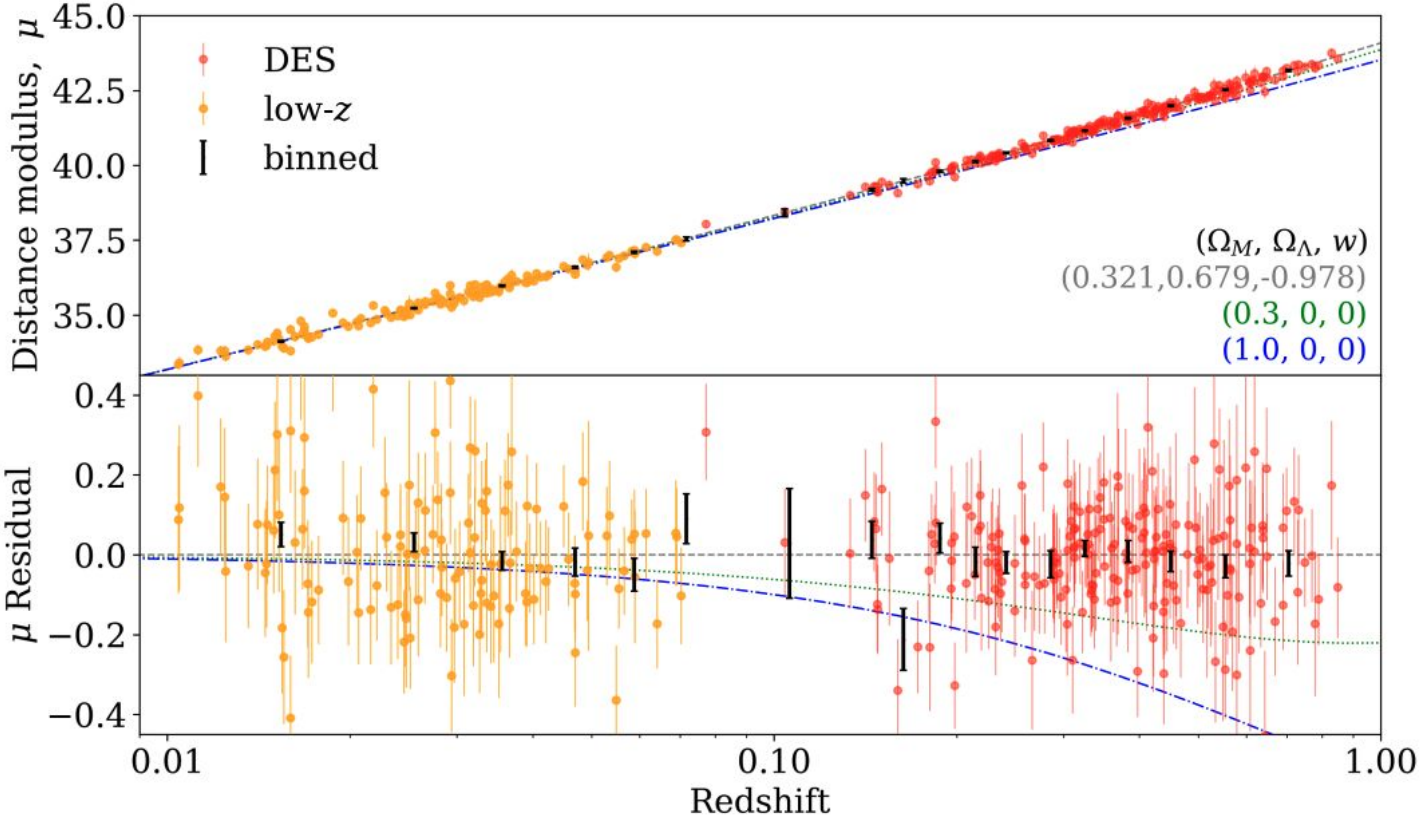
Weak Gravitational Lensing: Matter bends the space that light rays travel through. As a result, measuring distortions in the shapes of galaxies tells us about the distribution of matter between the source galaxy and our position.





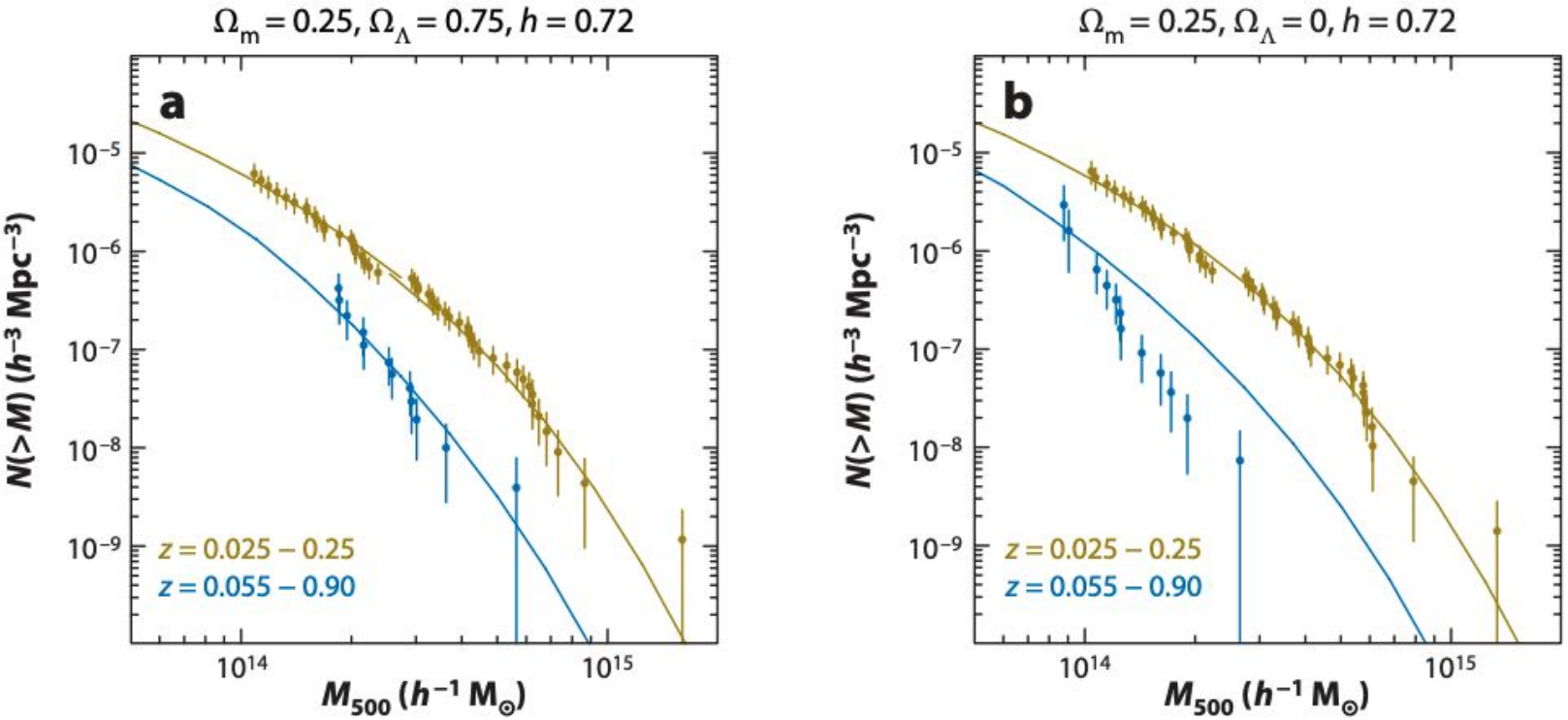
Credit: LSST Science Book; N. Jeffrey; Dark Energy Survey Collaboration

Supernovae: The breaking points of internal physical processes that lead stars to explode correspond to fixed intrinsic luminosities. As a result, we can reliably measure the distances to these 'standard candles'. Measuring their velocities as well, then, tells us directly how fast the Universe is expanding.



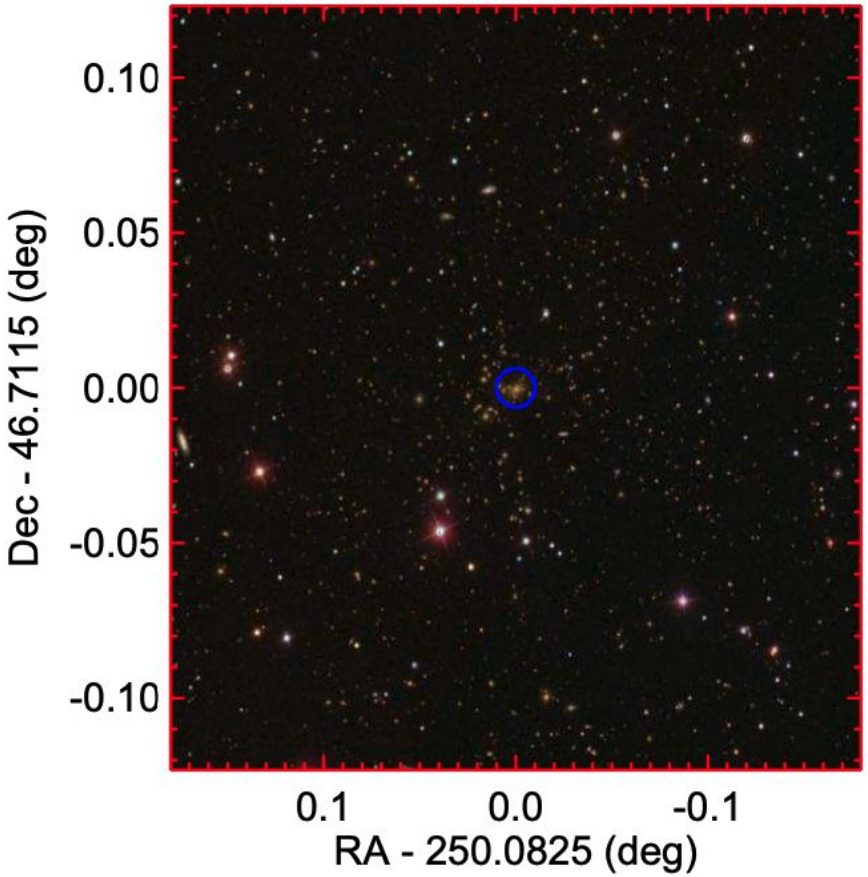
DES et al. 2018

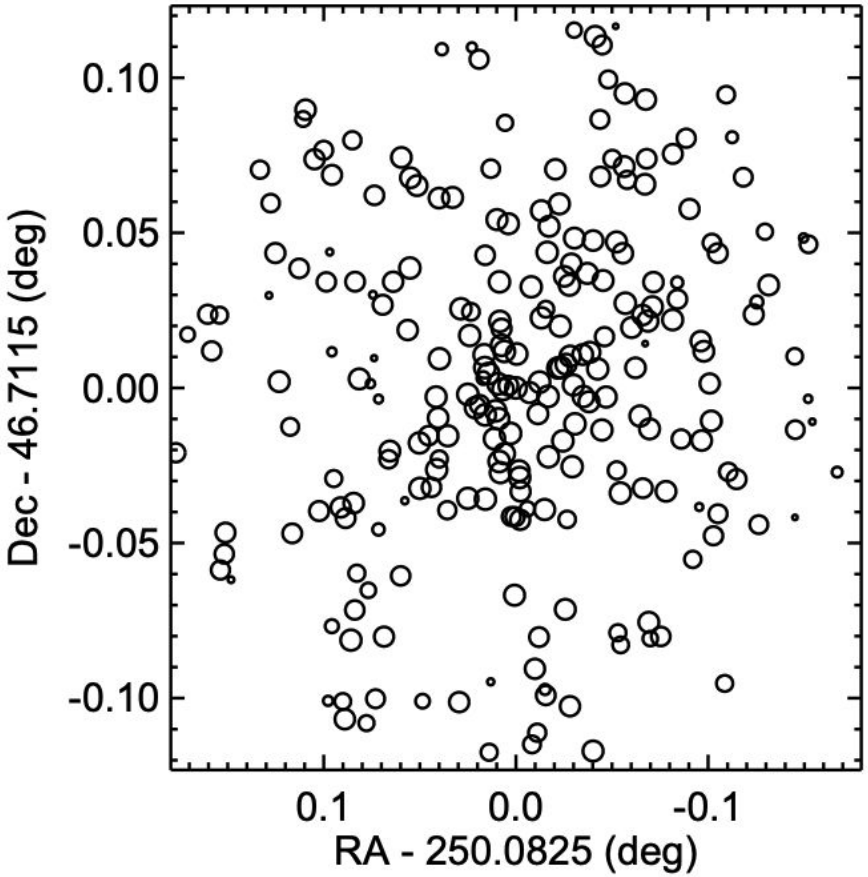
Galaxy Clusters: Structure grows from initial density fluctuations in the Universe. Galaxy Clusters, as the most massive bound objects, in the Universe, grow from the most extreme of the initial overdensities, and thus are a powerful probe of cosmology.



Vikhlinin et al. 2009b

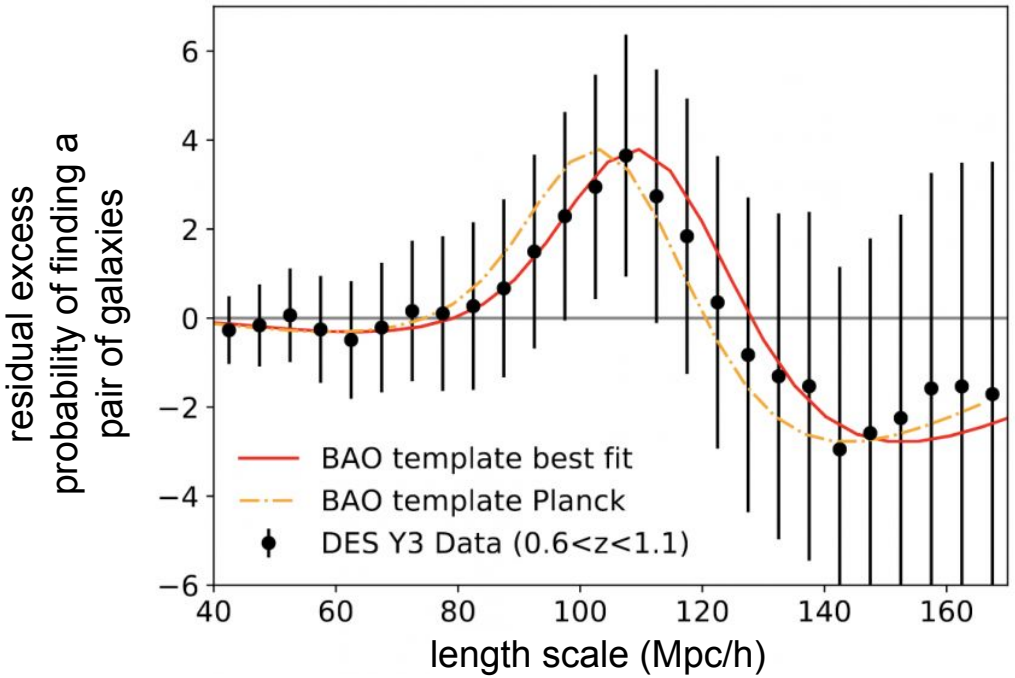
Galaxy Clusters: DES finds galaxy clusters to masses lower than other probes by searching for overdensities of bright red galaxies.





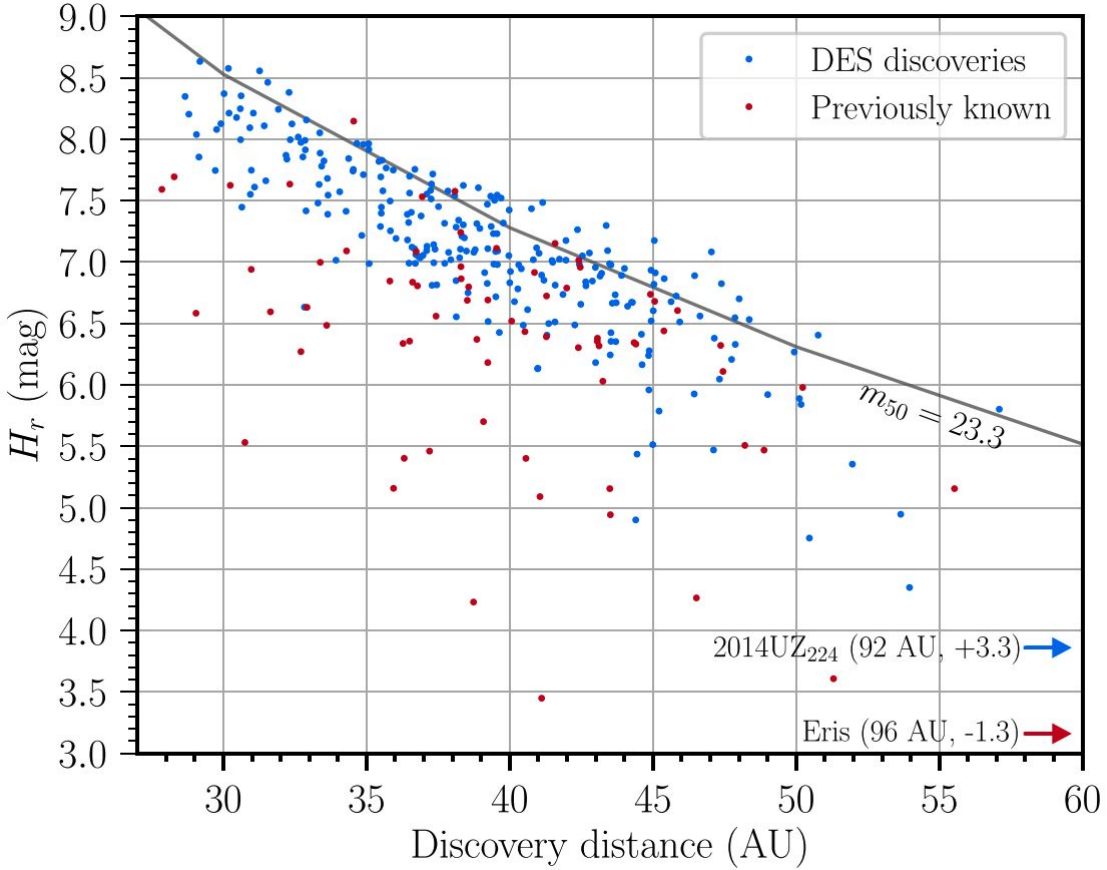
Rykoff et al. 2014

Baryon Acoustic Oscillations: In the early Universe, outward pressure from photon-matter interactions and inward gravitational pull counteracted each other in an oscillatory process. Once the Universe cooled enough for photons to free stream without interacting with electrons (recombination), the largest wavelength of that oscillation became a frozen imprint of the matter density field.



DES et al. 2018

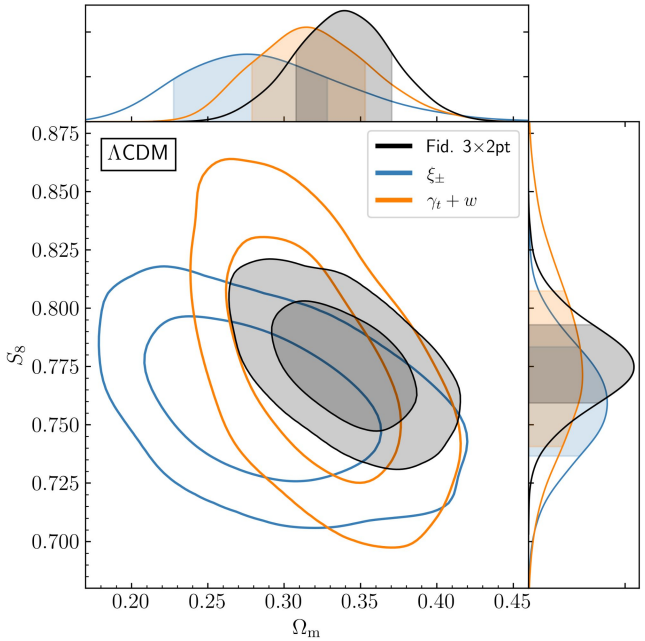
The Search for Planet 9: DES provides a rich and powerful dataset for identifying and measuring the orbits of Solar System Trans-Neptunian Objects to help shed light on the question of the existence of a ninth Solar System planet.

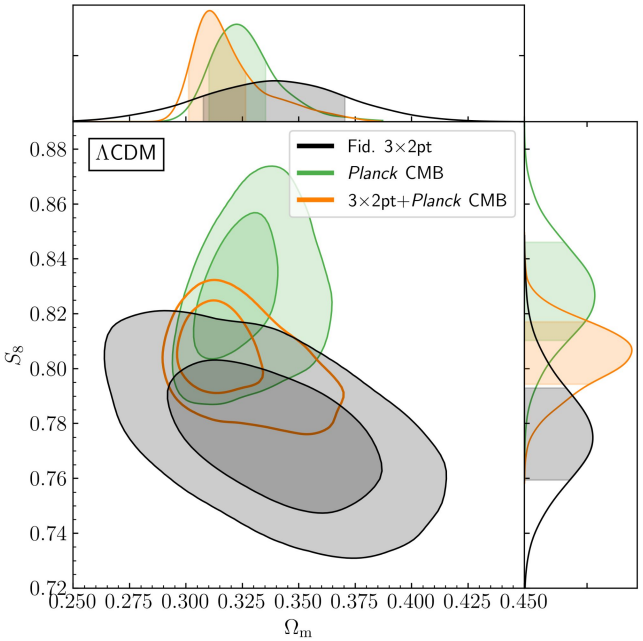


Bernardinelli et al. 2018

Science Results and Project Status

DES Y3 has done the most precise measurement of ΛCDM cosmological parameters with lensing data to date, finding consistency with *Planck* ΛCDM constraints but continues to find lensing being suspiciously low in matter clustering.





Dark Energy Survey Collaboration et al. 2021

Getting Involved

DES has produced an enormously useful dataset. See the link below to dig in to the data!

https://www.darkenergysurvey.org/the-des-project/data-access/

Y3 catalogs to be made public following the acceptance of all Y3 analysis papers.

Questions?