Dark Energy Spectroscopic Instrument: Science Overview

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Successful Start of Dark Energy Spectroscopic Instrument (DESI) Follows Record-Setting Trial Run

International collaboration, under the aegis of Berkeley Lab, aims for 3D map of the universe, unraveling of mysterious 'dark energy'

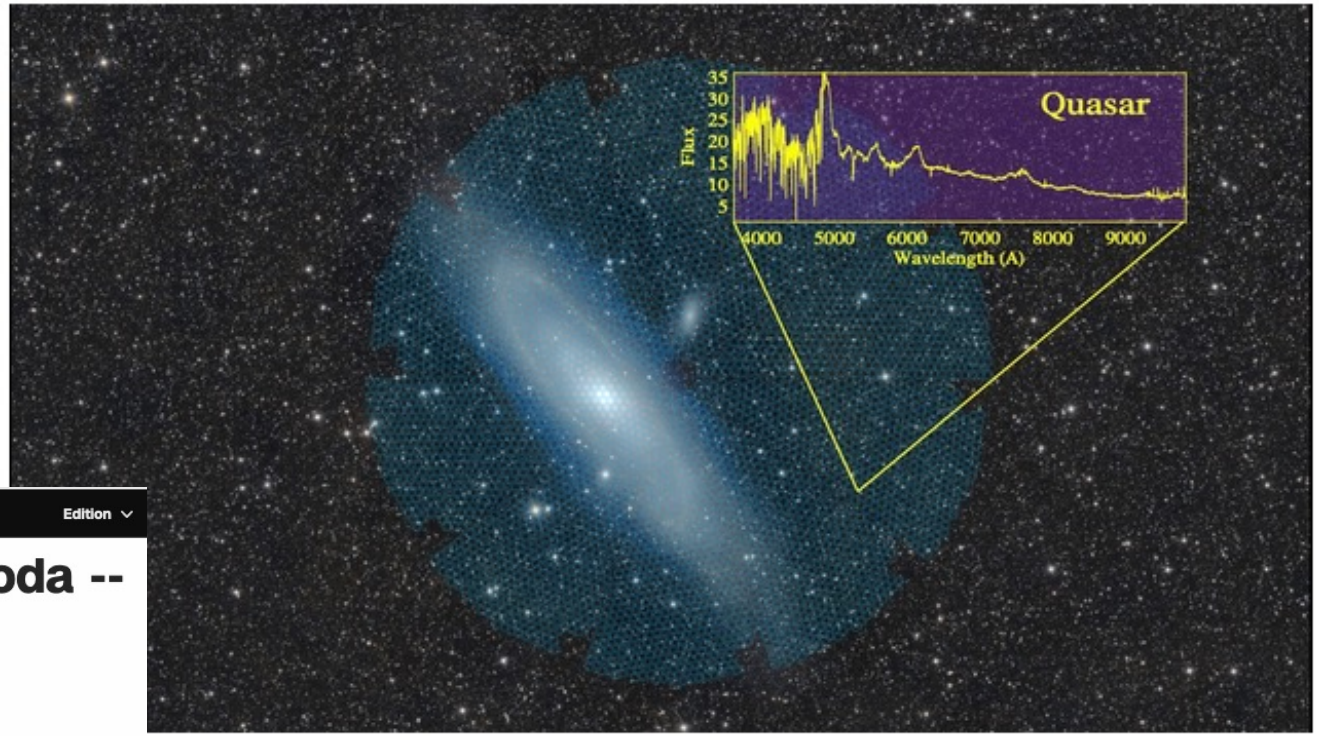
News Release Media Relations 510-220-8529 • **May 17, 2021**

0 SHARES

DESI started a 5-year survey on May 15th 2021

First Stage-IV Dark Energy experiment on sky

It will soon become the largest 3D map yet!

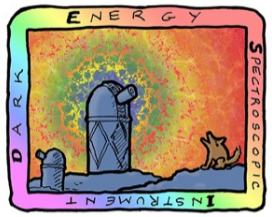


CNN Opinion Political Op-Eds Social Commentary Edition

Scientists are going back to Einstein to best Yoda -- and know the fate of the universe

Opinion by Don Lincoln

Updated 0332 GMT (1132 HKT) June 4, 2021



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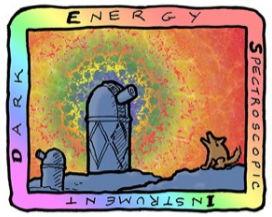
Three DESI talks in this session:

1. Science Overview: Andreu Font-Ribera (IFAE)
2. Instrument Overview: Paul Martini (OSU)
3. Data Overview: Julien Guy (LBNL)



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1. **Science goals: dark energy, modified gravity and massive neutrinos**
2. Main probes: Baryon Acoustic Oscillations (BAO) and Redshift Space Distortions (RSD)

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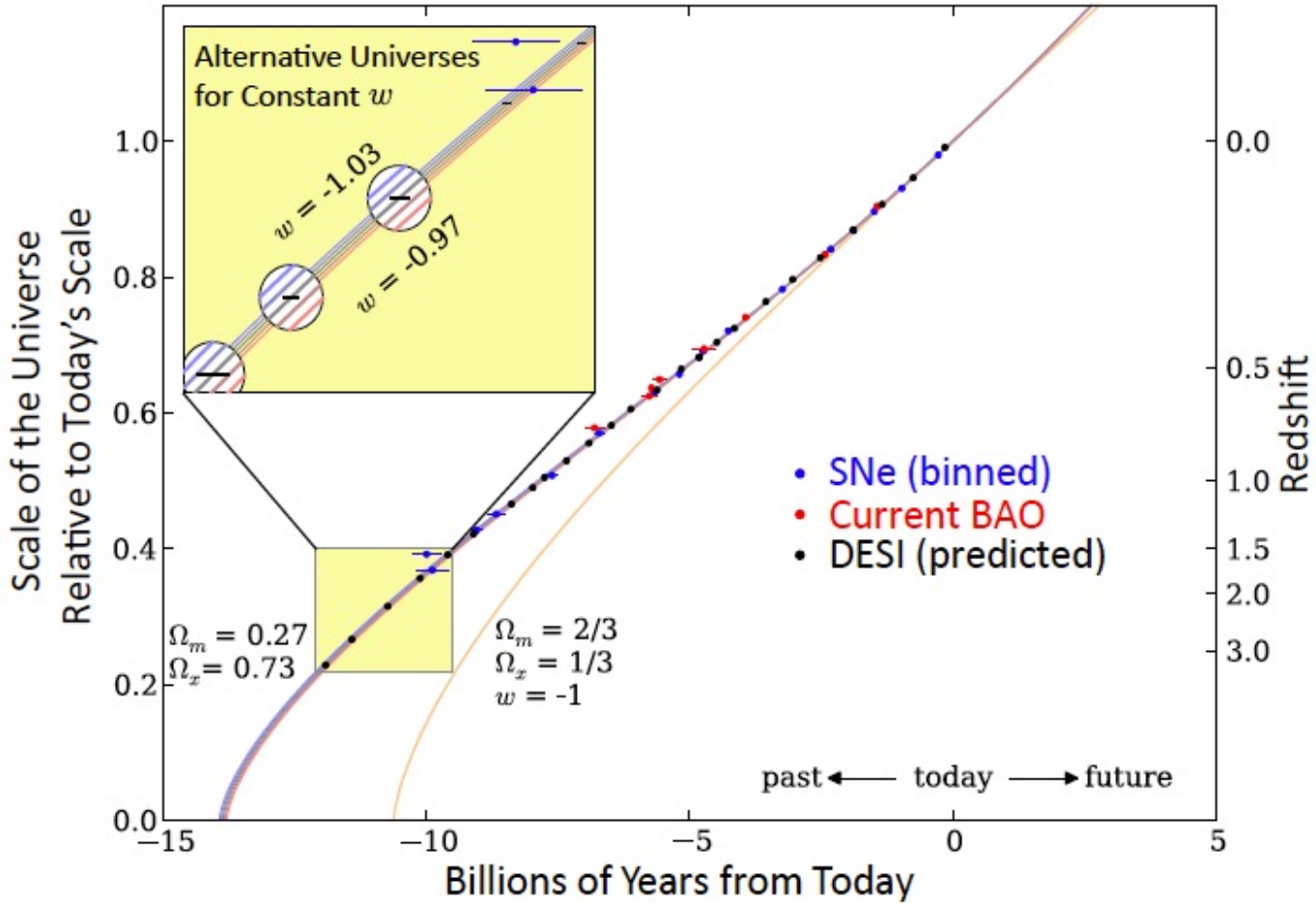
Dark Energy

- The accelerated expansion of the Universe is now confirmed by independent cosmological probes
- Its cause is one of the biggest questions in physics, and a main science case for ongoing and future experiments
- DESI will use a robust standard ruler (Baryon Acoustic Oscillations) to measure the expansion history and constraint the equation of state of dark energy

$$w = p/\rho$$



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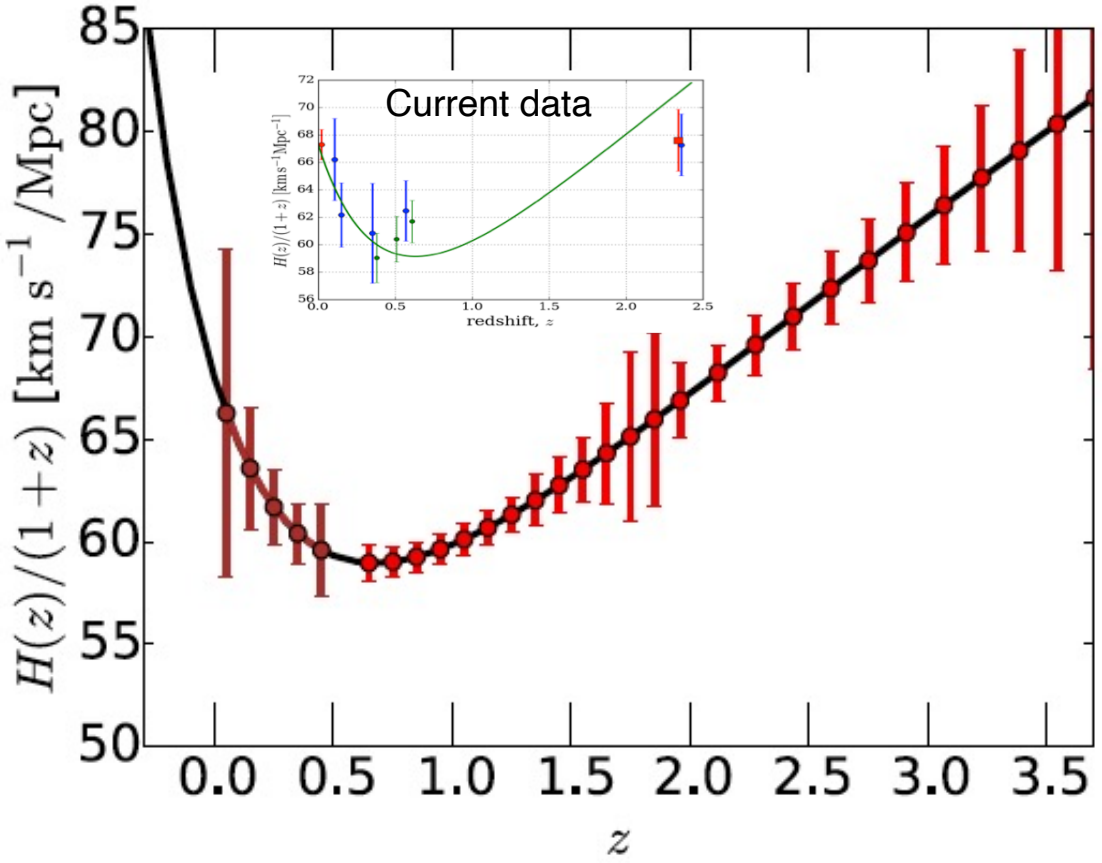
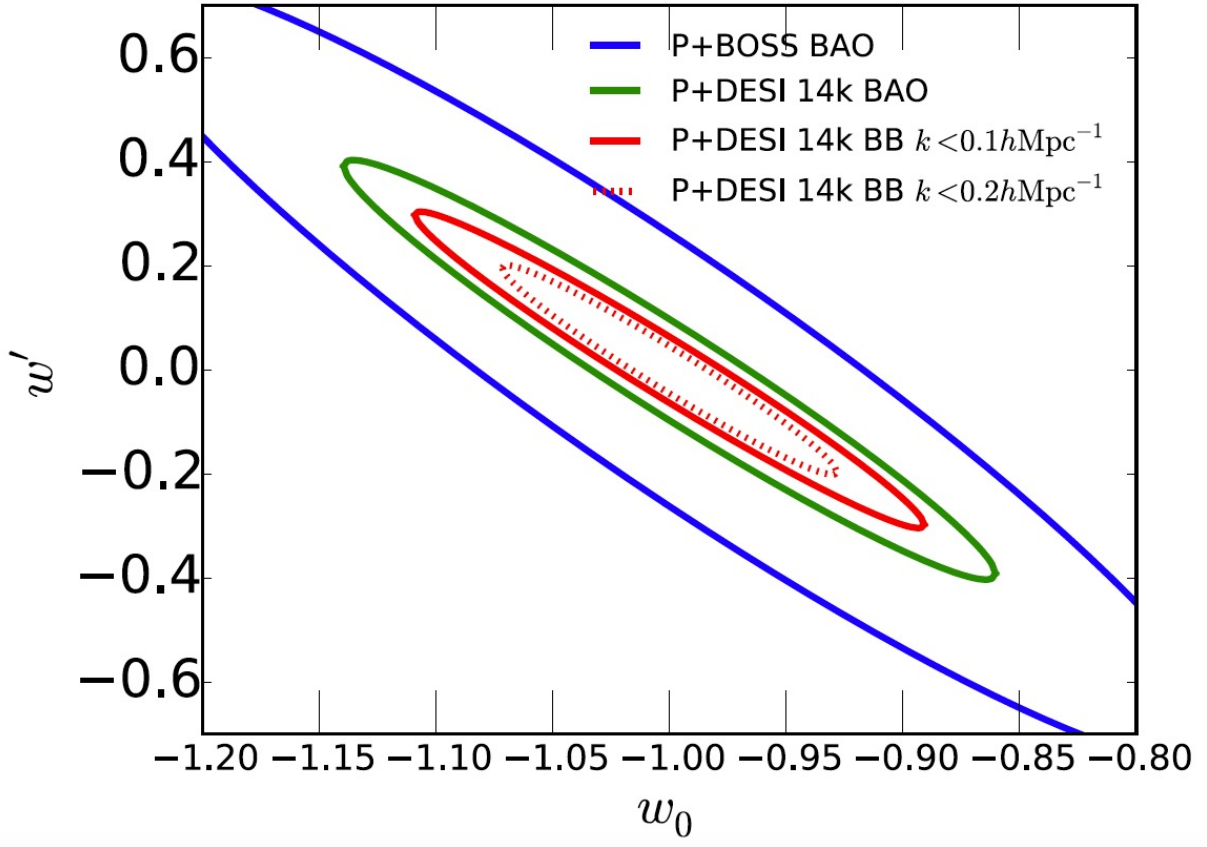
Dark Energy





DESI BAO data will measure the expansion history of the Universe in the range 0 < z < 3.5

It will constraint the equation of state of dark energy, and distinguish between models

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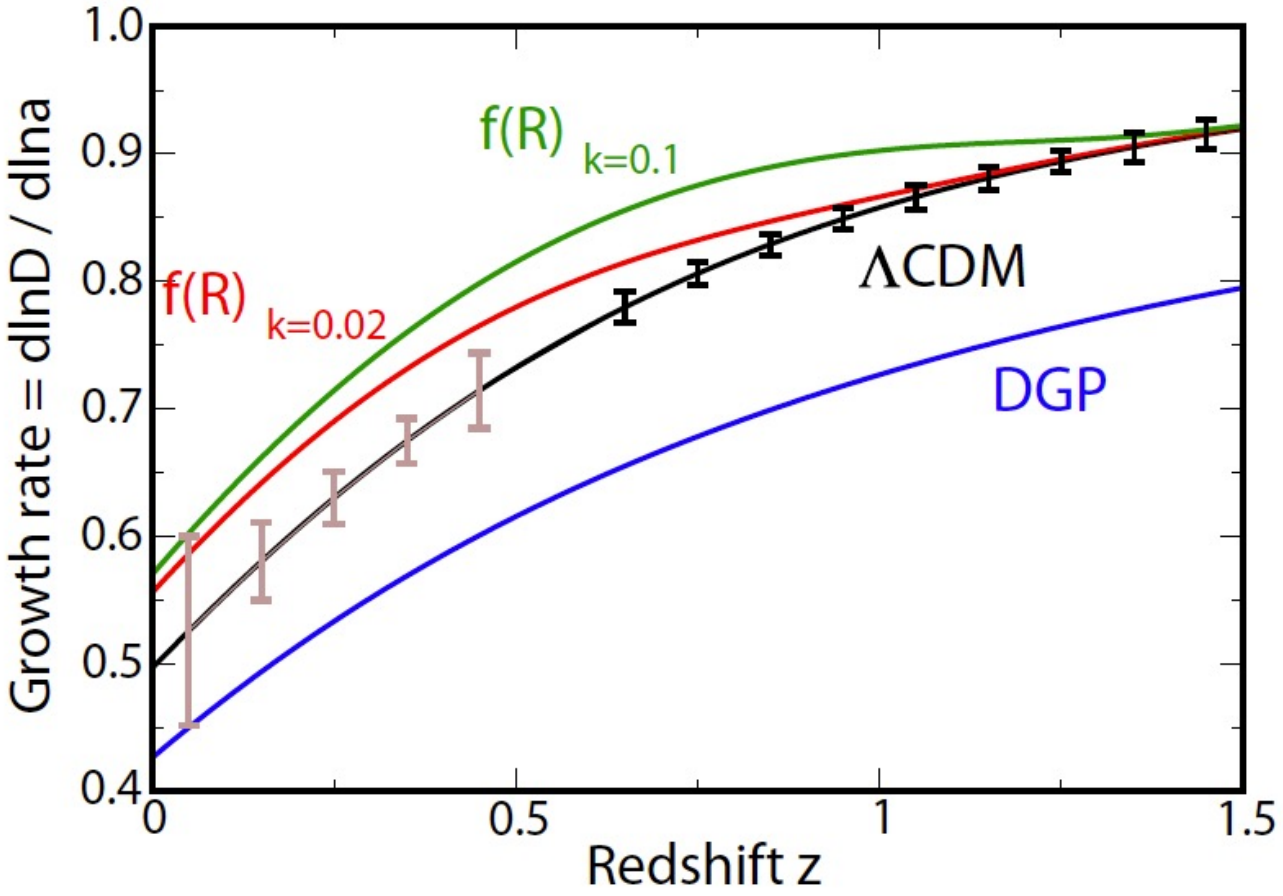
Modified Gravity

- Modified gravity (MG) models can mimic the expansion of dark energy (DE) models
- One can distinguish between MG and DE by also measuring the growth of structure
- DESI will study the anisotropy in the distribution of galaxies to provide accurate measurements of the growth rate



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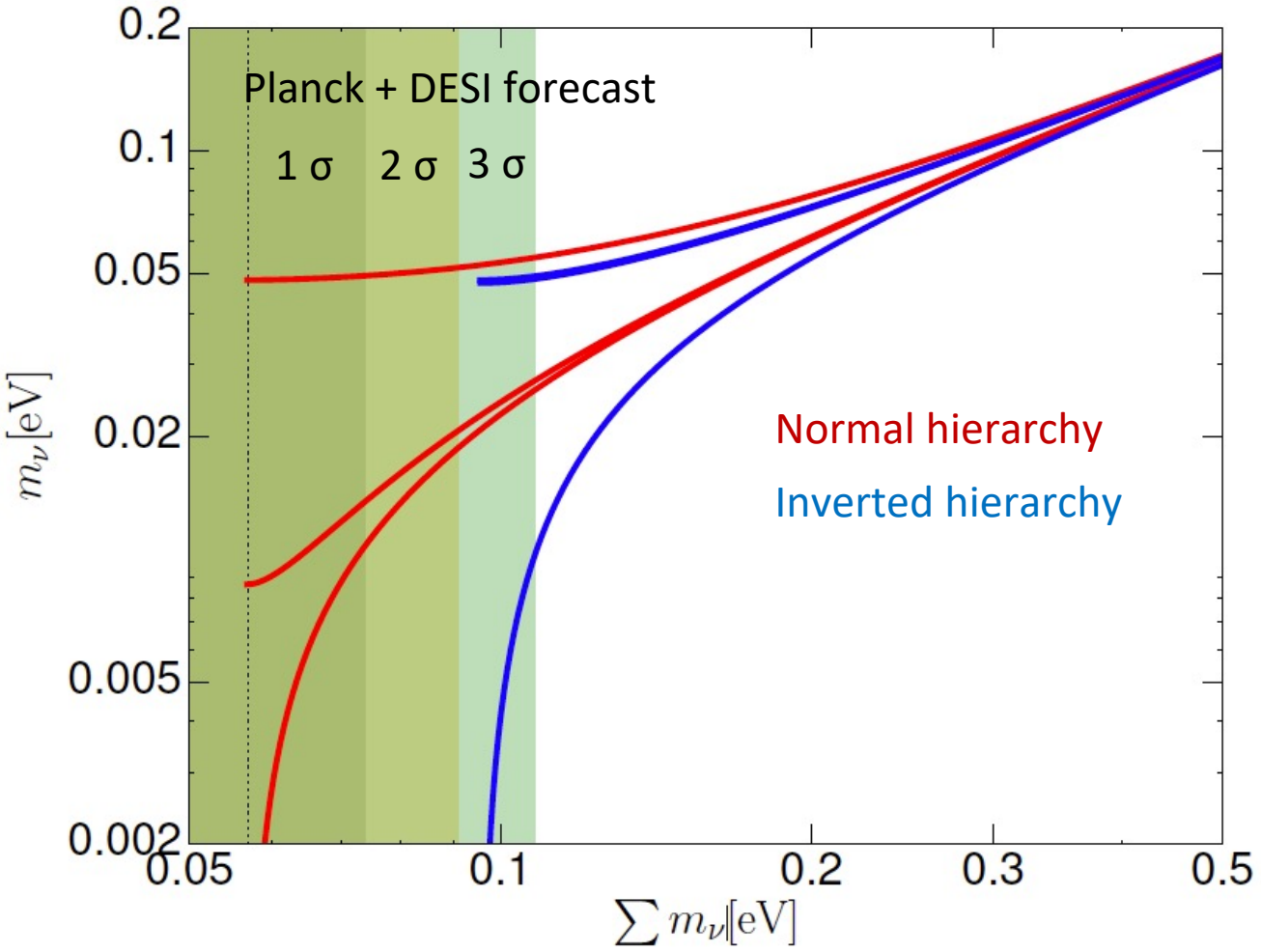
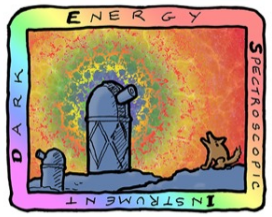
Massive neutrinos

- Massive neutrinos leave an imprint in the distribution of matter in the Universe, affecting both its expansion and growth
- In combination with Planck, DESI will be able to accurately measure the sum of the neutrino masses within 0.017 eV
- Depending on the actual measurement we might be able to distinguish between the different neutrino hierarchies





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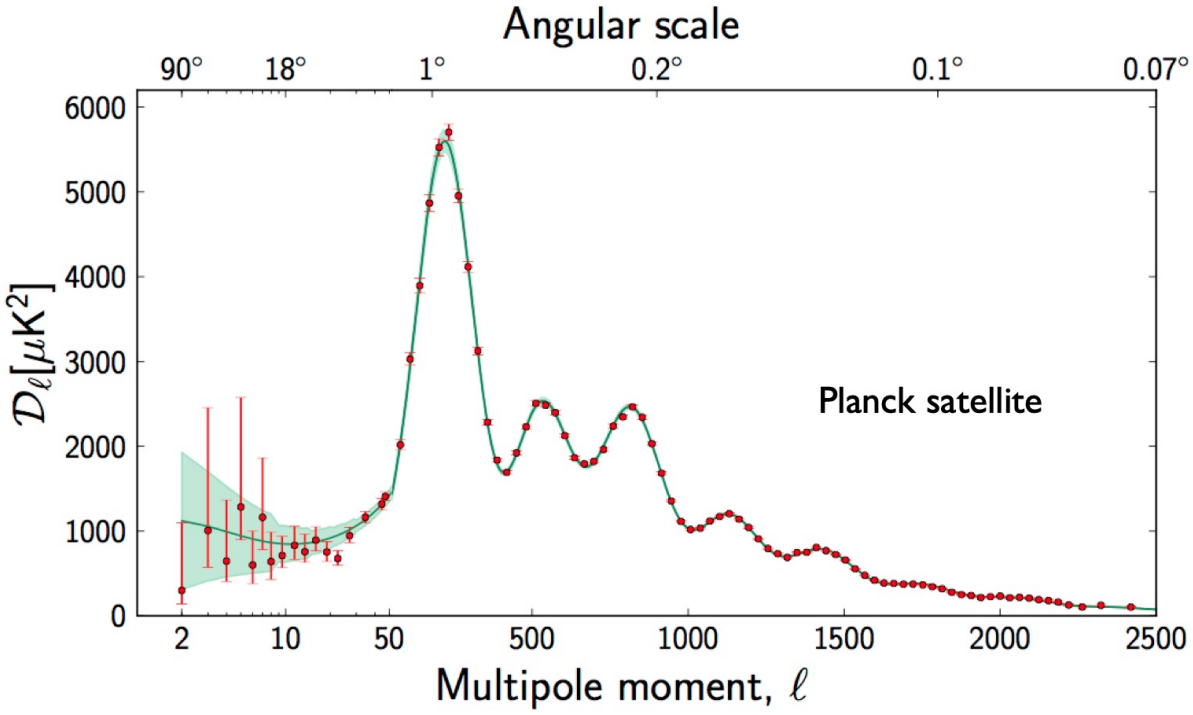
Baryon Acoustic Oscillations (BAO)

Acoustic waves in the photon-baryon plasma in the early Universe left an imprint in the CMB, at a well-known scale known as the “sound horizon”



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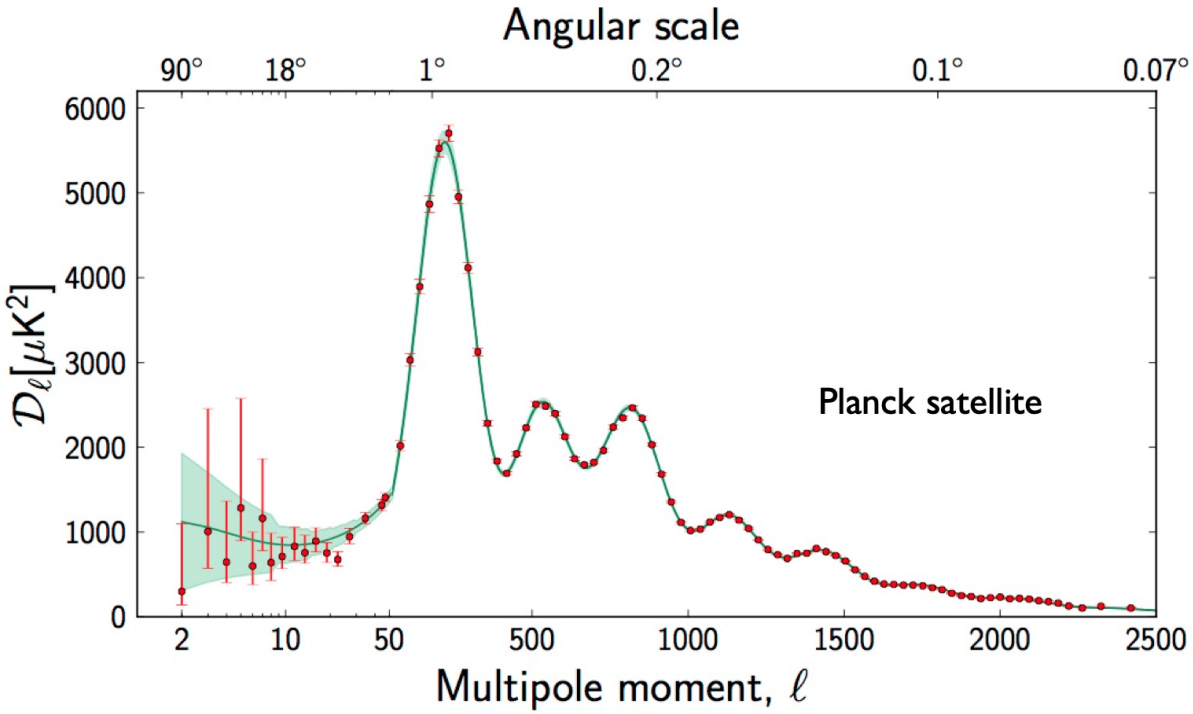
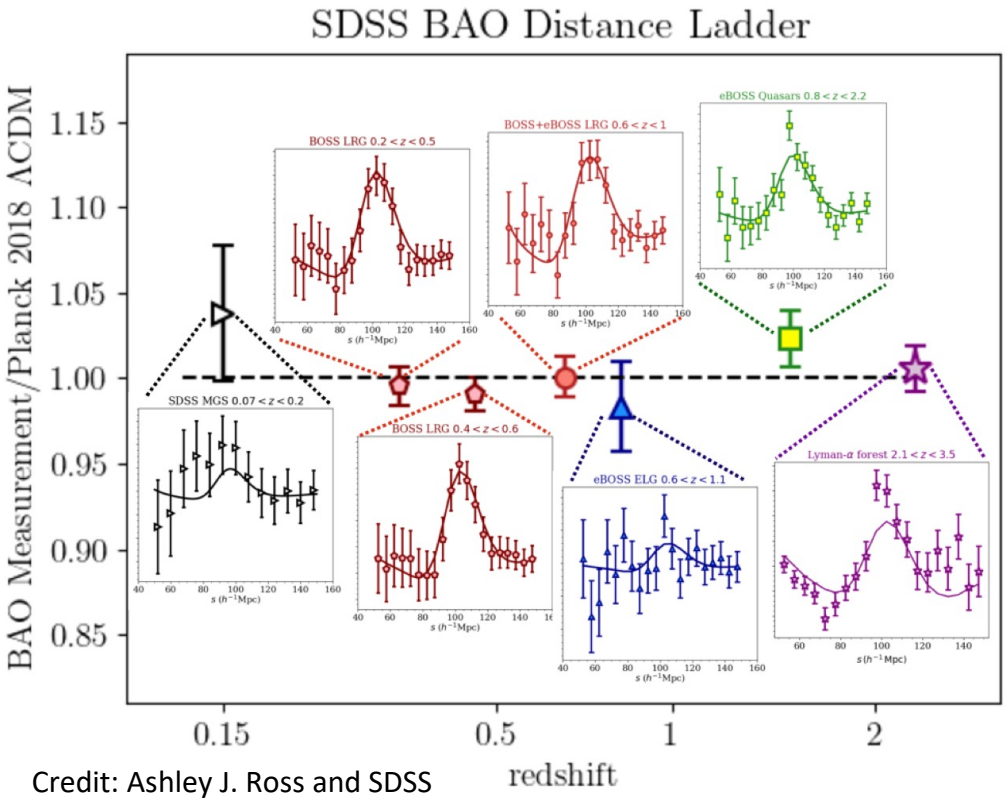


BAO have also been detected in the distribution of matter at low redshift, and can be used as a standard ruler to measure distances to galaxies



Credit: Ashley J. Ross and SDSS

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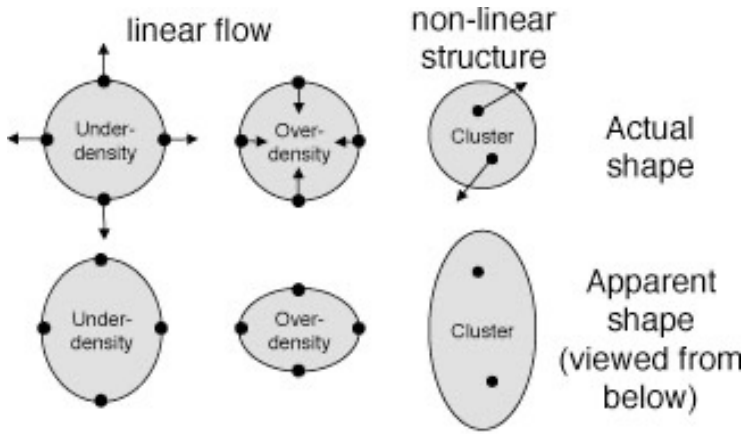
Redshift Space Distortions (RSD)

Our galaxy maps are distorted, since our radial coordinate is inferred from its redshift (velocity)

On large (linear scales), the anisotropy in the galaxy correlations depends on the amplitude matter fluctuations and the theory of gravity



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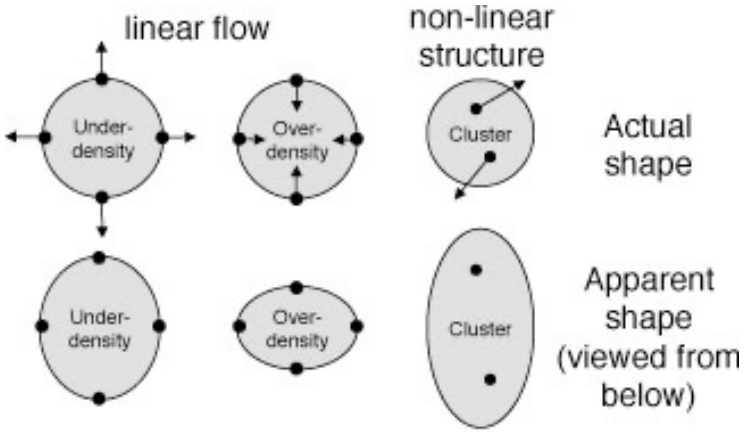
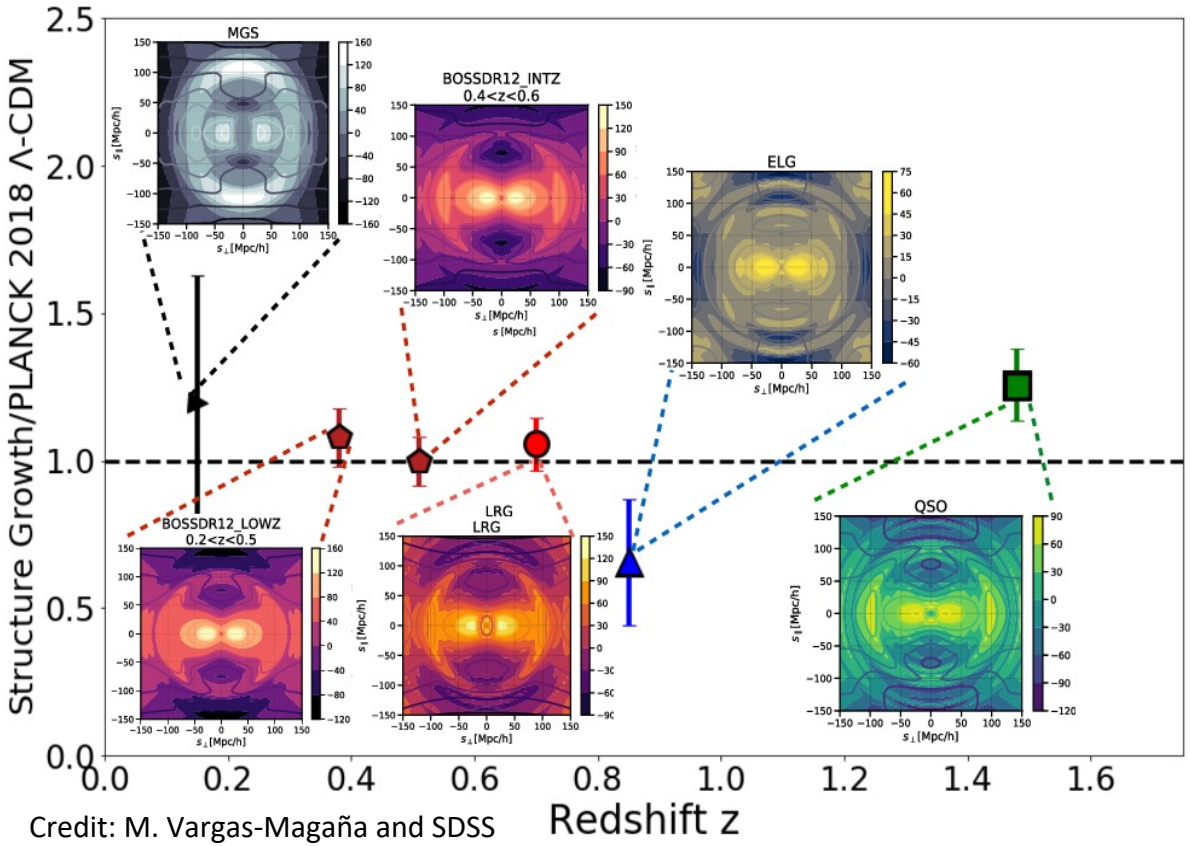


Credit: Will Percival

RSDs can be used to measure the growth of structure



Credit: M. Vargas-Magaña and SDSS

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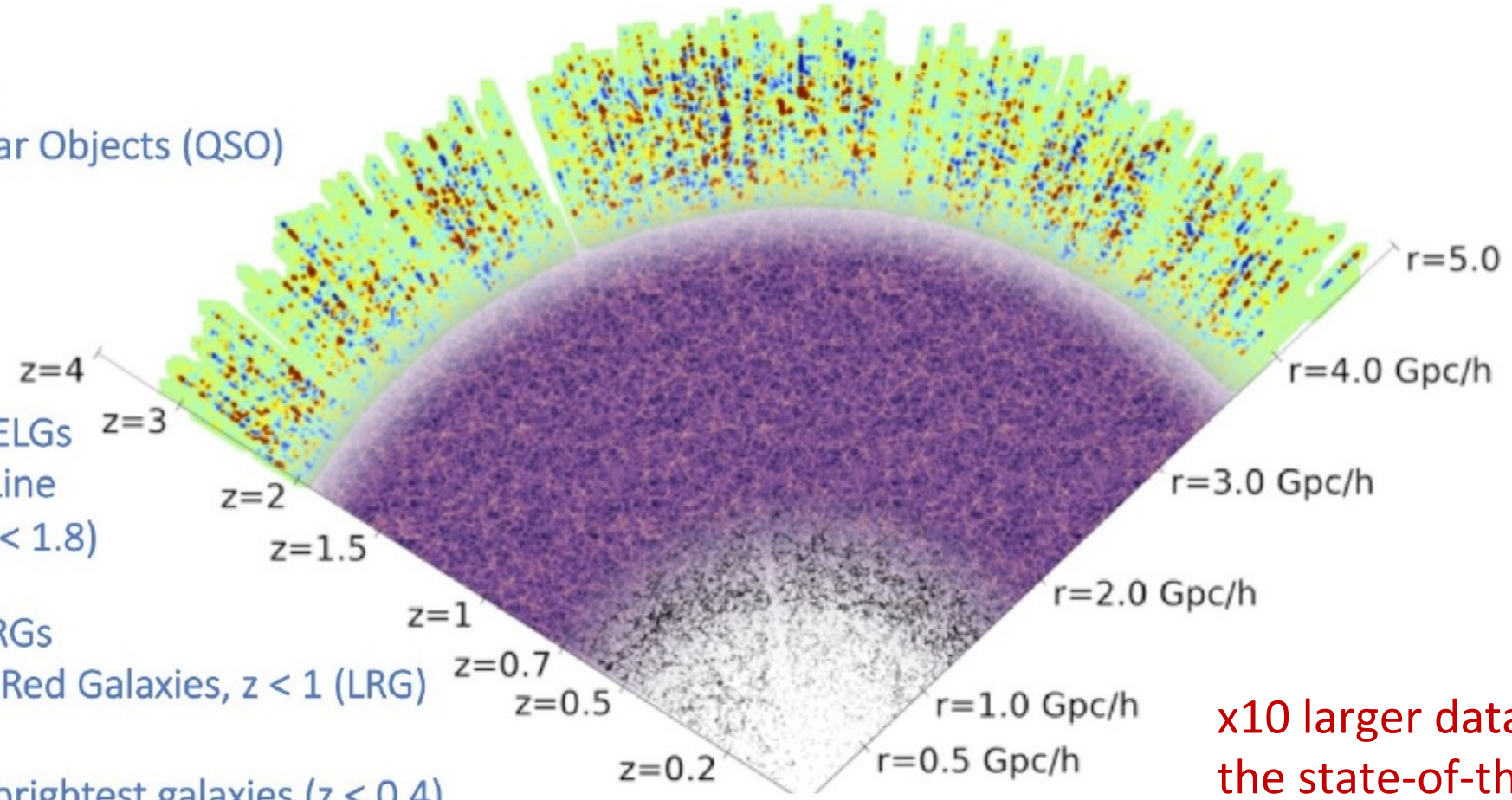
DESI main survey

2.7 million
Quasi Stellar Objects (QSO)

13 million ELGs
(Emission Line Galaxies, z < 1.8)

7.5 million LRGs
(Luminous Red Galaxies, z < 1 (LRG)

9 million brightest galaxies (z < 0.4)



x10 larger dataset than the state-of-the-art (SDSS)

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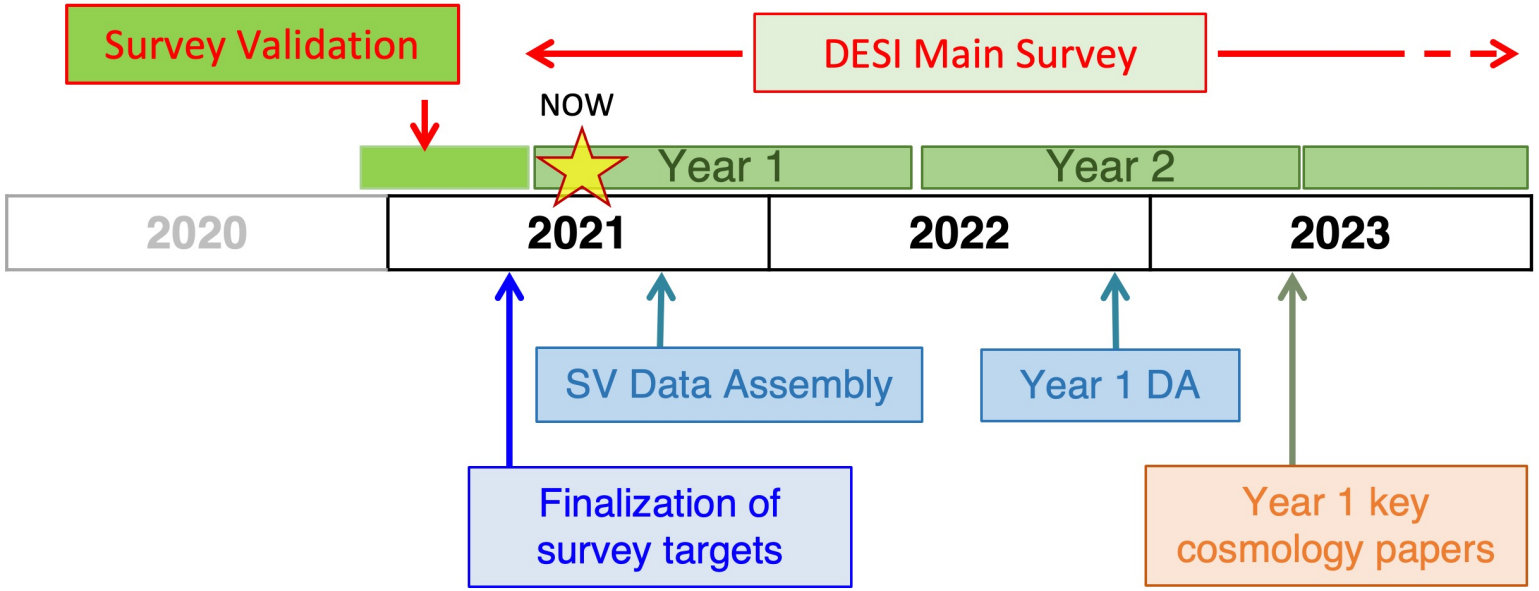
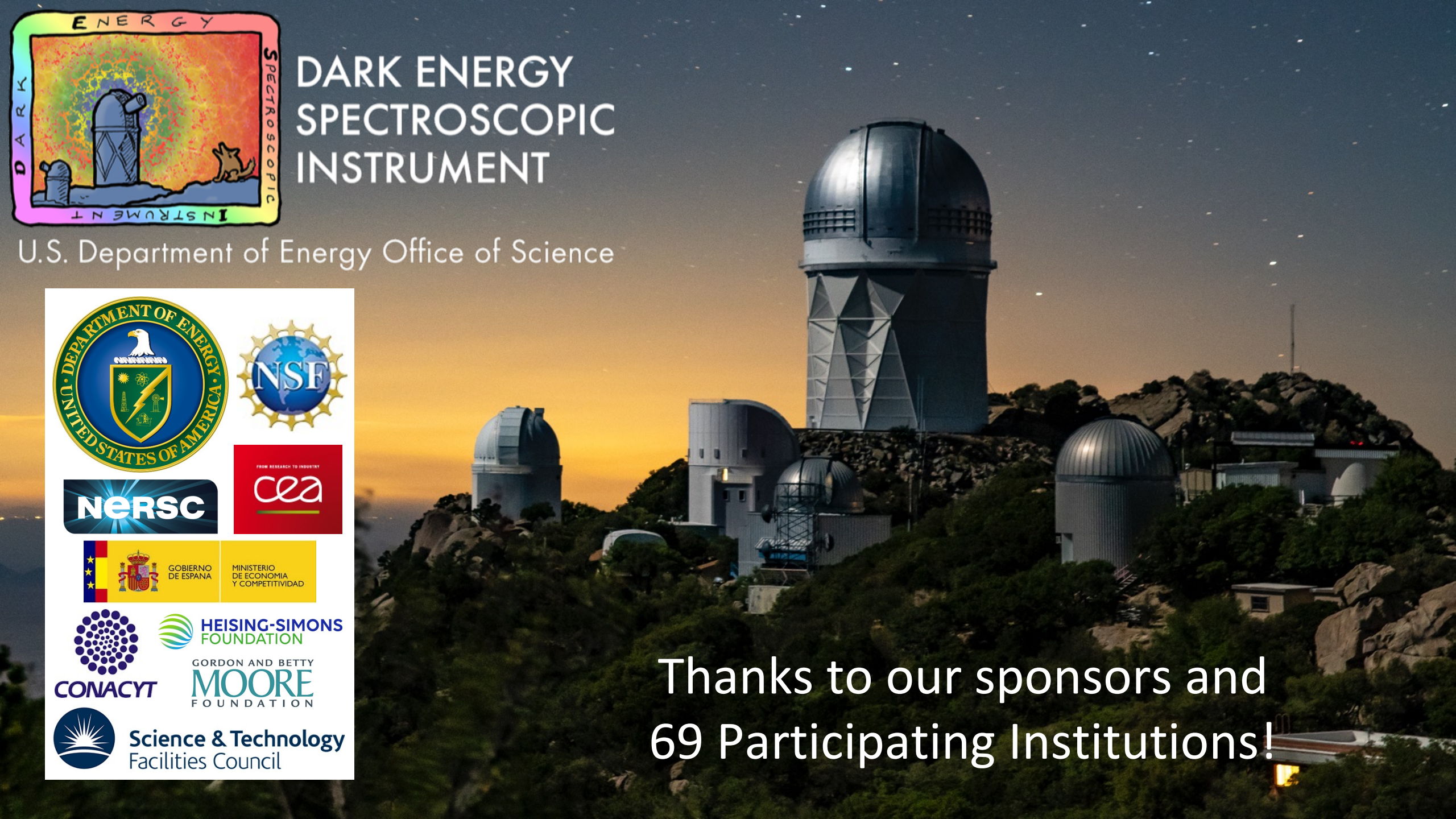
Summary



- DESI has just started!
- Soon it will become the largest spectroscopic galaxy survey to date
- In 2023 DESI will present its first cosmological results
- These will set the state of the art in terms of dark energy, modified gravity and neutrinos masses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DESI Legacy Imaging Surveys

- During the next 5 years DESI will survey 1/3 of the night sky (14k sq.deg.)
- It will accurately measure the redshift of over 30 million galaxies and quasars
- Targets selected from a long imaging campaign (2014-2019) using three optical telescopes, complemented with All Sky WISE (infrared NASA satellite)
- All imaging data public with useful tools to navigate it (www.legacysurvey.org)