

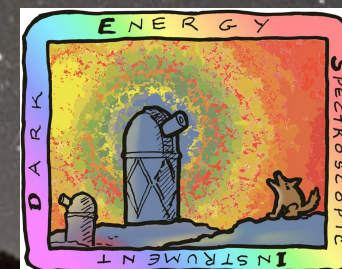
# What is the Dark Energy?

## Clues from the Clustering of DESI Galaxies

Quarknet program  
LBL, 06/17/2025



Antón Baleato Lizancos





# Outline

1. My trajectory
2. Your questions!
3. My research



# Outline

**1. My trajectory**

2. Your questions!

3. My research



# Who am I?

My name is Antón  
Baleato Lizancos

This already tells you  
something about me...





# Galicia, Spain

Where I'm from!





# BC, Canada 2010-2012

Final two years of high school



Pearson UWC (Sc'ianew land)





# NYC 2012-2014

Undergrad at Columbia





# Cambridge, UK 2016-2021

## Grad school



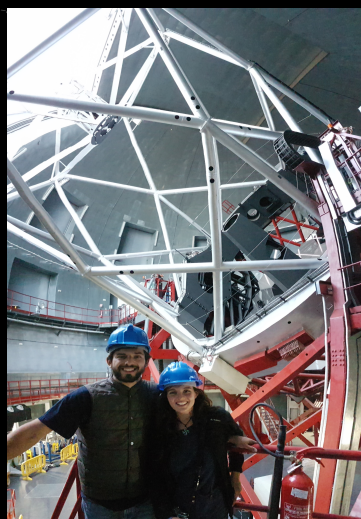


# Berkeley 2021 - Postdoc





# Science has taken me to cool places!





# My work

Cosmology theory & data analysis

DESI

Simons Observatory

(Tohono O'odham land)



ATACAMA DESERT - CHILE

(Ckunza land)

# Life as an academic

## Pros:

- Not a 9-5 job
- Holidays
- Intellectually stimulating environment — a community of collaboration
- Great autonomy
- Always learning (but no exams)
- Get paid to ponder something you are interested in
- Typically good for society

## Cons:

- Not a 9-5 job
- 2-3 yr positions until you find a permanent job — hard to plan ahead
- Hard to find a job in a specific place — a challenge for families
- Not as lucrative as other sectors
- Competition can lead to narrow focus on work



# Outline

1. My trajectory
- 2. Your questions!**
3. My research

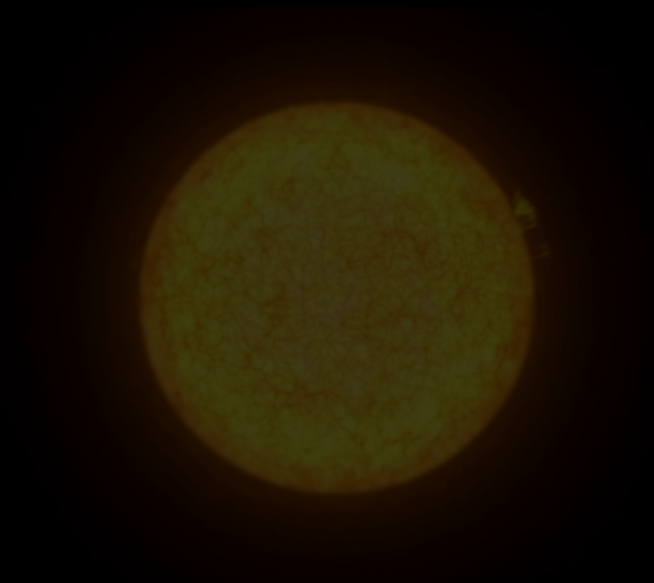
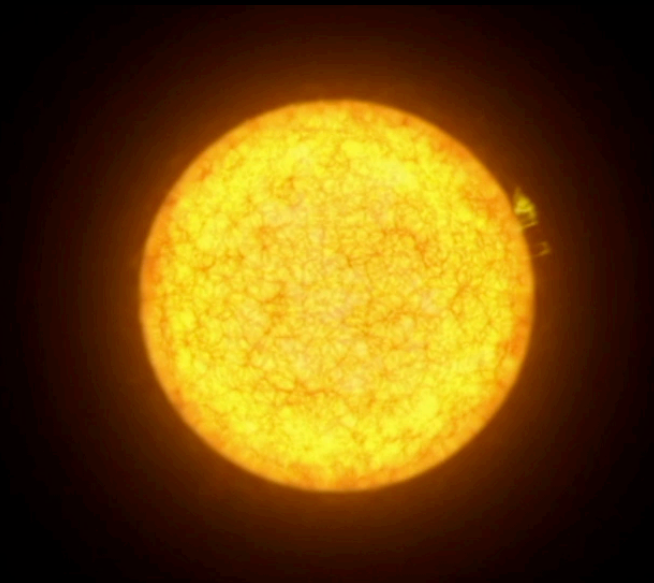
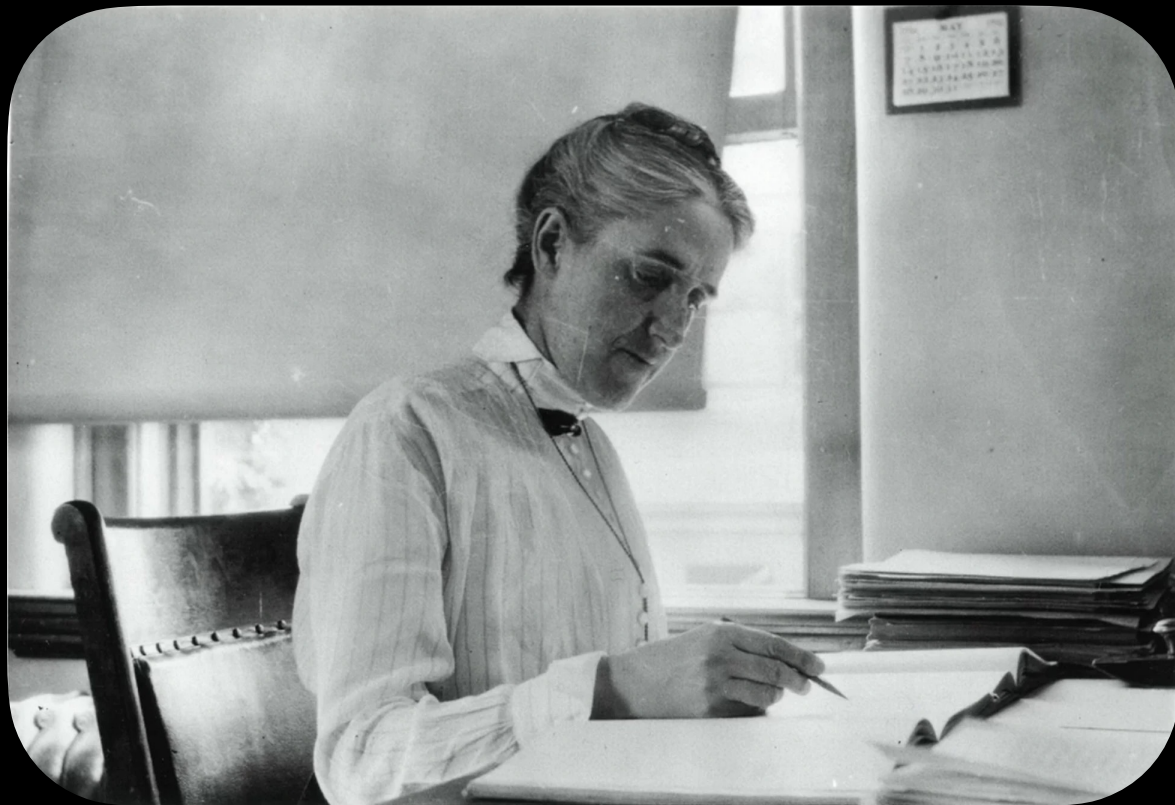
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# H. Leavitt & Cepheid variable stars

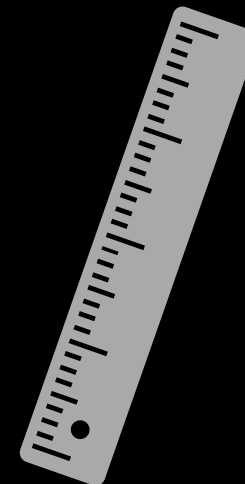




# Hubble & the distance to Andromeda

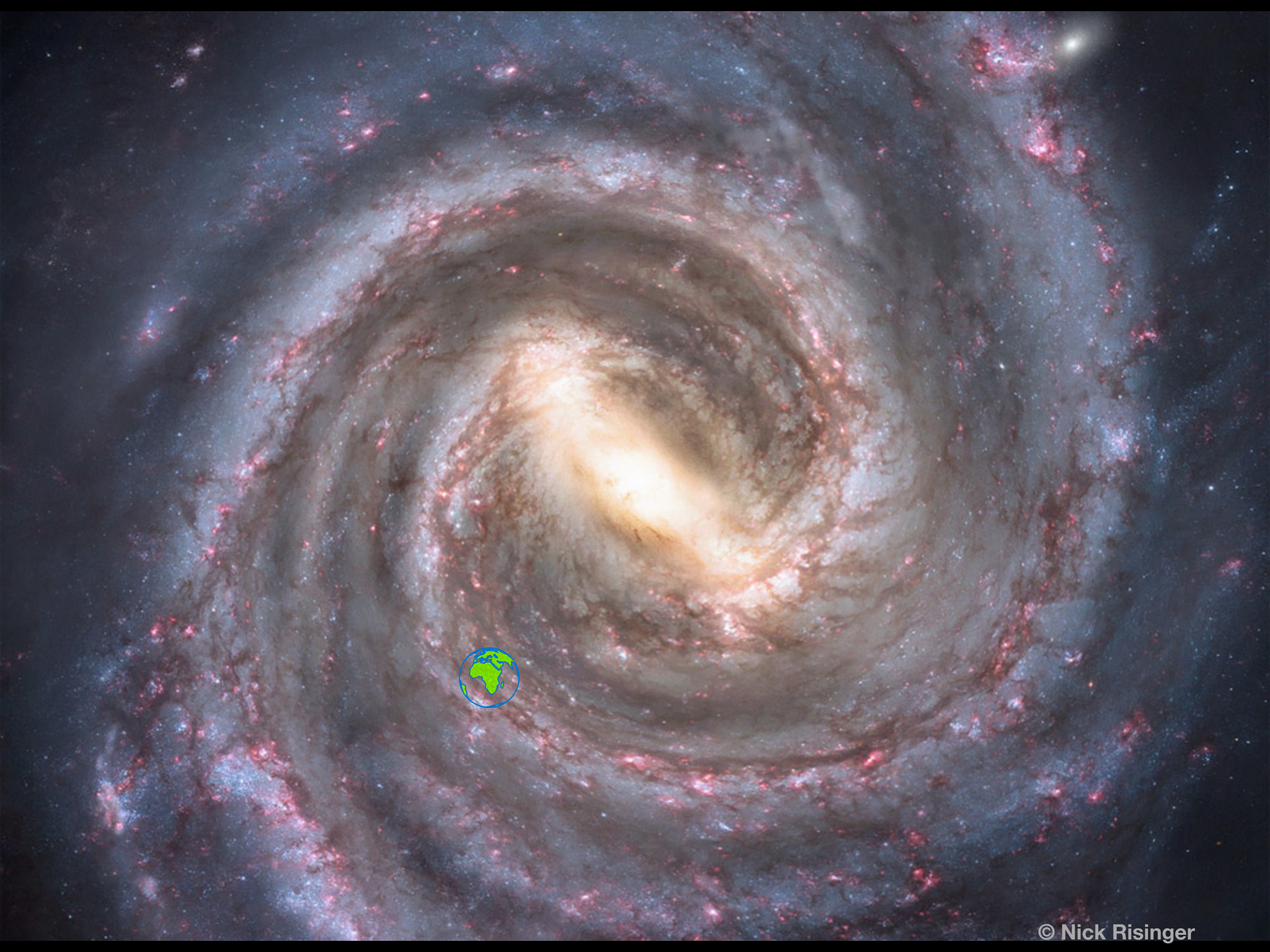


Andromeda

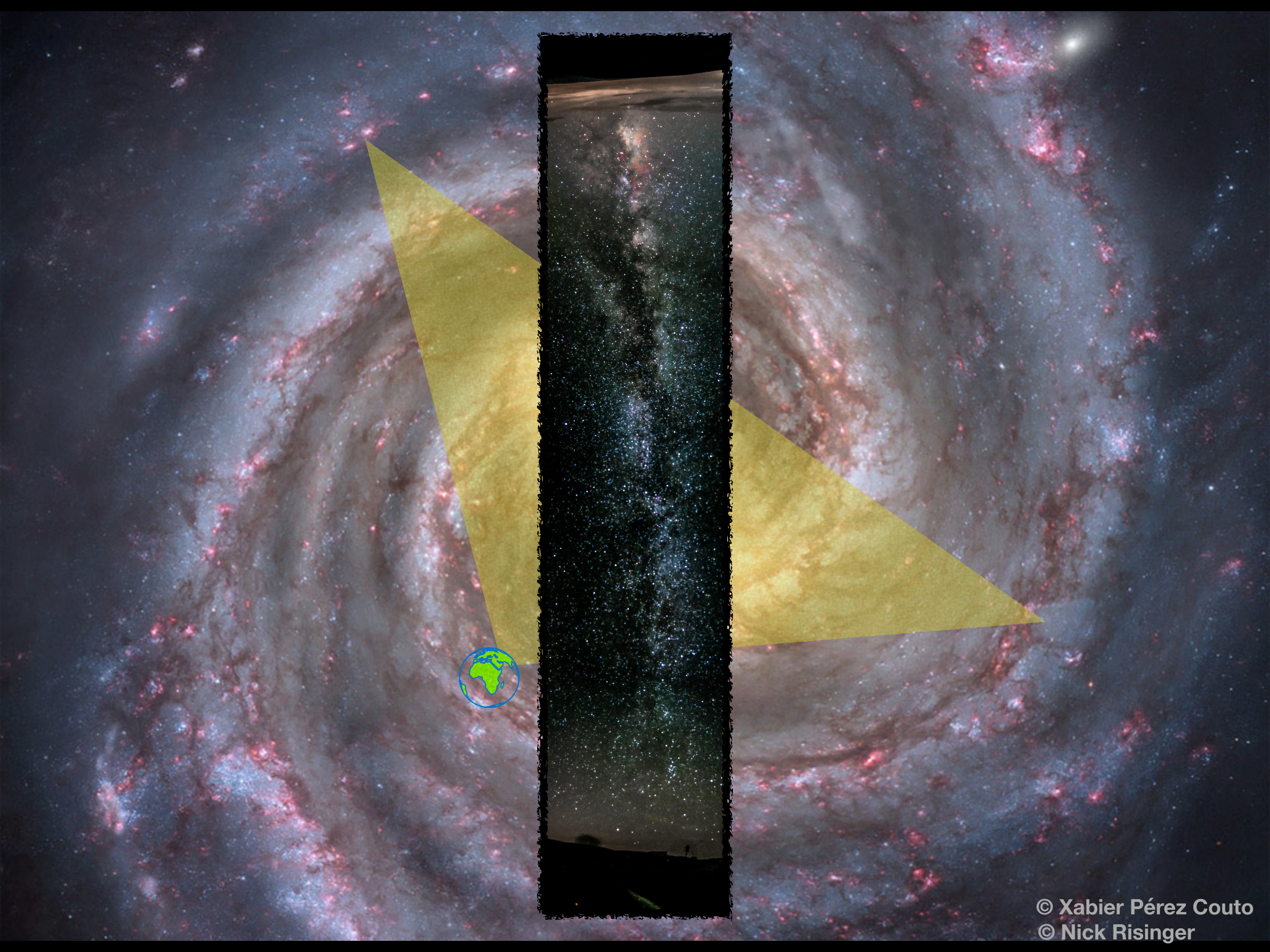


Milky Way

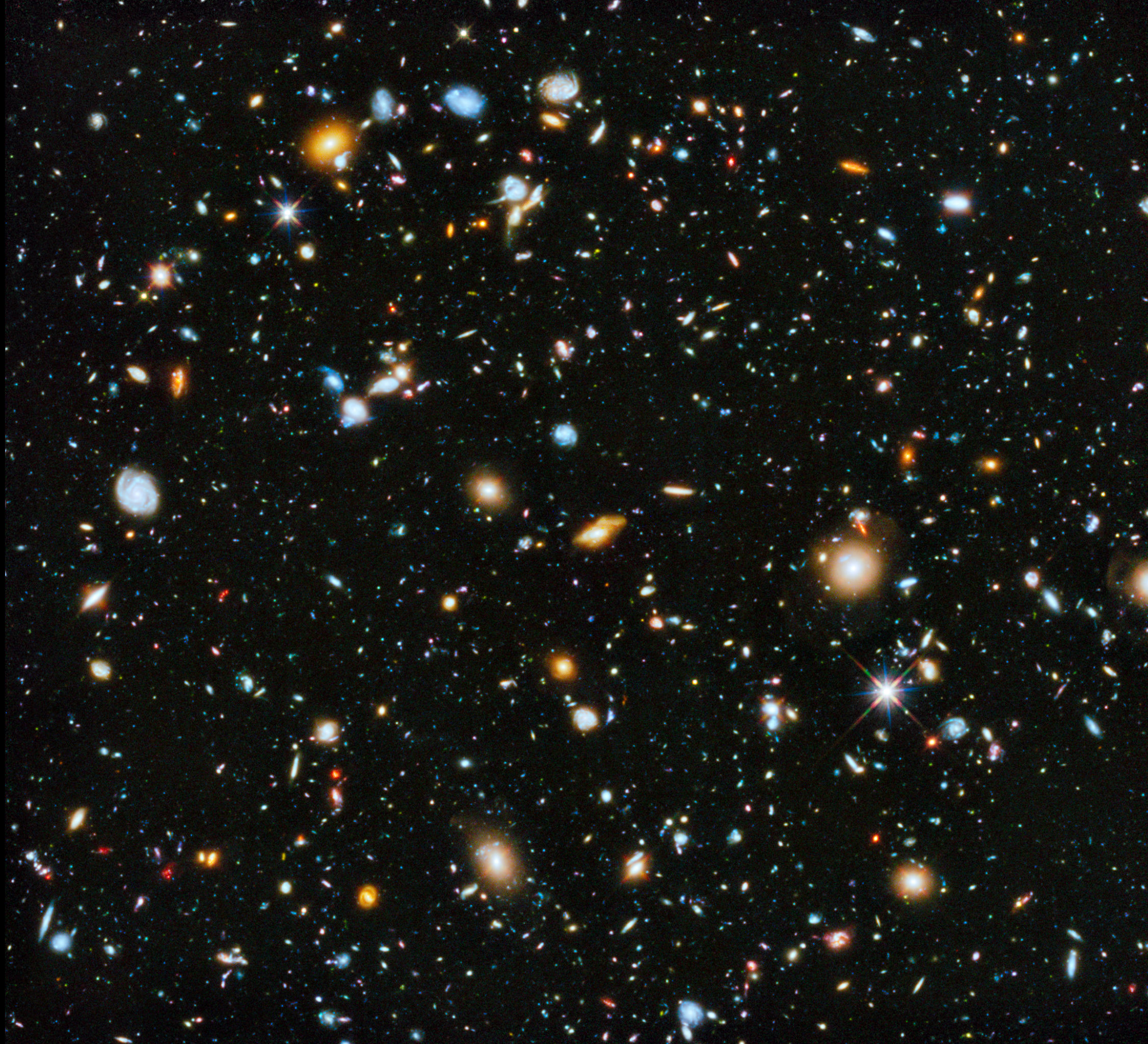




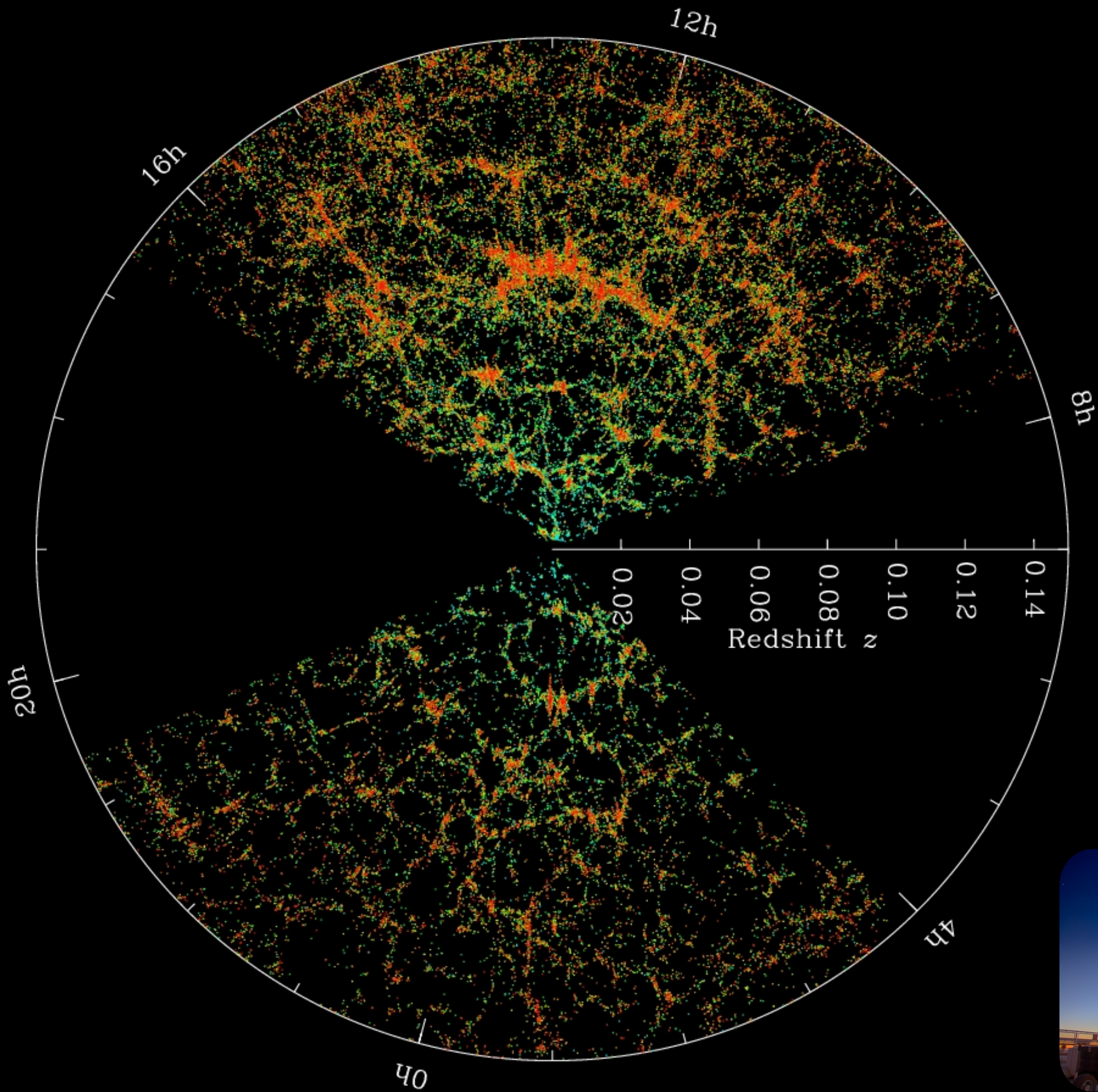




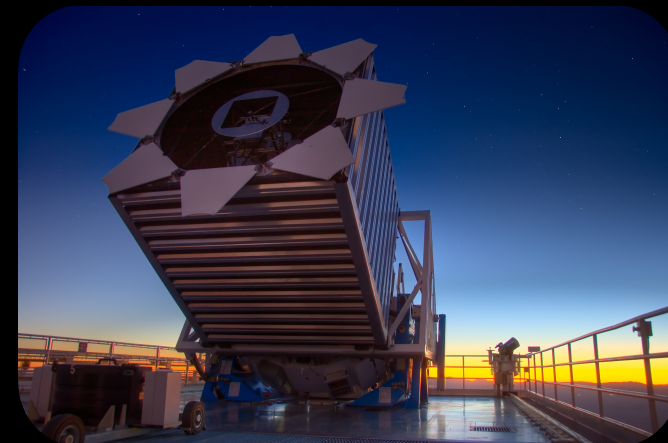


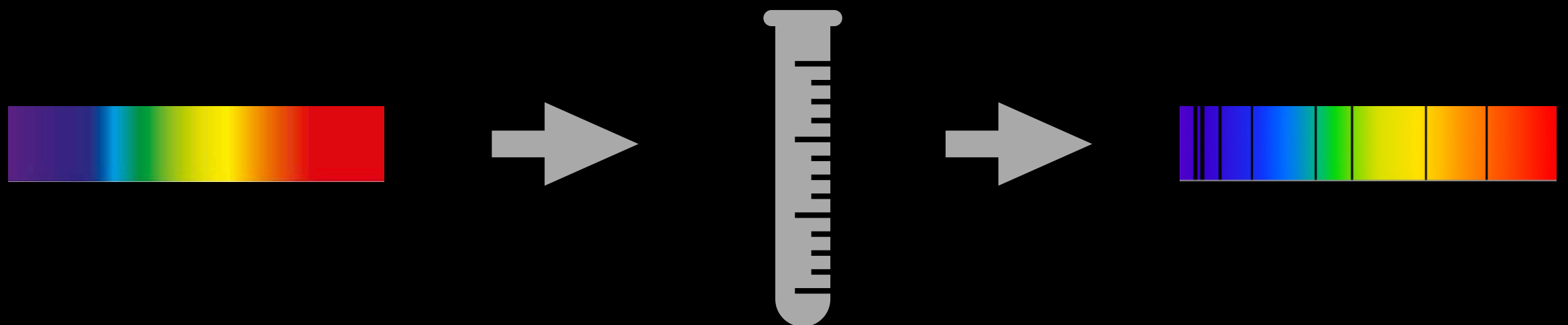
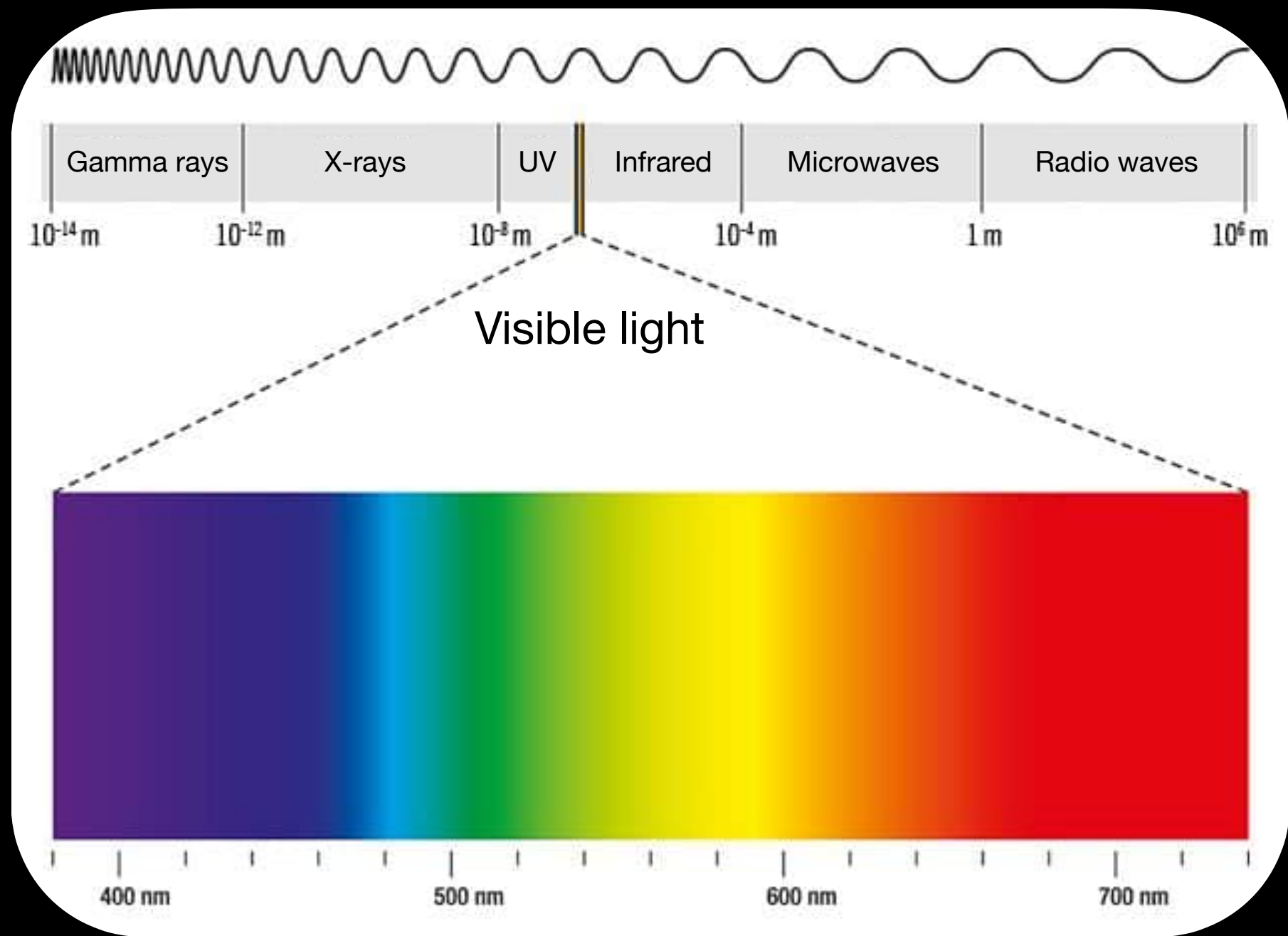




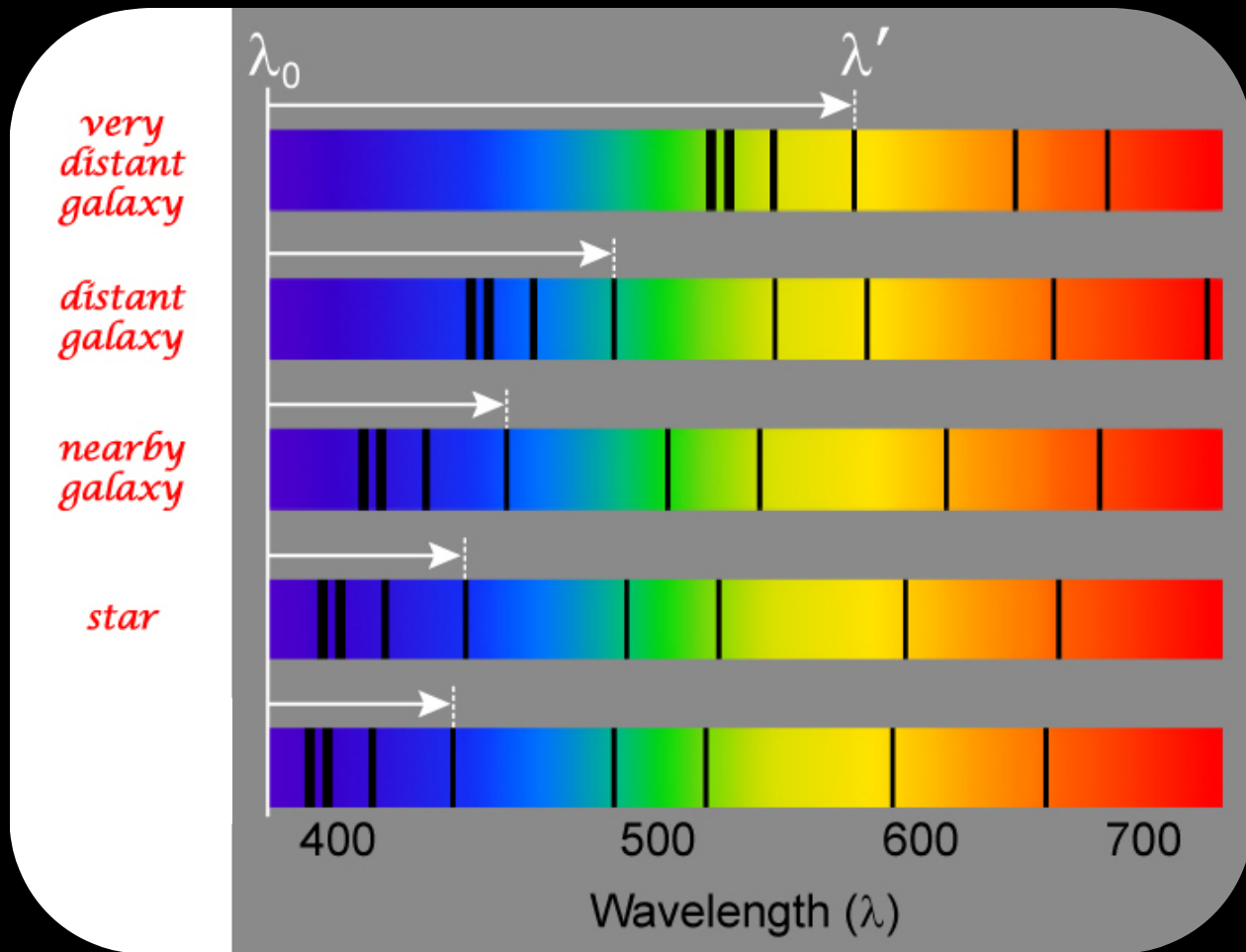


SDSS

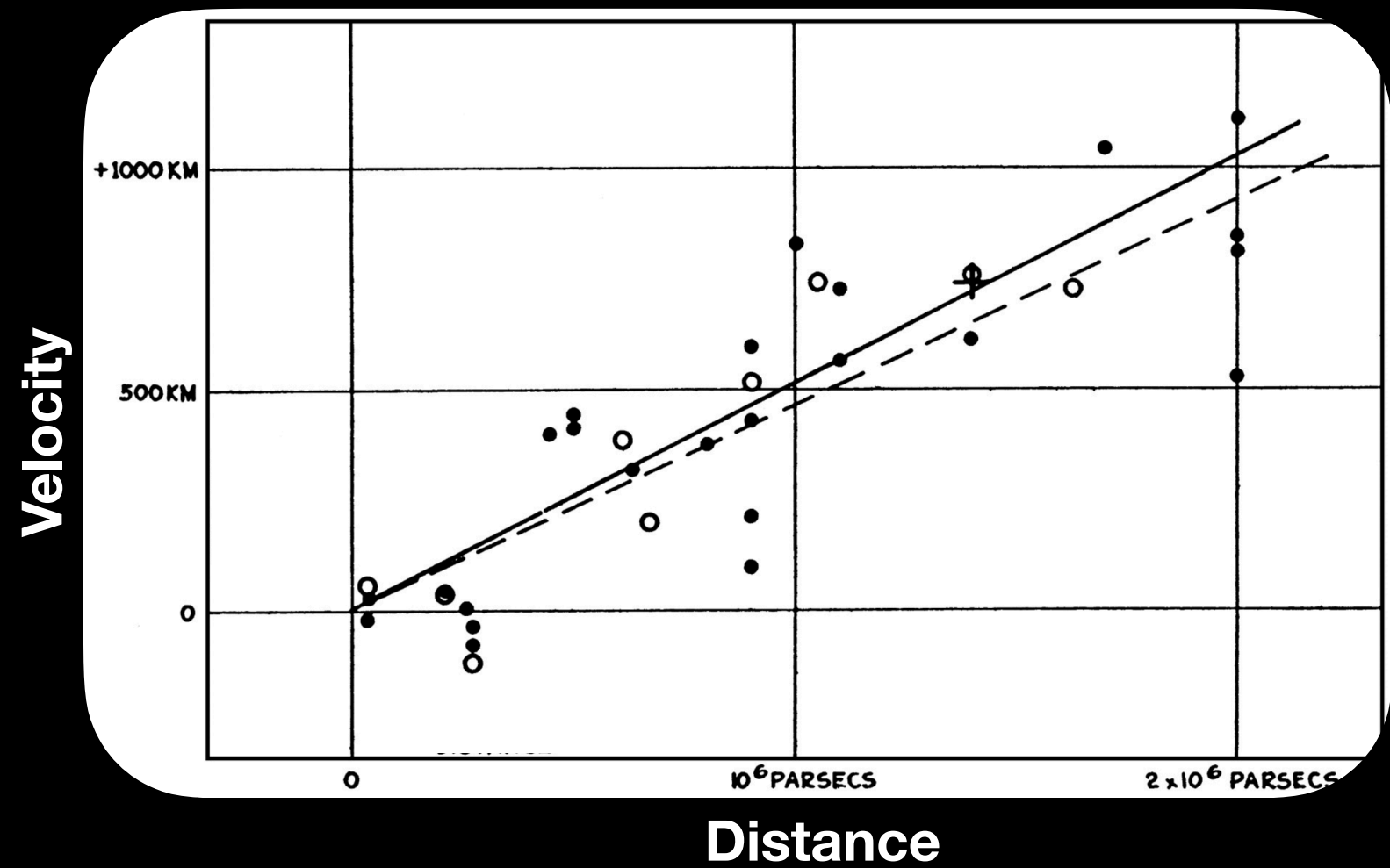








JPL/Caltech



# The Universe expands





# The Universe expands



© Micaël Reynaud



# The Universe expands



© Micaël Reynaud



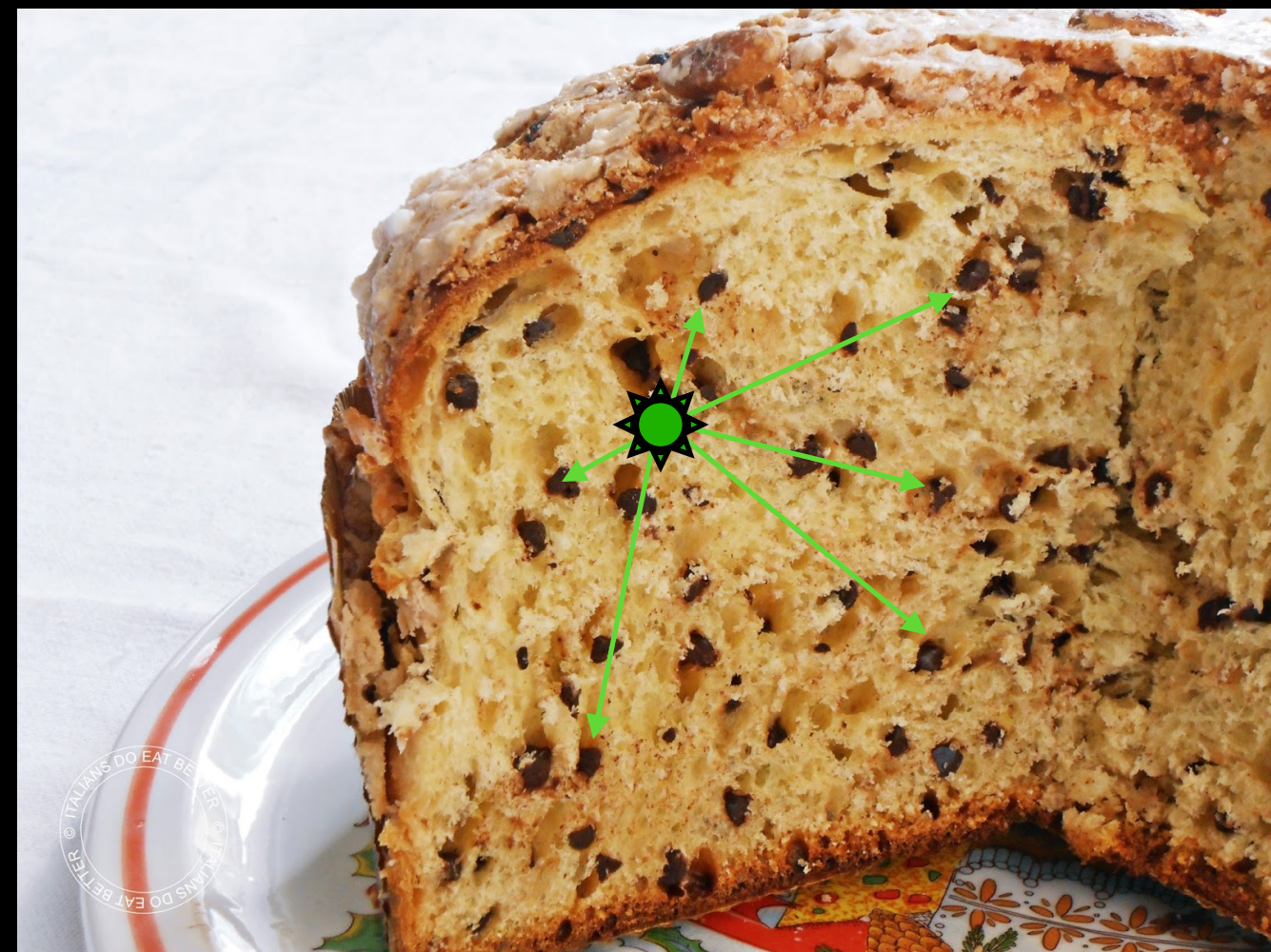
# The Universe expands



© Micaël Reynaud



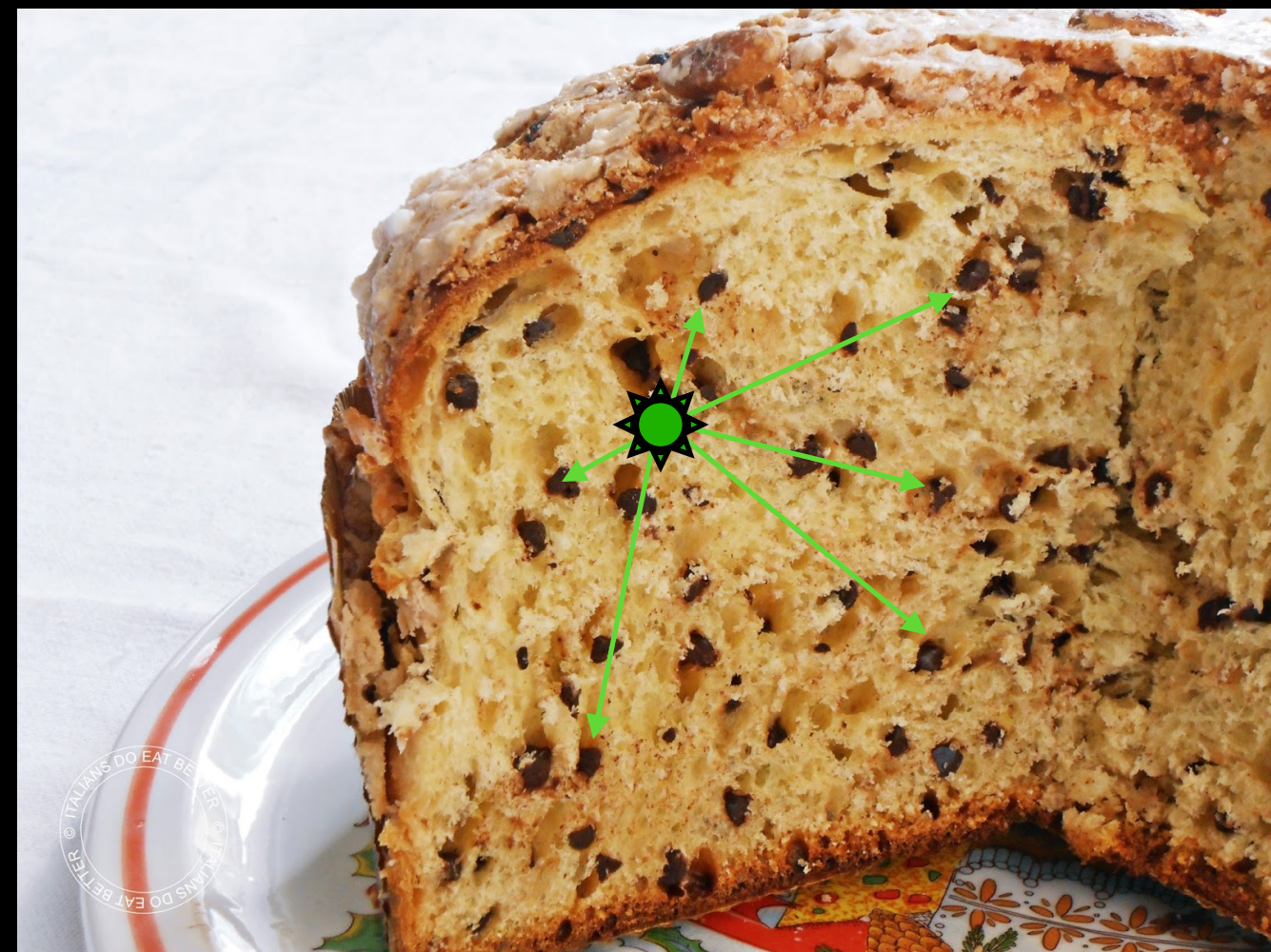
# The Universe expands



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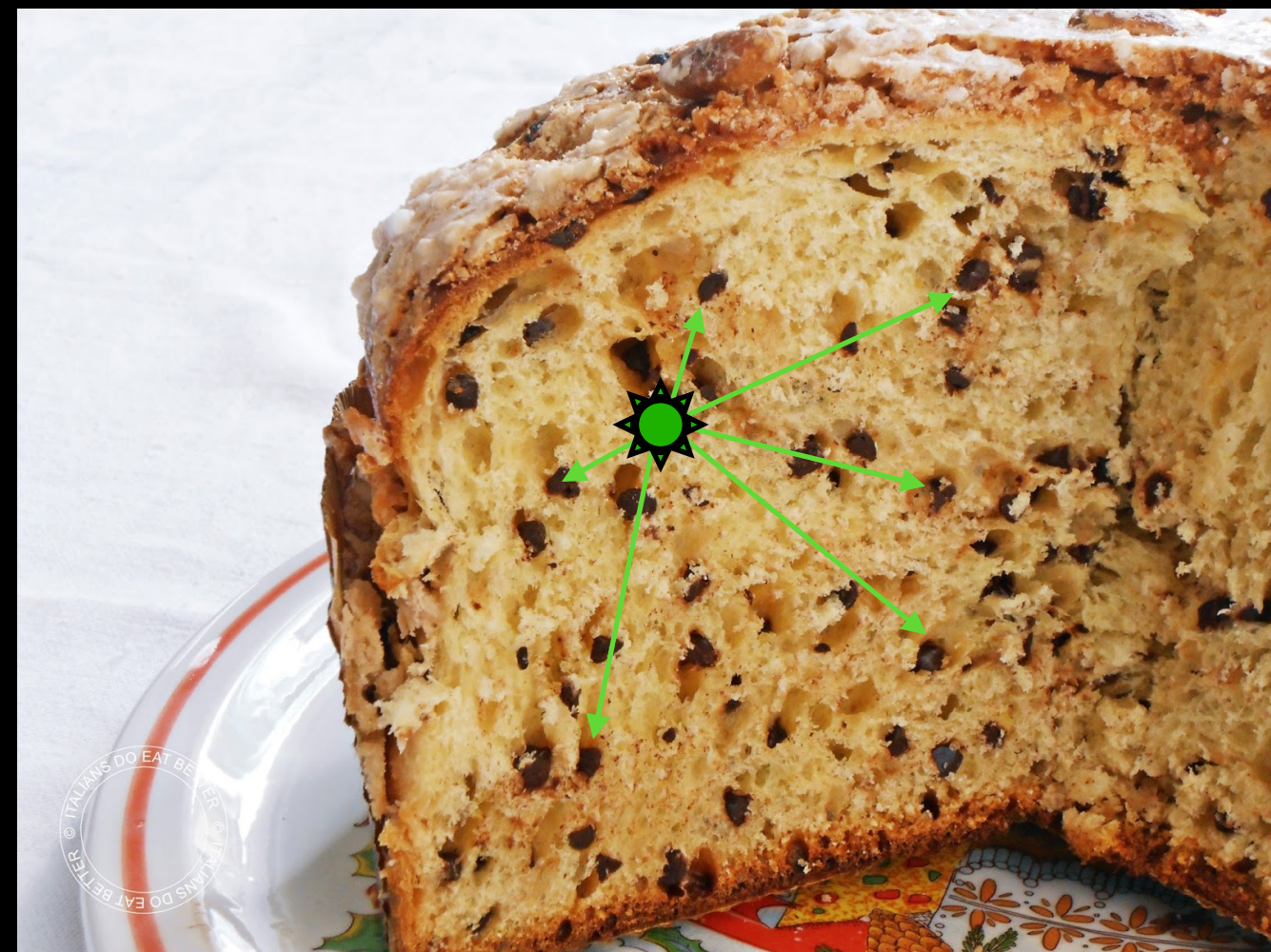
# The Universe expands



© Micaël Reynaud



# The Universe expands



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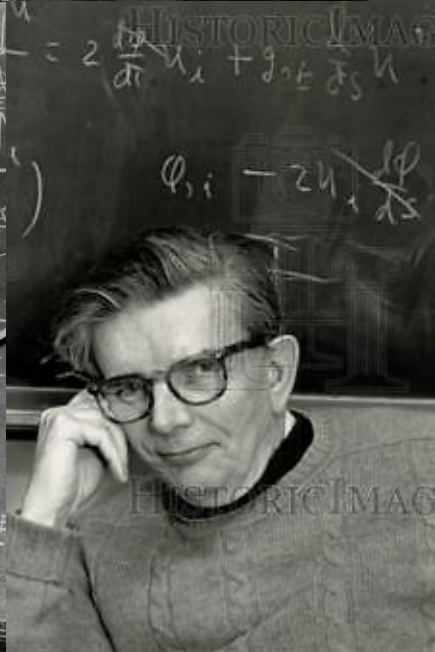
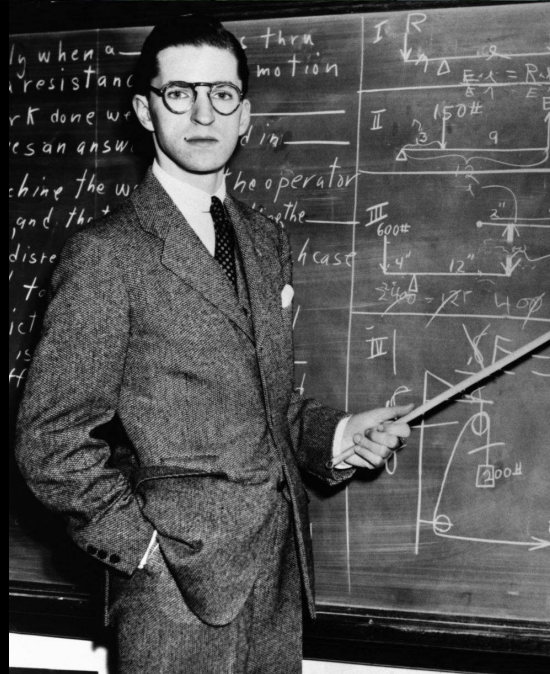
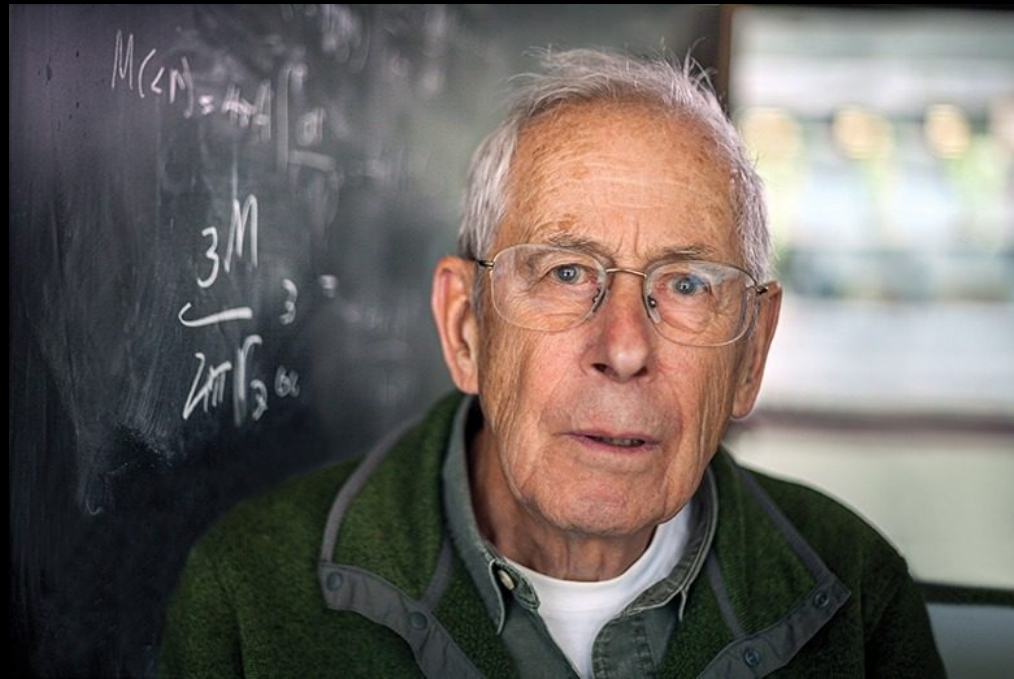




**The Universe is 13.8 billion years old**

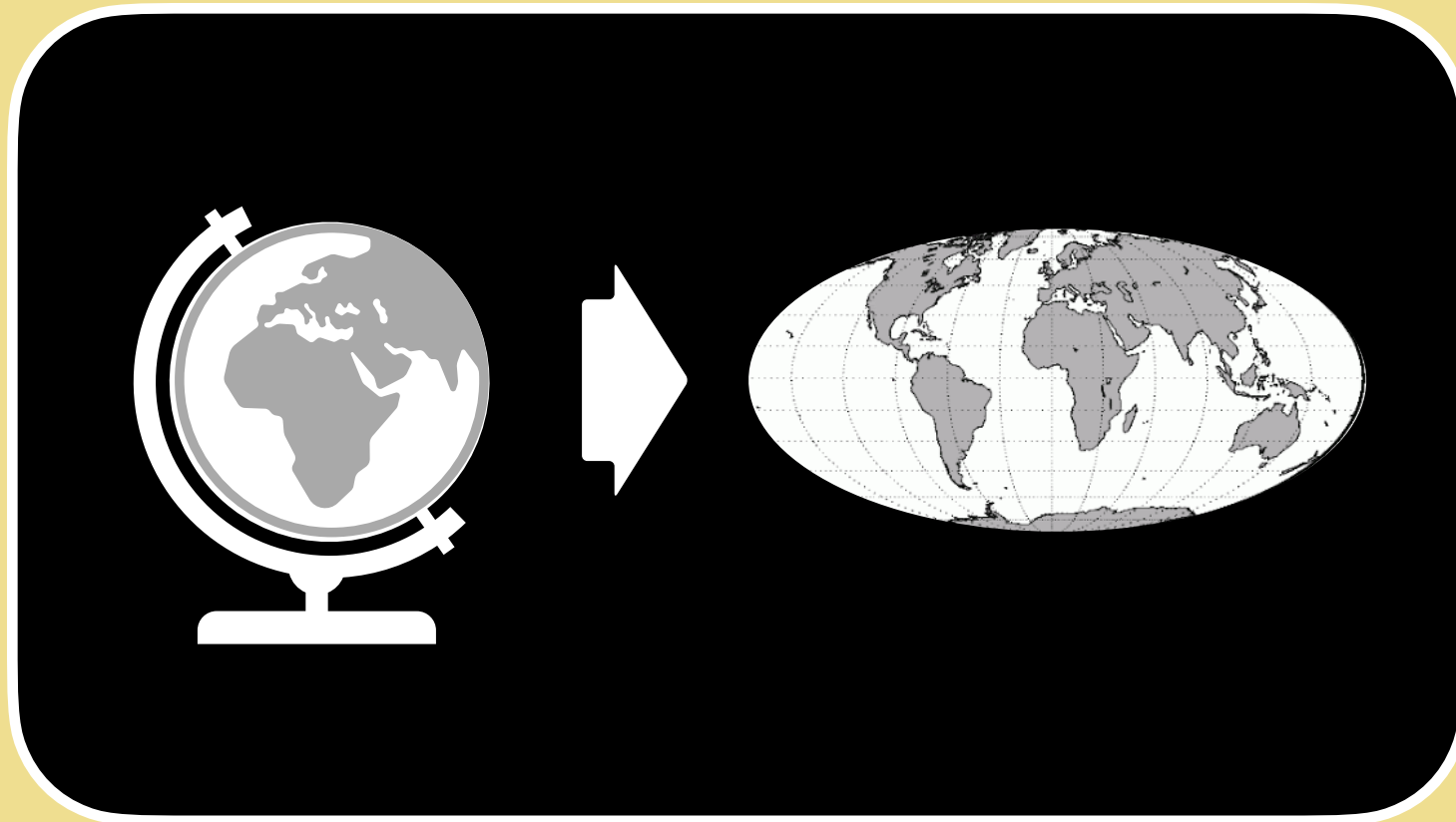


# The Cosmic Microwave Background (CMB)



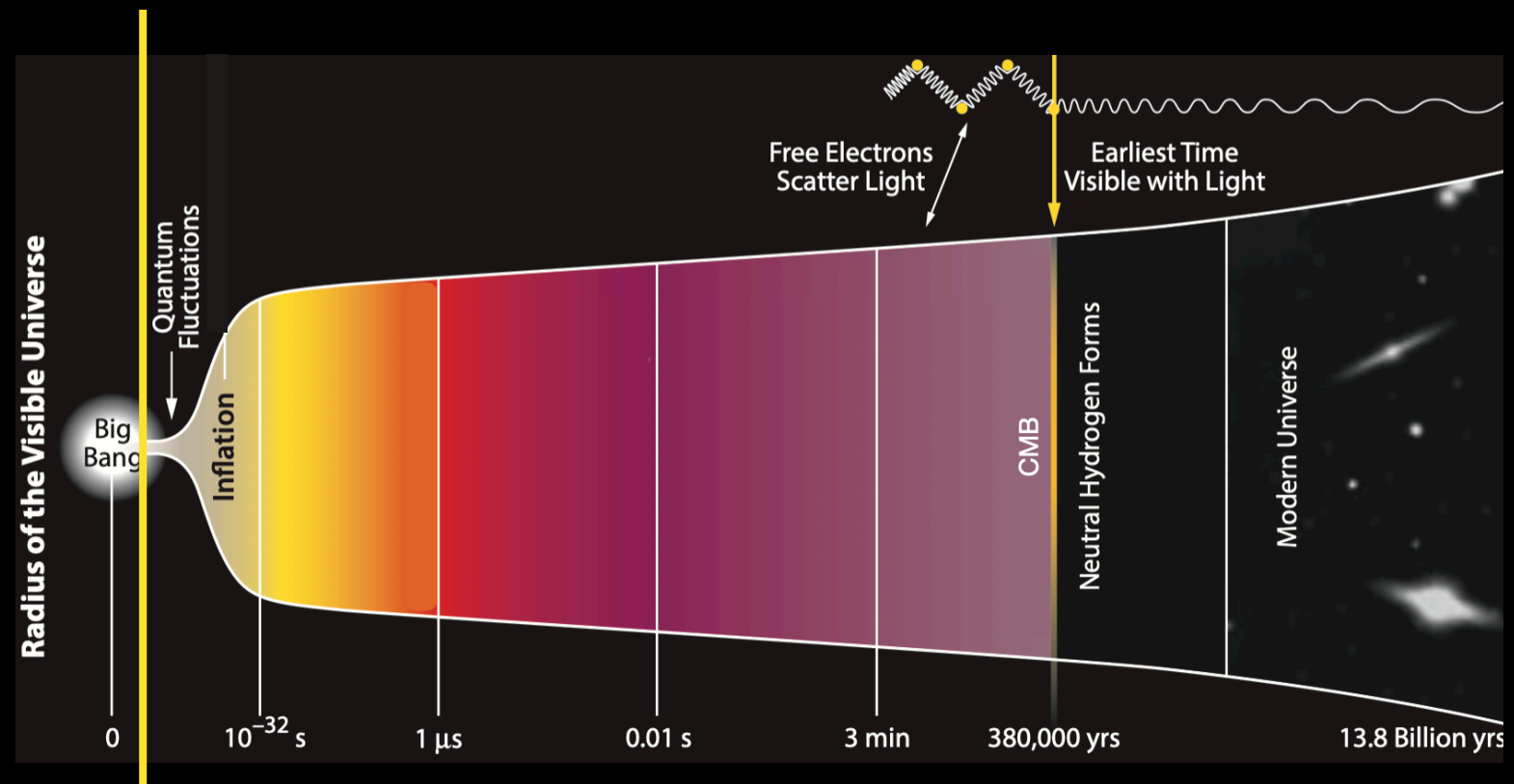
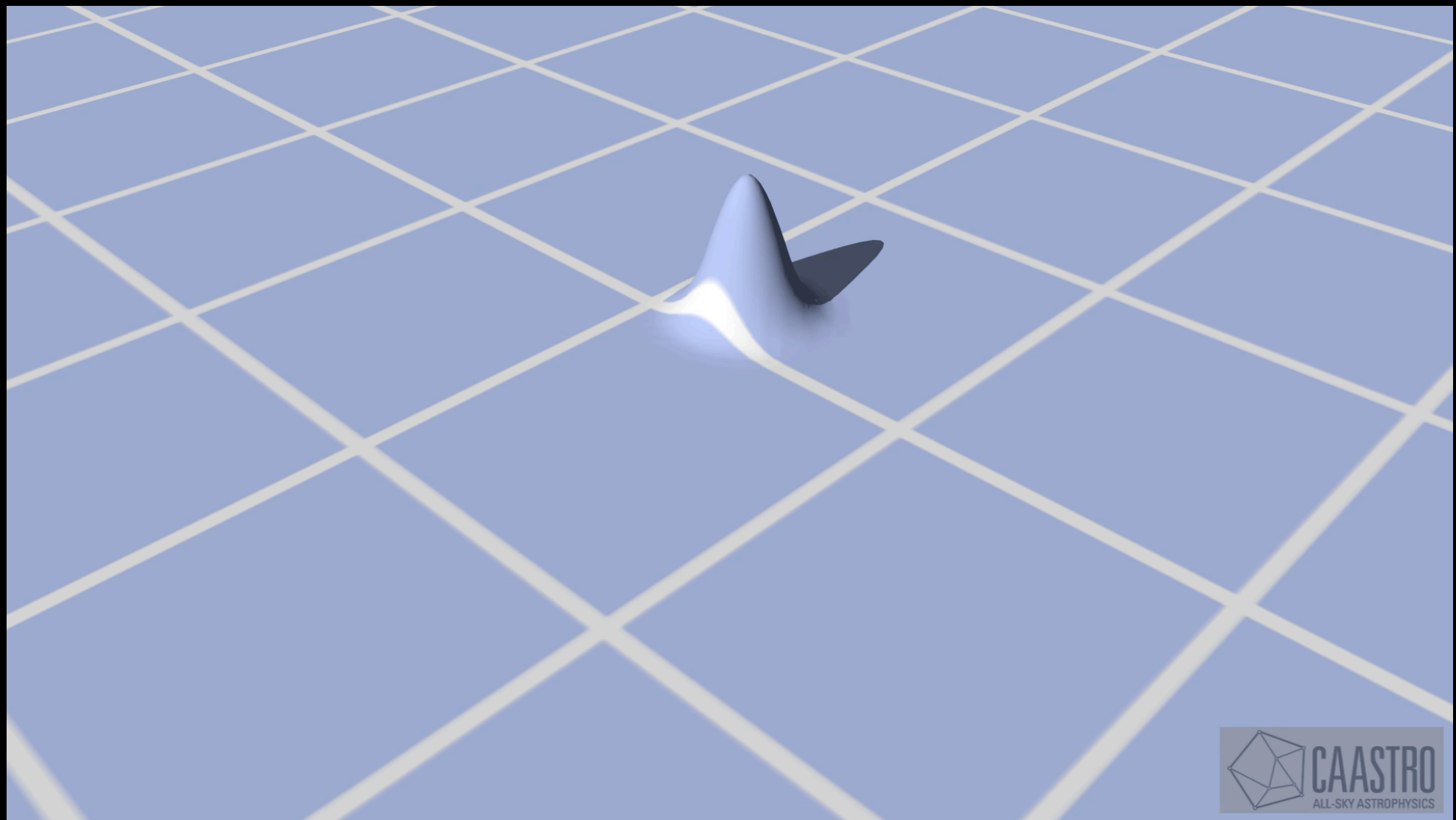


$T \approx 2.73 \text{ K}$



**13.8 billion years ago — when the Universe was just 380,000 years old**







**...with small clumps: the seeds of everything that surrounds us!**

**13.8 billion years ago — when the Universe was just 380,000 years old**



**planck**

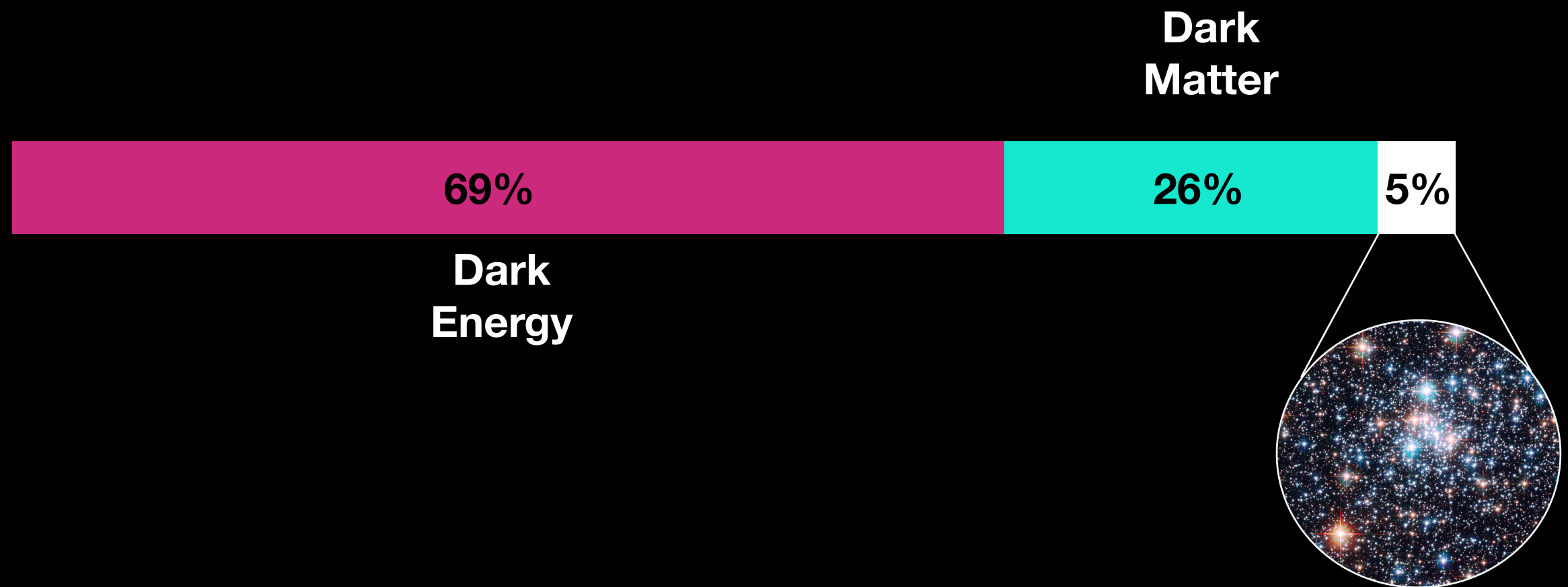


**The clumps grow...**

**... and in them appear galaxies, stars... and us!**



# A recipe with mysterious ingredients



... that works

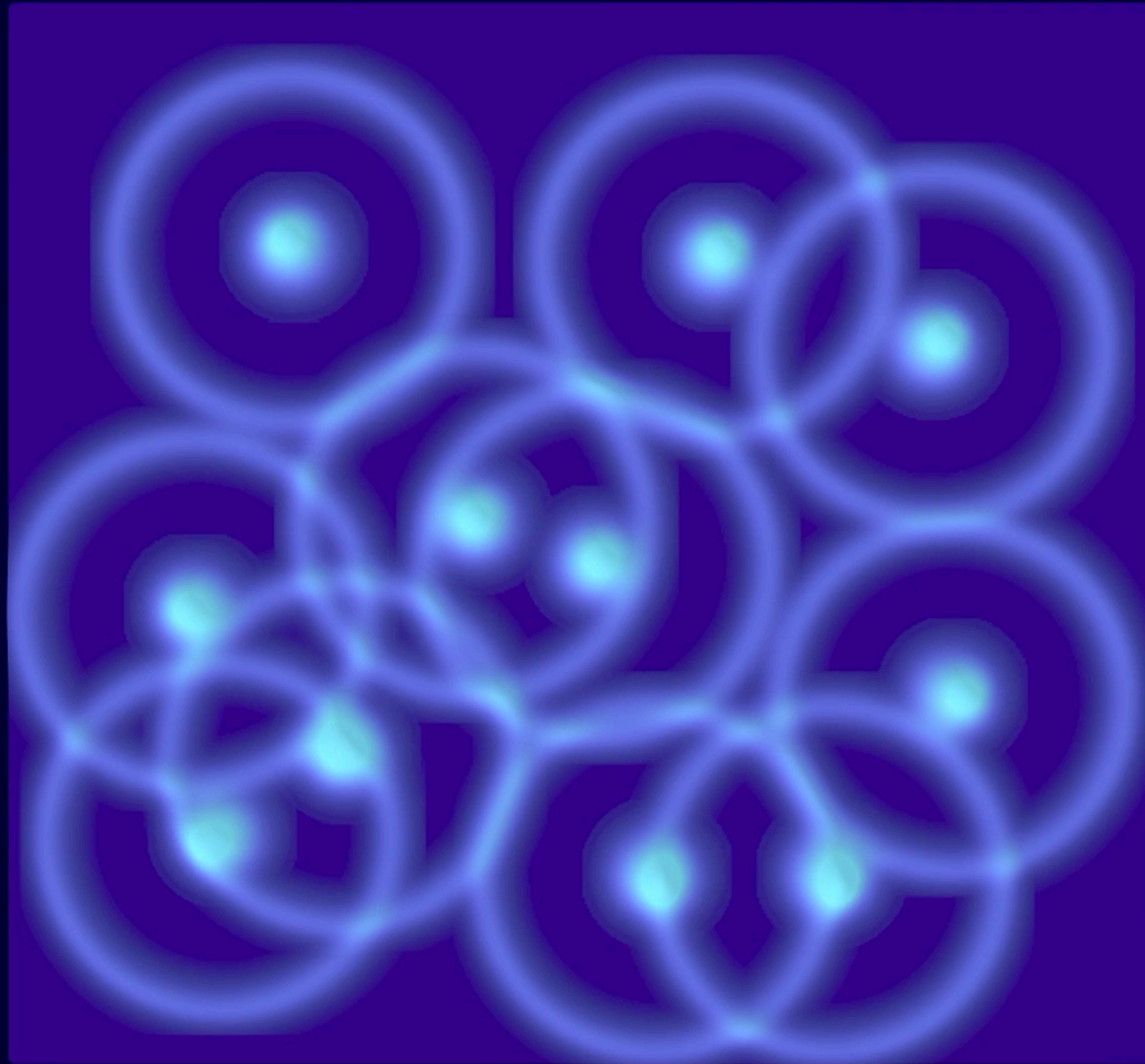


# Testing dark energy

- In the standard model, the density of dark energy is constant — it never dilutes. But what if its energy density evolves over time?
- Depending on the properties of dark energy, the Universe will expand at a different rate, and the clumping of galaxies will be different.
- “Standard rulers” such as BAO help us chart the expansion history of the Universe

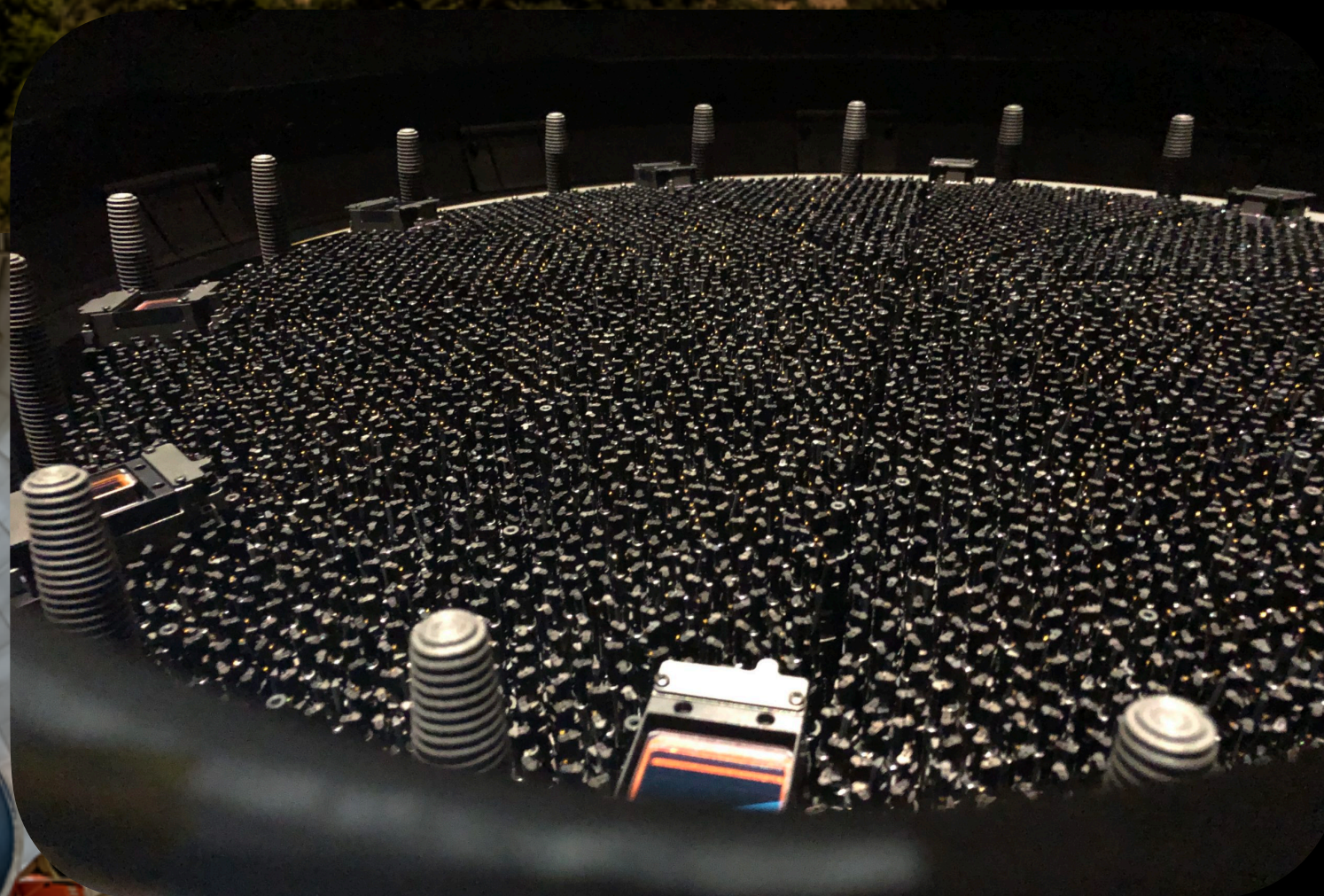
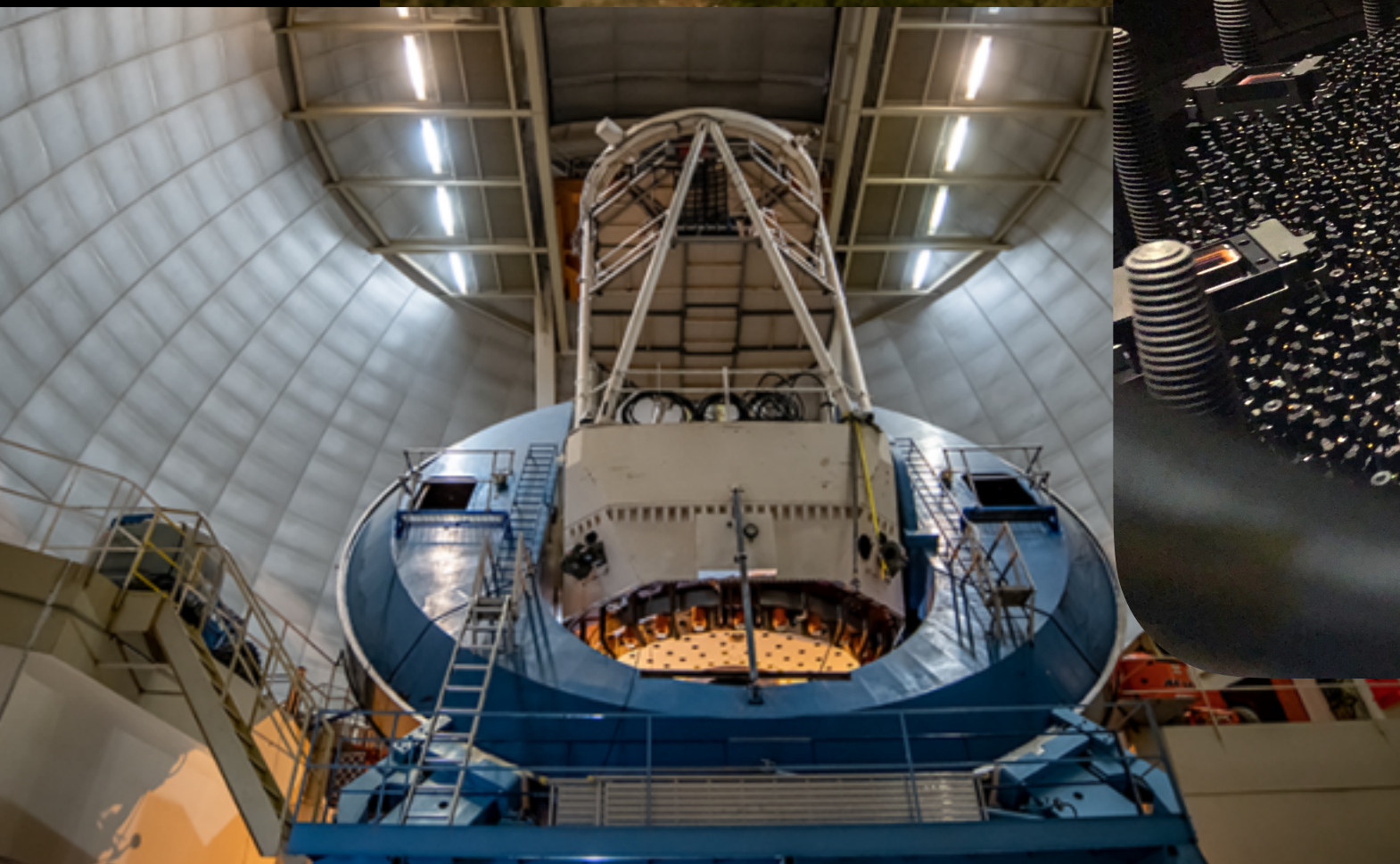
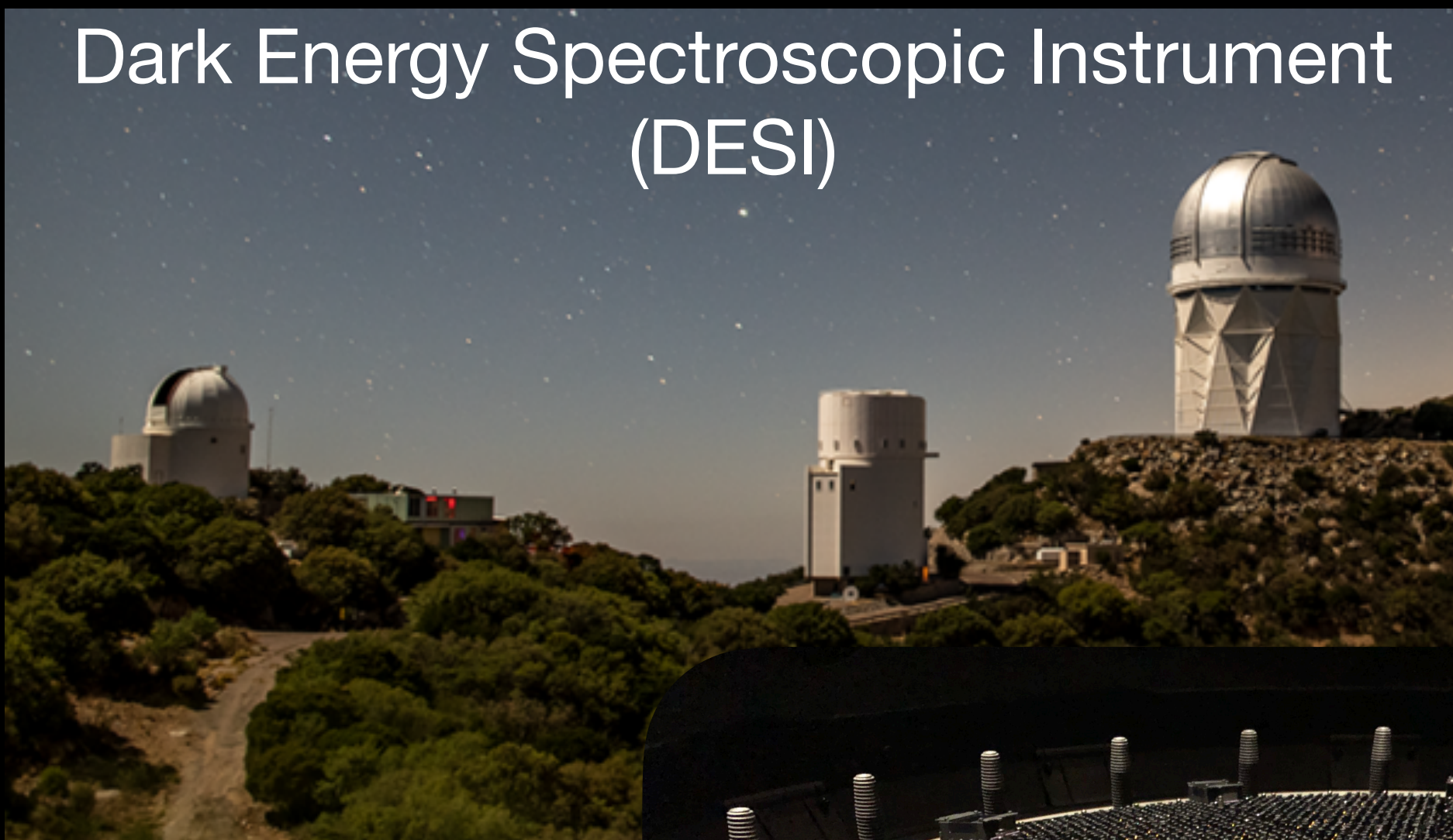


# Testing dark energy with BAO





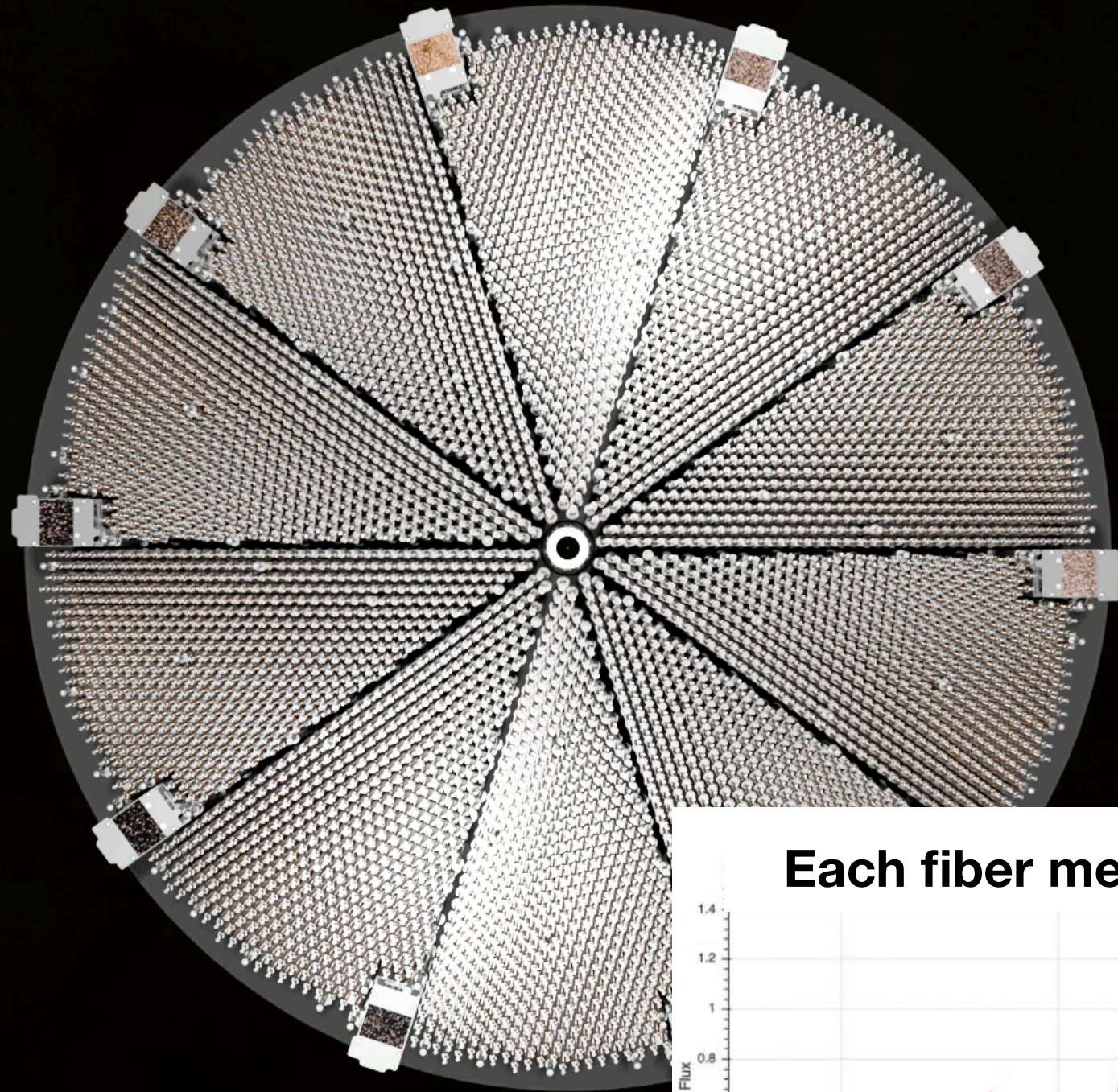
# Dark Energy Spectroscopic Instrument (DESI)



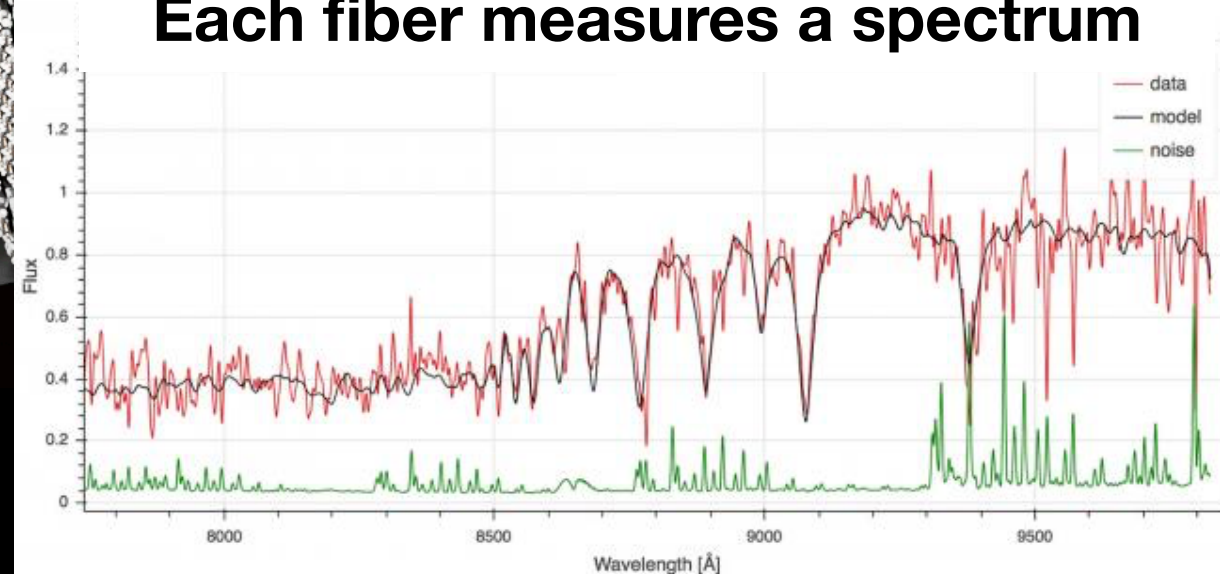
5,000 fibers positioned by robots



# Dark Energy Spectroscopic Instrument (DESI)

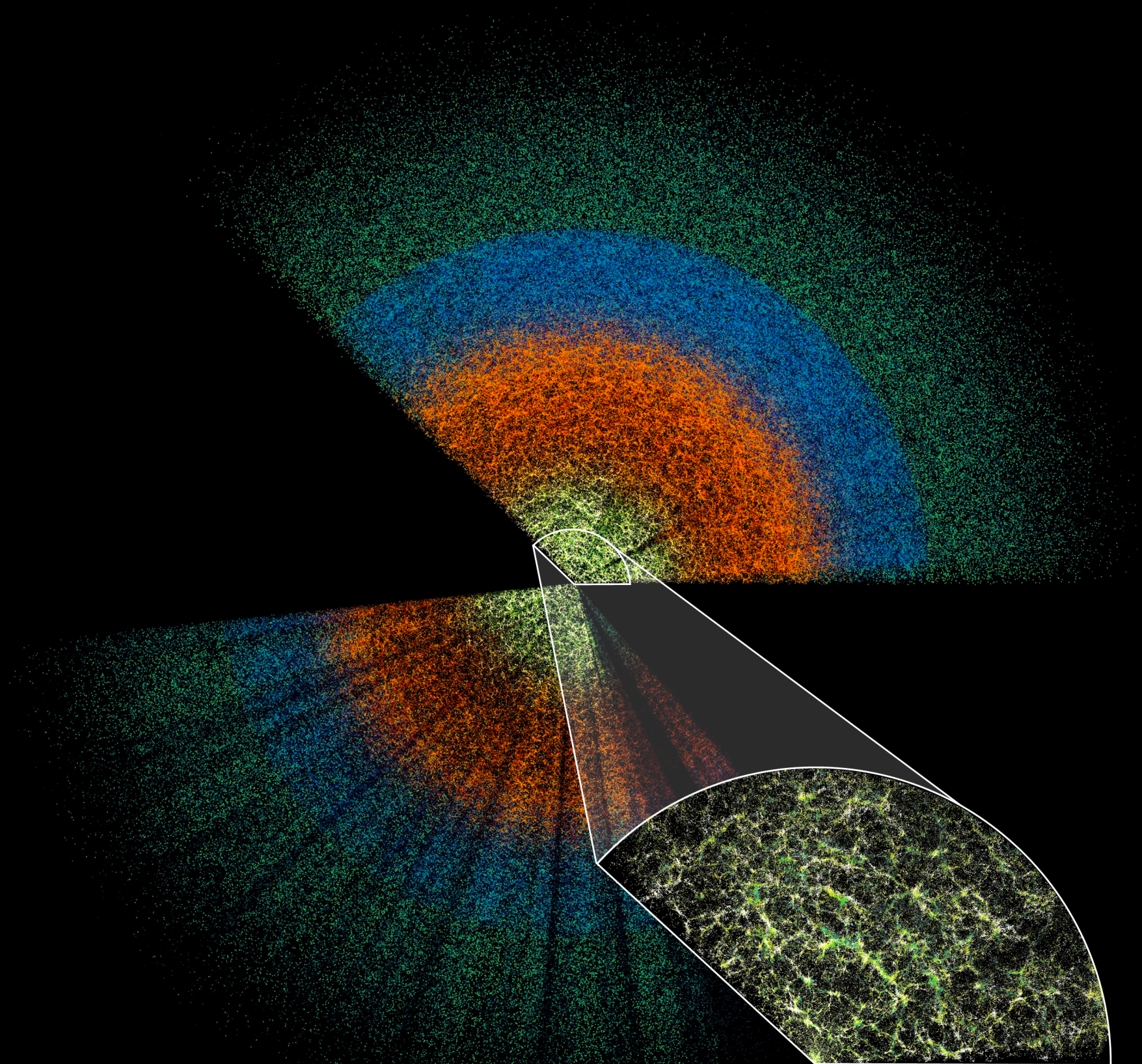


**Each fiber measures a spectrum**



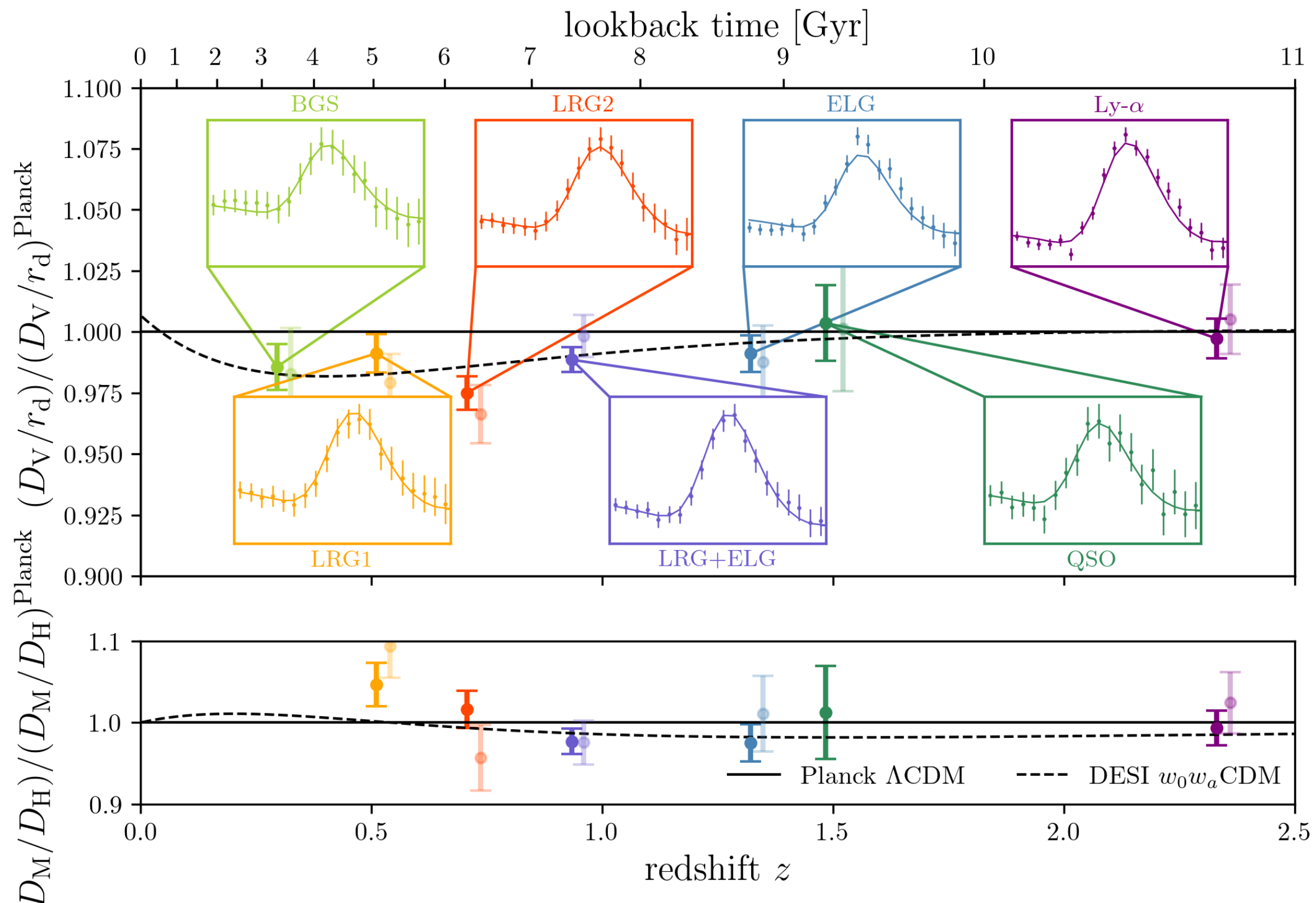


# Dark Energy Spectroscopic Instrument (DESI)





# DESI 2025 results



The model with evolving dark energy ( $w_0w_a$ CDM) fits the data better!



# Prospects

- DESI has ~5 years of data “in the can”.
- In addition to the BAO analysis, we’re working on “full-shape” analyses, and the combination with gravitational lensing.
- We could soon confirm or refute the evolution of dark energy.



# Conclusions

- In recent decades, we've developed a successful description of the Universe, but based on ingredients that remain a mystery
- The main one is dark energy: new data from DESI shows that it may be evolving over time, defying expectations
- A wealth of new data coming in the next decade from DESI extensions, Rubin, Euclid, Simons Observatory ++, we'll soon be learning a lot!