

# Texas Cosmology Center (TCC)

Eiichiro Komatsu

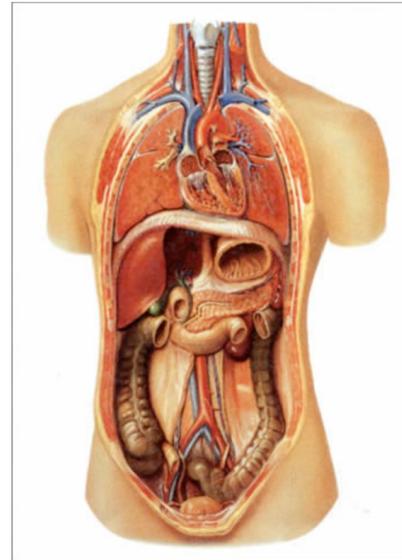
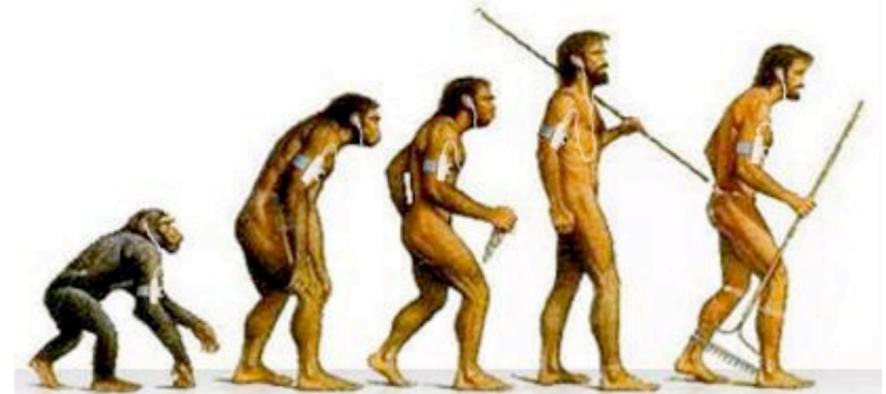
Foundation Advisory Council Meeting

April 17, 2009

# Cosmology - What is it?

- Study of **various properties of the Universe**, including:

- Emergence
- Evolution (History)
- Structure
- Composition
- Etc.





*From "Cosmic Voyage"*

# Golden Age of Cosmology

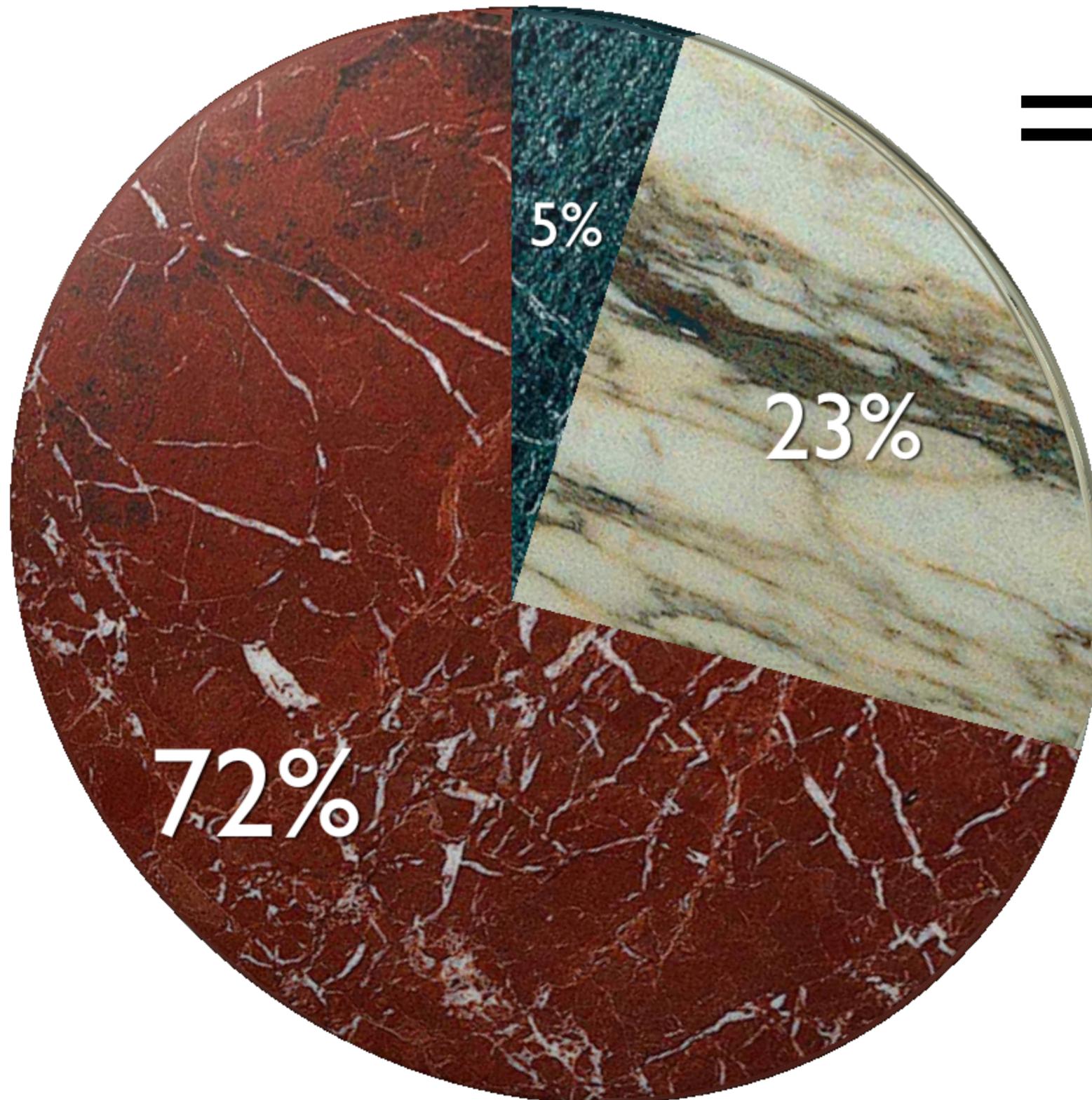
- **Why Golden Age?** Ask questions about our Universe. For most of them, we have good answers: the answers that were obtained over the last decade.
- *How old is our Universe?*
  - **$13.7 \pm 0.1$  billion years old.**
- *What is the geometry of our observable Universe?*
  - **Flat** (Euclidean), to about 1% level.

# But, this is just the beginning

- A **real reason** why we think we are living in the Golden Age of Cosmology?

## Composition of the Universe

# Cosmic Pie Chart = Cosmic Puzzles



- Cosmological observations over the last decade told us that **we don't understand much of the Universe.**



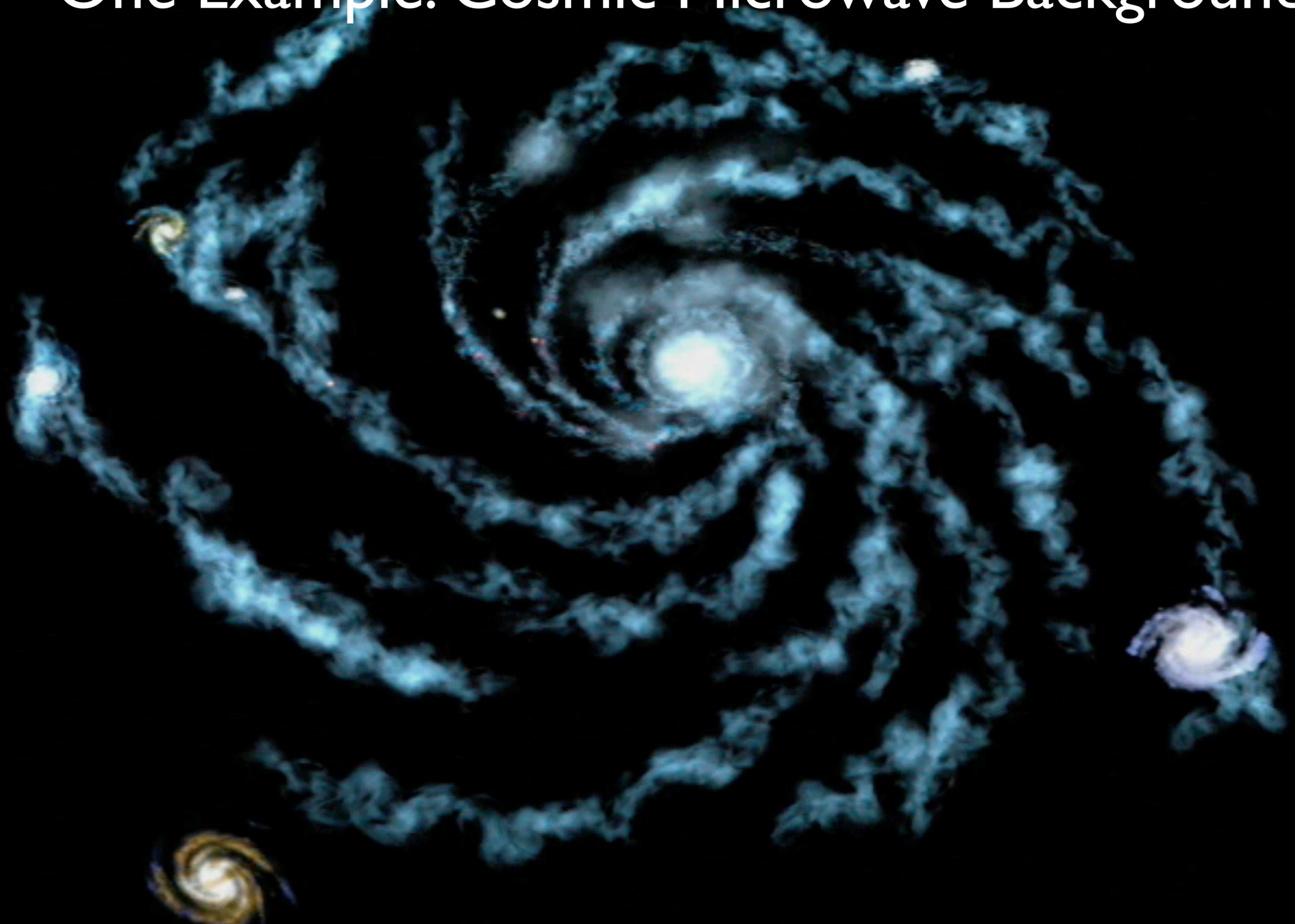
# Golden Age of Cosmology

- **Q. Why Golden Age?**
- **A. Because we are facing extraordinary challenges.**
  - What is Dark Matter?
  - What is Dark Energy?
- Isn't that exciting?

# How Do We Know That?

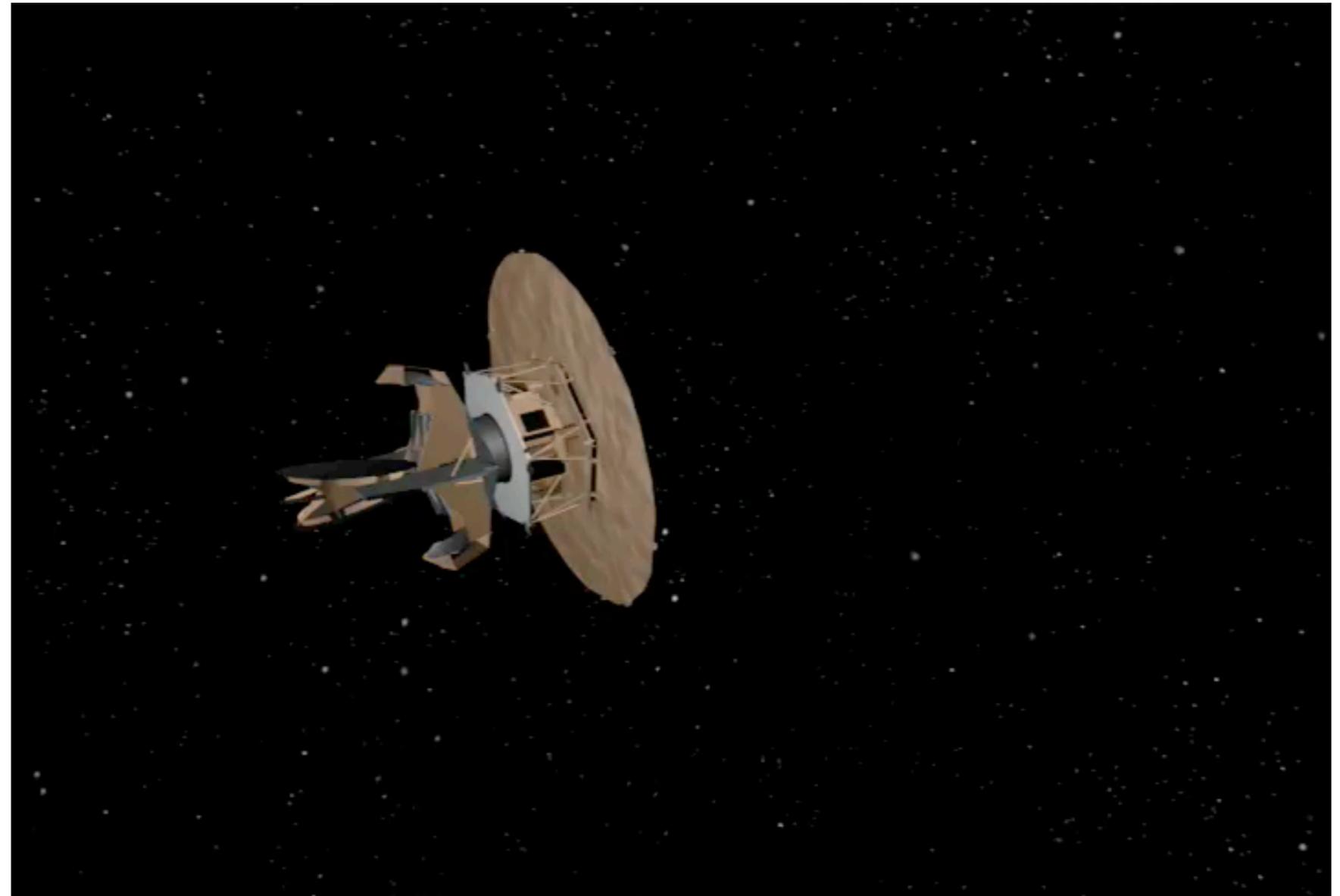
- An incredible collaboration between theory and observations in modern cosmology.
- **Both** theory and observations have experienced remarkable advances over the last decade.
- And, theoretical ideas and observations continue to collaborate and influence each other.
- **That's the heart of the Texas Cosmology Center.**

# One Example: Cosmic Microwave Background



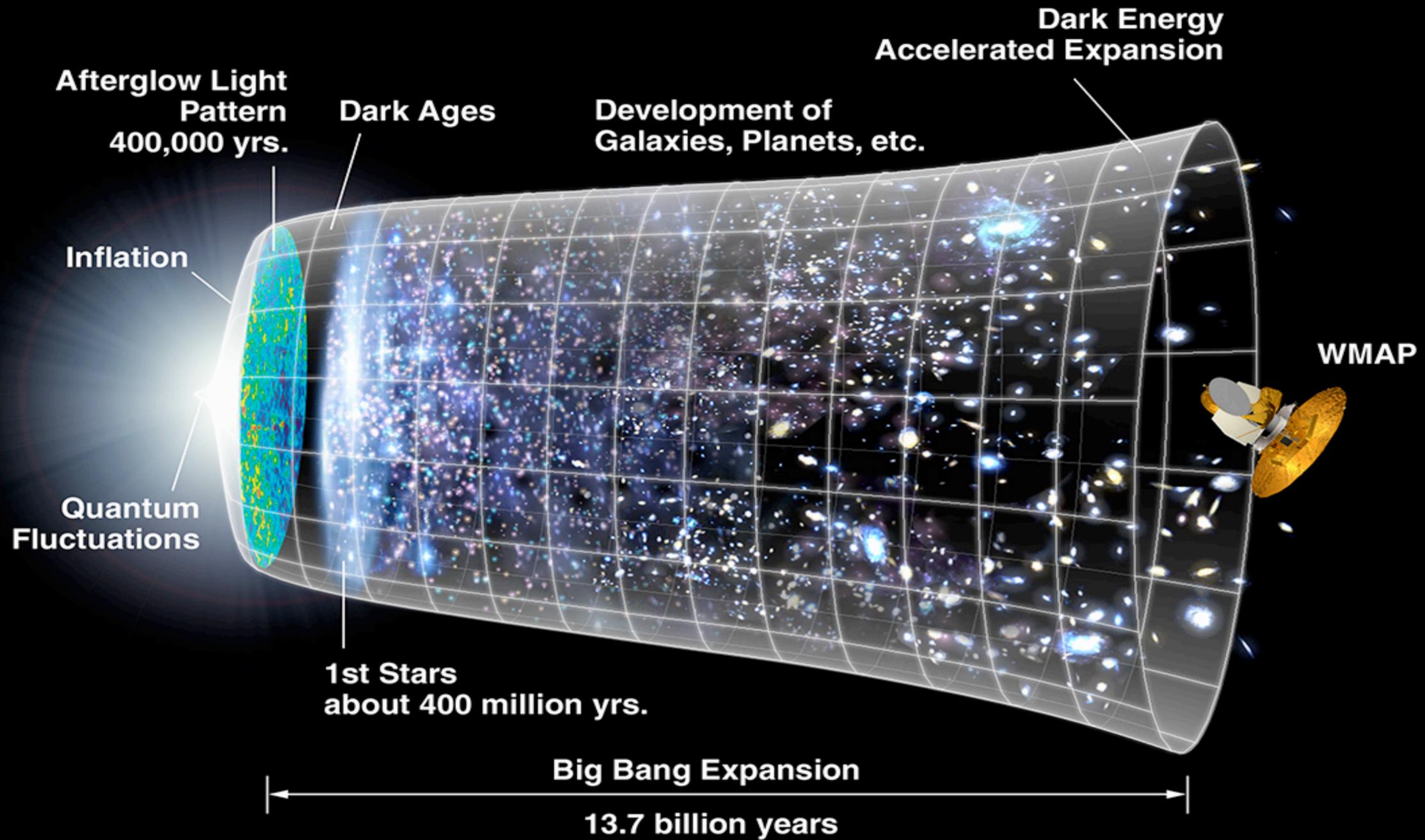
# Journey Backwards in Time

- The Cosmic Microwave Background (**CMB**) is *the fossil light from the Big Bang*
- This is the oldest light that one can ever hope to measure
- CMB is a direct image of the Universe when the Universe was only 380,000 years old

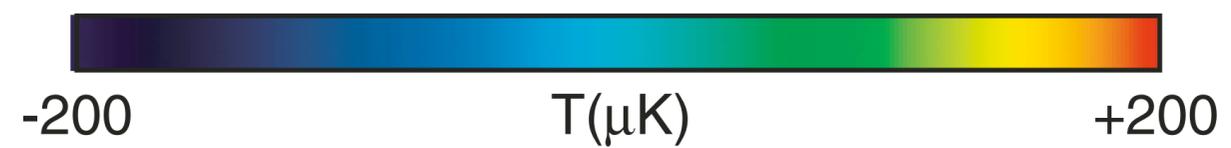
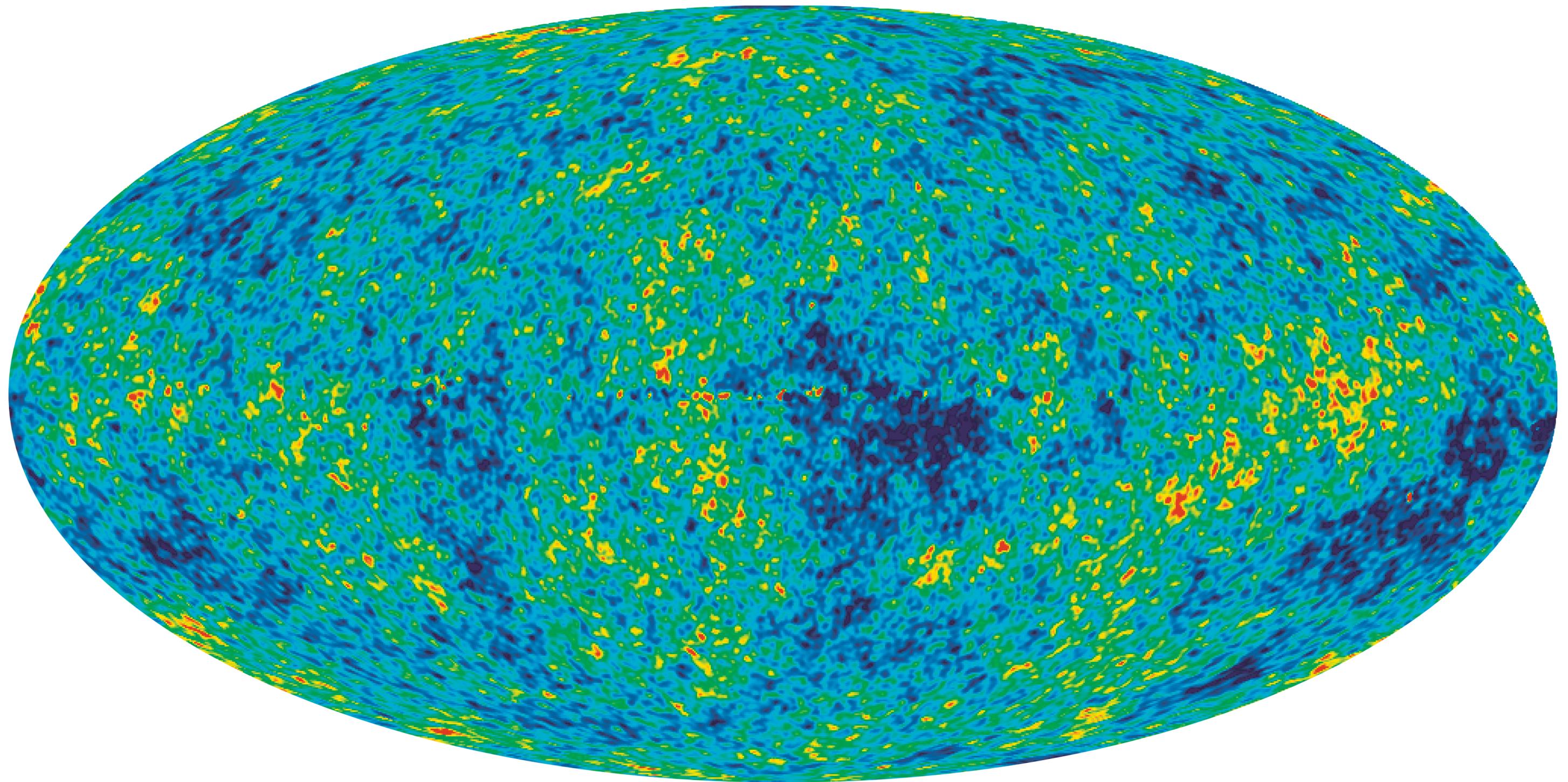


- CMB photons, after released from the cosmic plasma “soup,” traveled for **13.7 billion years** to reach us.
- CMB collects information about the Universe as it travels through it.

# CMB: A Messenger From the Early Universe...



# How were these ripples created?

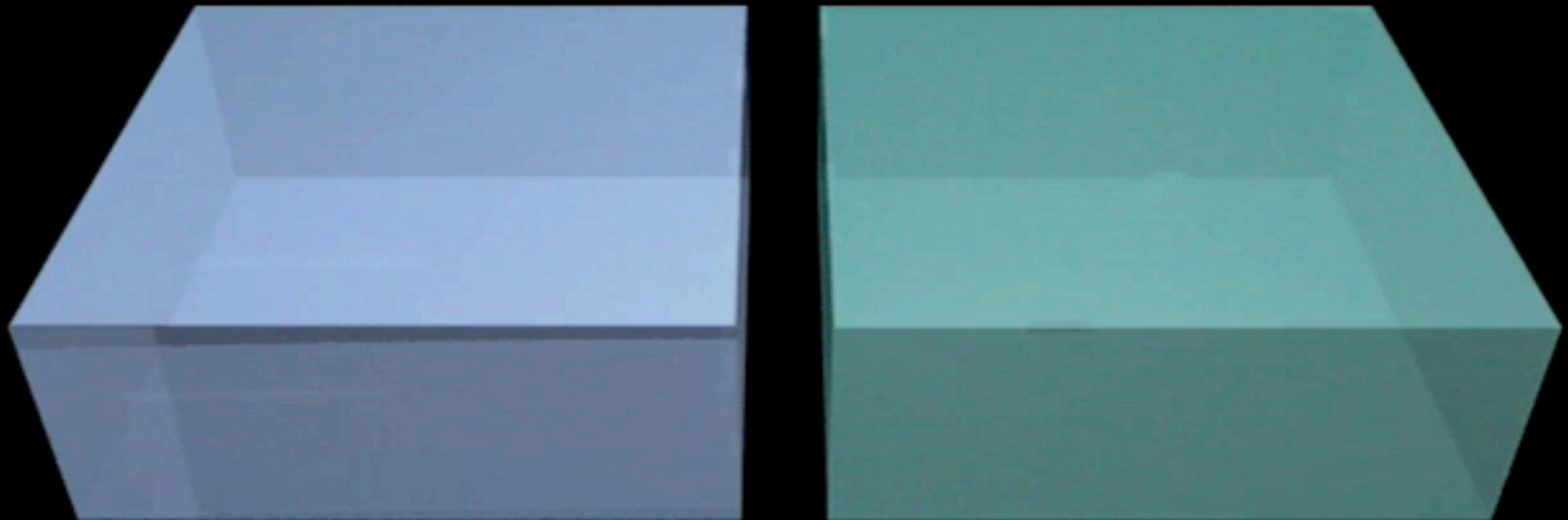


WMAP 5-year

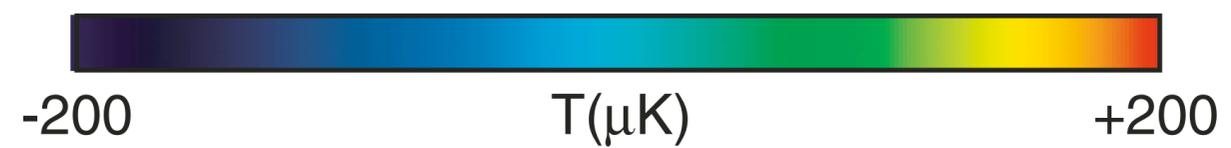
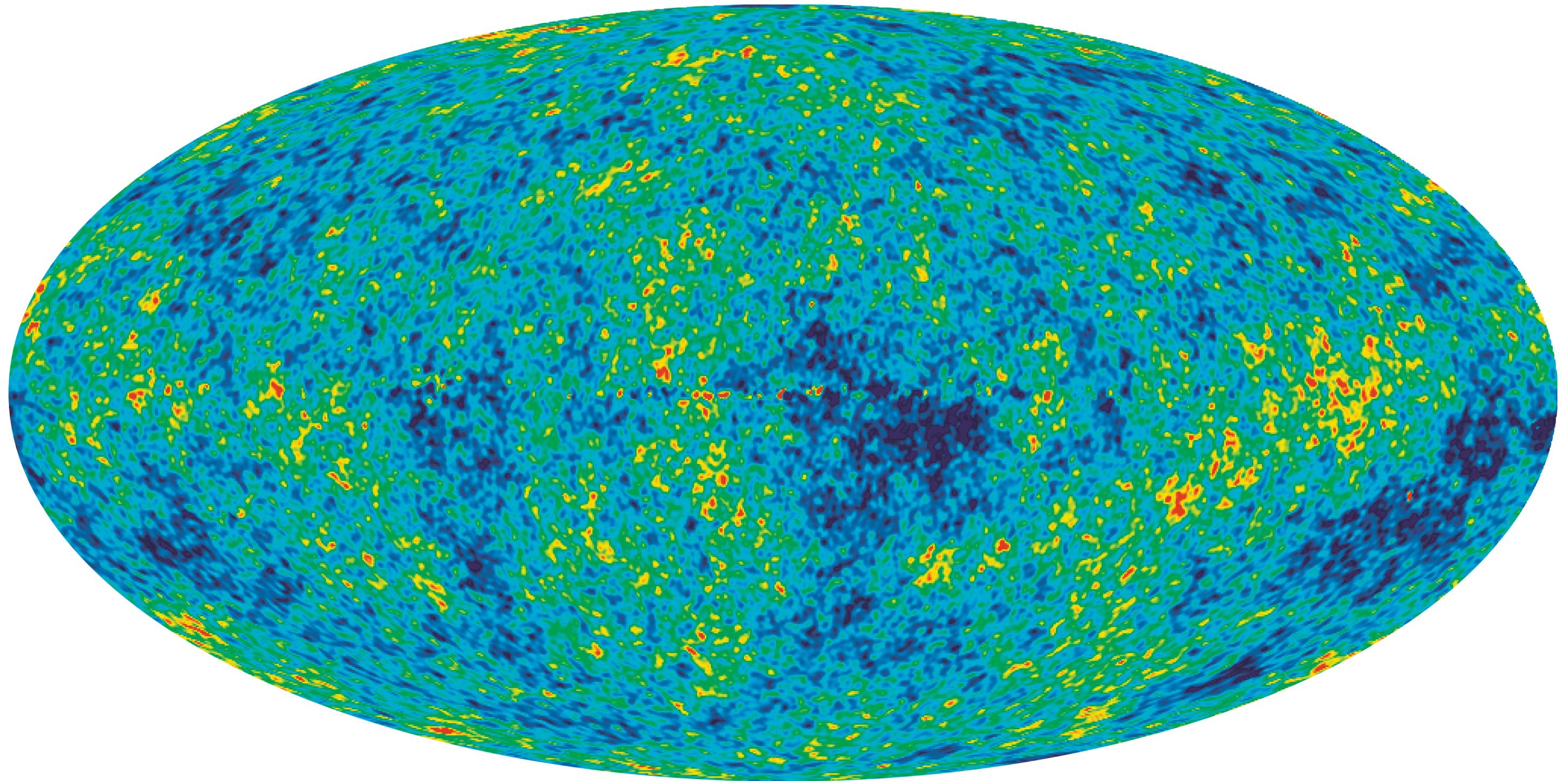
# Here Comes the Power of *Theory*

- When the Universe was hot... can you imagine?
- The Universe was a hot soup made of:
  - Protons, electrons, and helium nuclei
  - Photons and neutrinos
  - Dark matter
- What would happen if you “perturb” the soup?

# The Cosmic Sound Wave

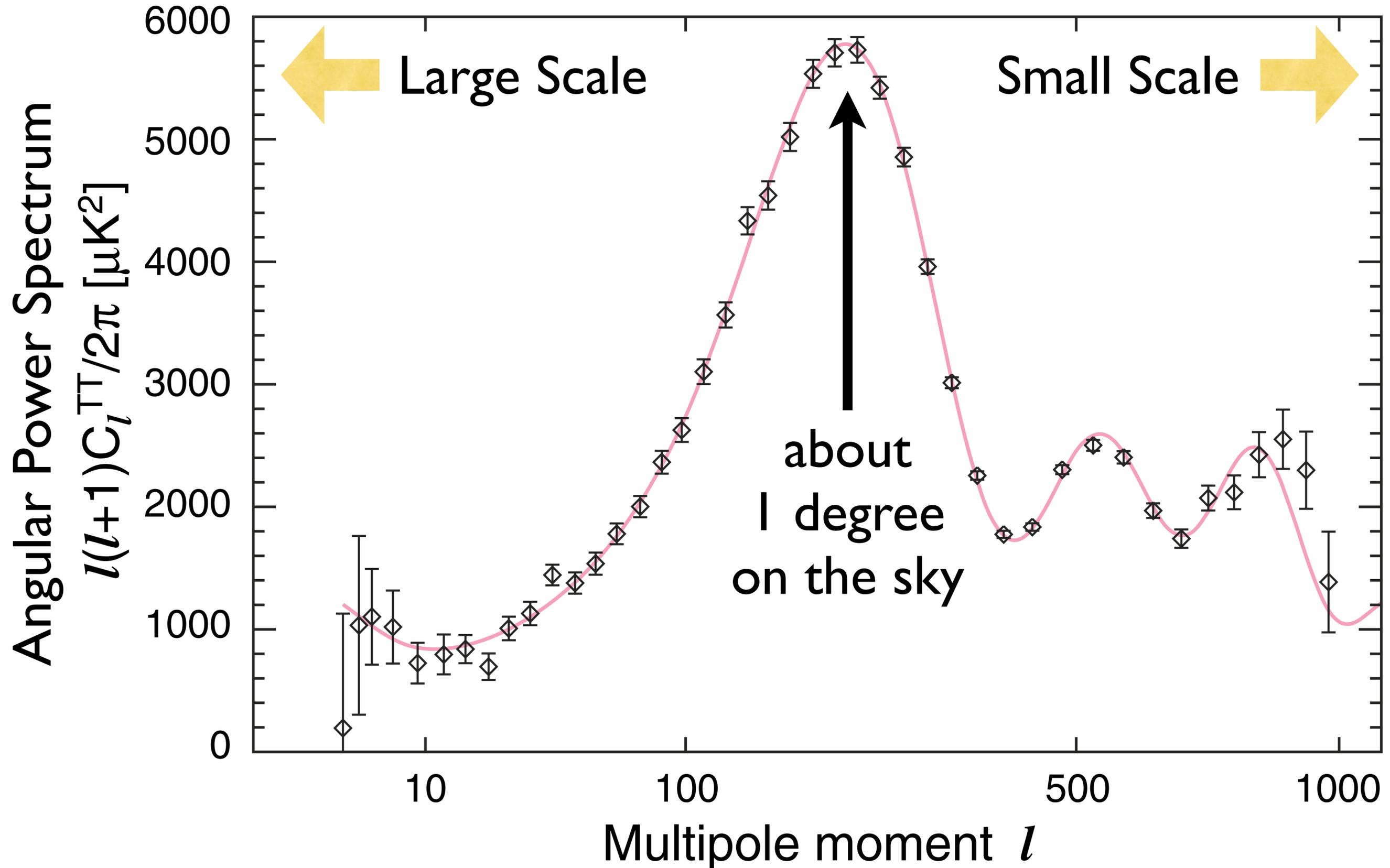


# Can You See the Sound Wave?

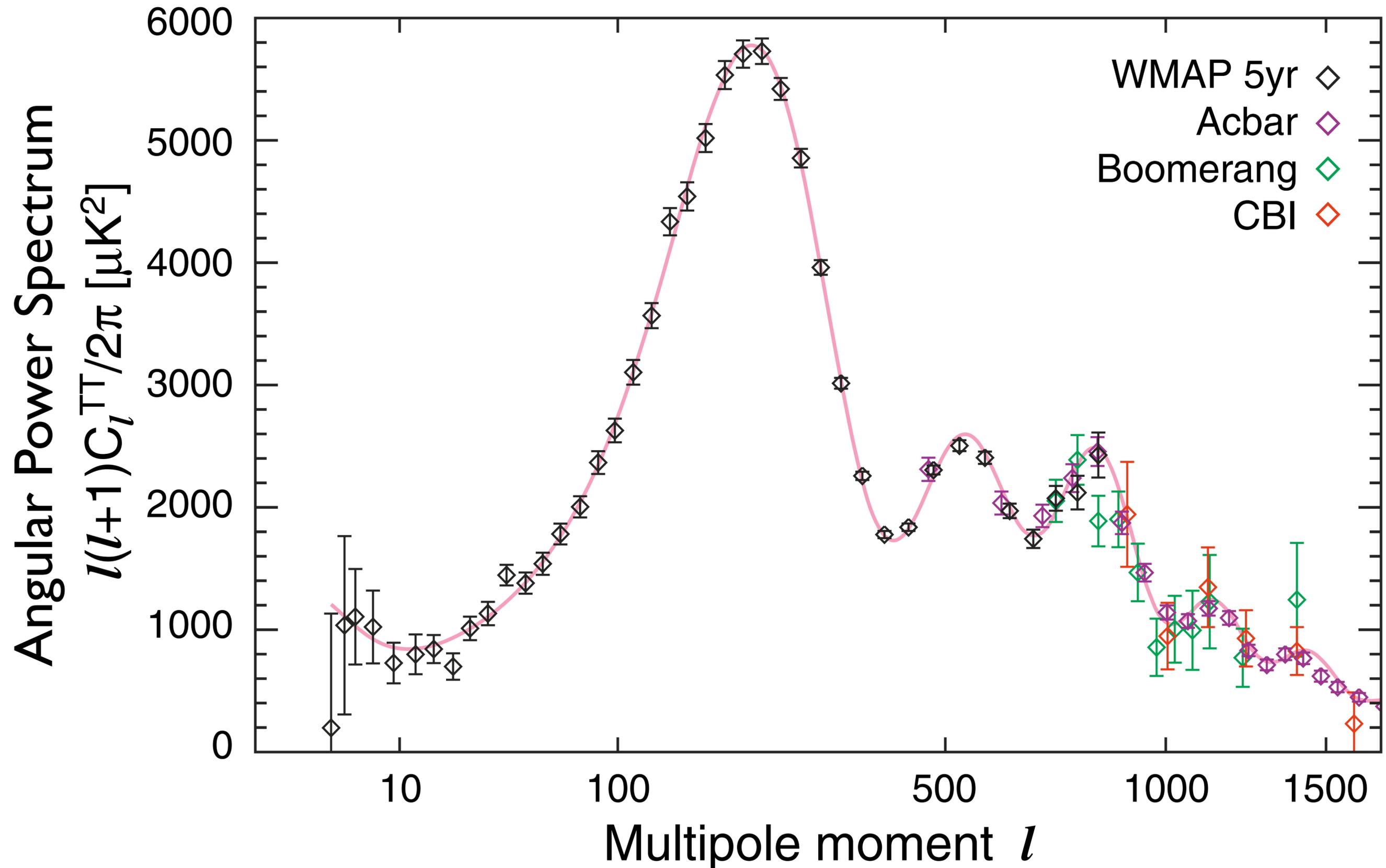


WMAP 5-year

# Image-Wave Decomposition



# Theory and Observations Match



# New University Research Unit

## *Texas Cosmology Center*

### *Astronomy/Observatory*

Volker Bromm

Karl Gebhardt

Gary Hill

Eiichiro Komatsu

Milos Milosavljevic

Mike Montgomery

Paul Shapiro

Don Winget

### *Physics*

Duane Dicus

Jacques Distler

Willy Fischler

Vadim Kaplunovsky

Richard Matzner

Sonia Paban

Steven Weinberg

[new junior faculty] <sup>18</sup>

# TCC: Goals

<http://www.tcc.utexas.edu/>

- TCC provides a focal point for interdisciplinary efforts between the Departments of Astronomy and Physics.
- Dynamic collaborations between theorists and observers, astronomers and physicists: crucial for making a big impact in the field.
- Make HETDEX the successful experiment.

# TCC: Current Status

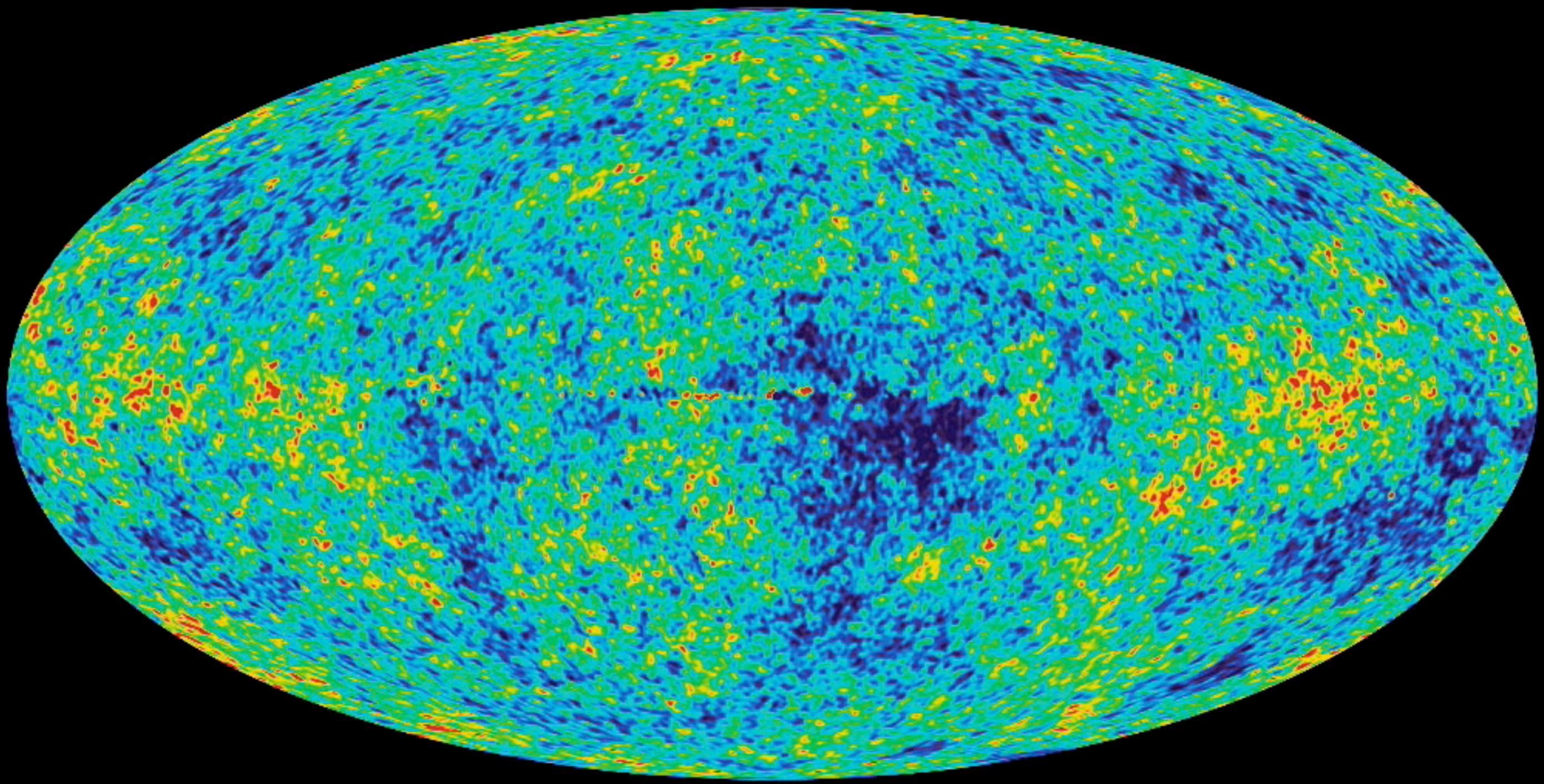
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- TCC was just established on January 1, 2009
  - 16 papers already published under TCC over 3 months!
- TCC is currently funded by the UT Provost's Office, CNS Dean's Office, Departments of Astronomy and Physics, and McDonald Observatory
- Hiring one junior faculty in the Dept. of Physics (offer being made)
- Hired two TCC post-doctoral fellows to begin in September (will hire two more next year)

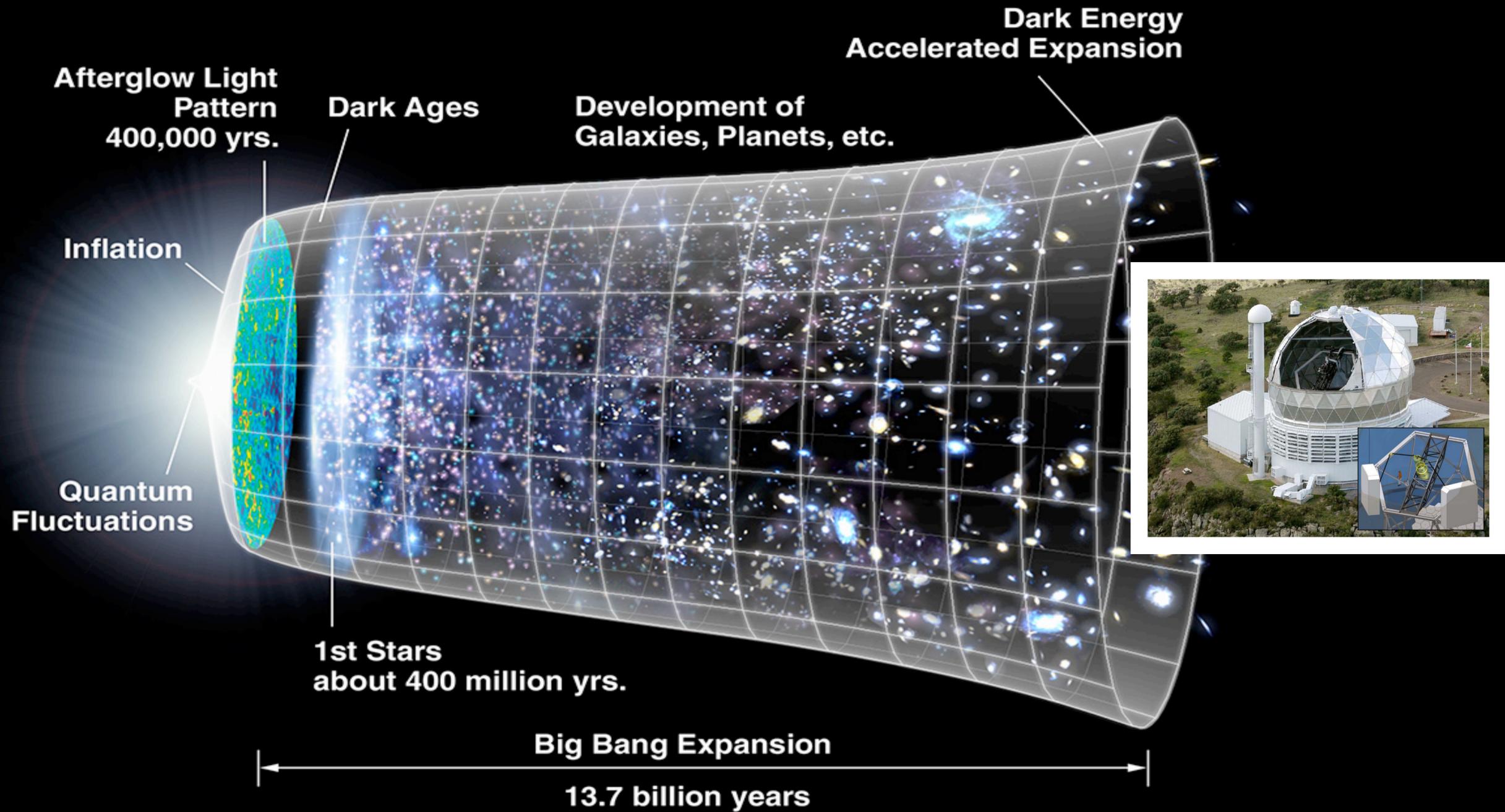
# TCC: Next Steps

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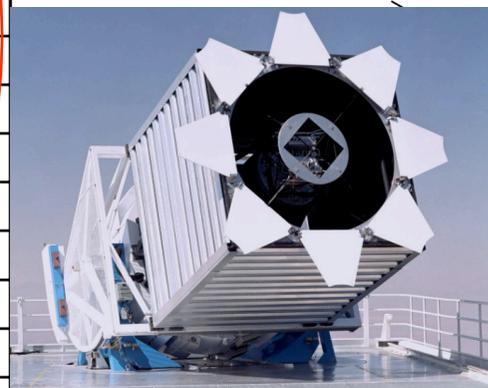
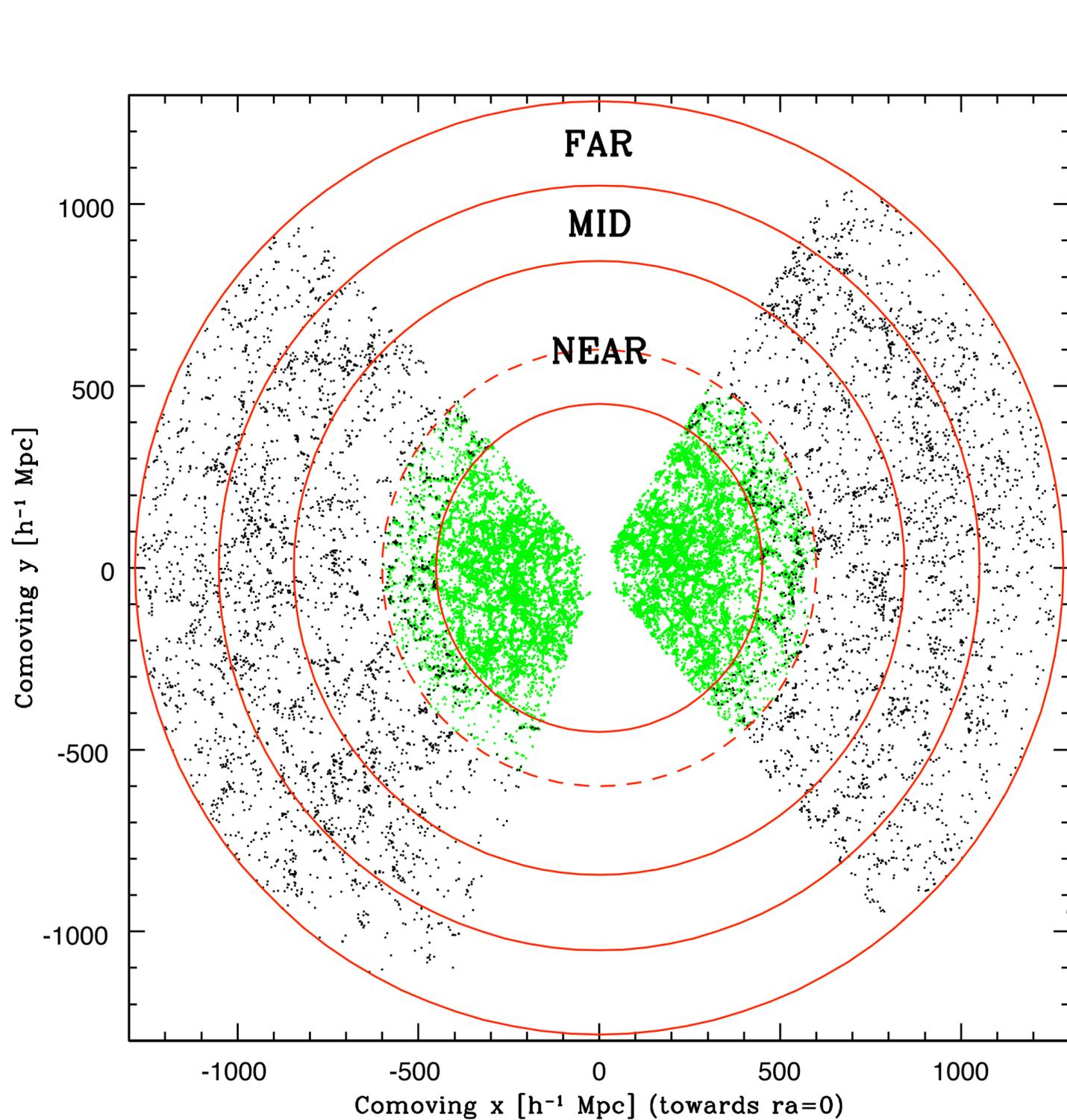
- We will organize meetings and conferences
- Seek external support: both federal (NSF, DOE) and private
- Immediate need is to double the number of postdocs from 4 to 8.
- Hire two more faculty members (one in astronomy and one in physics) to fulfill the Strategic Goal “*Vision Plan*”
- *And of course, do great science!*



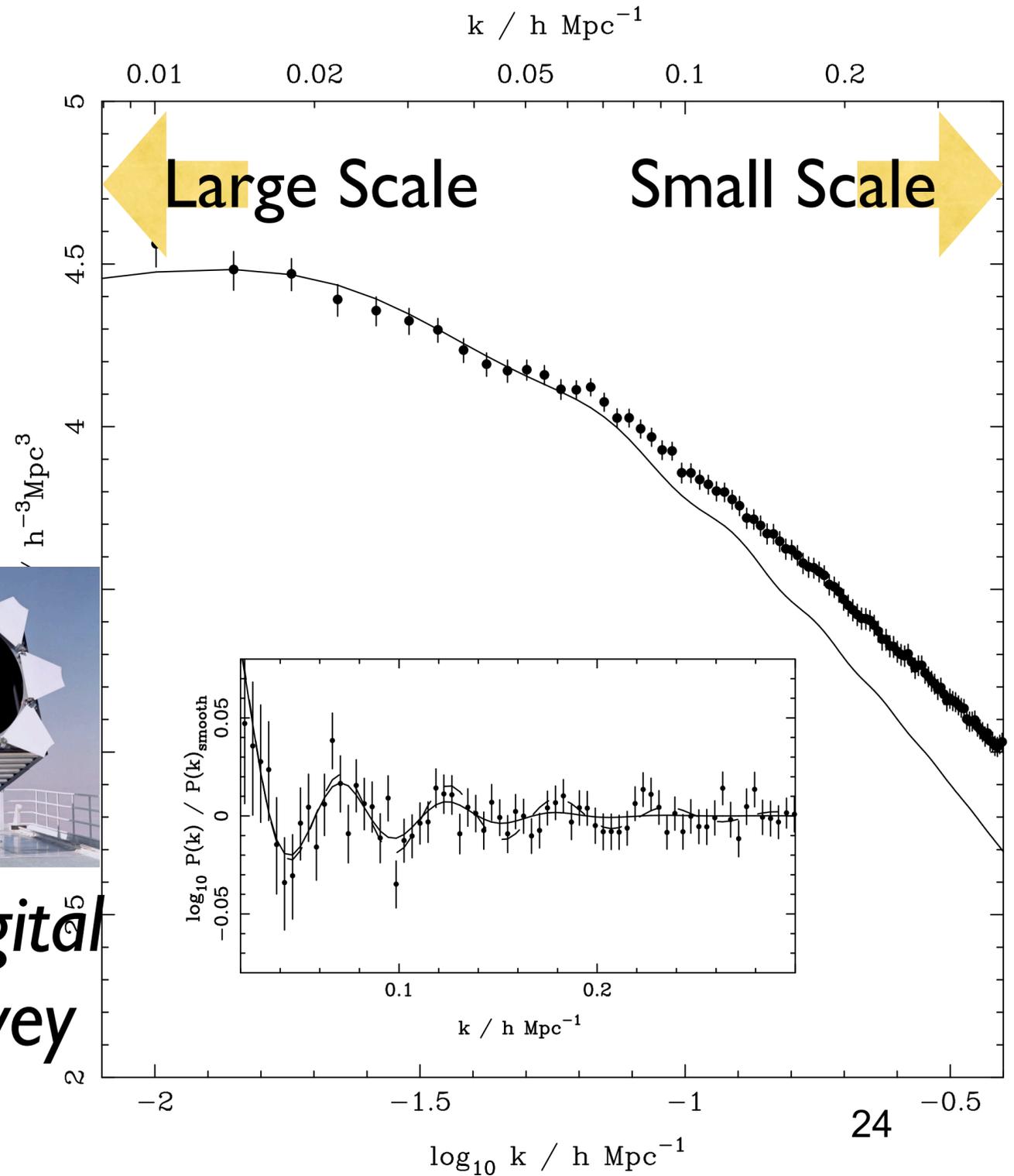
# What Will HETDEX Do?



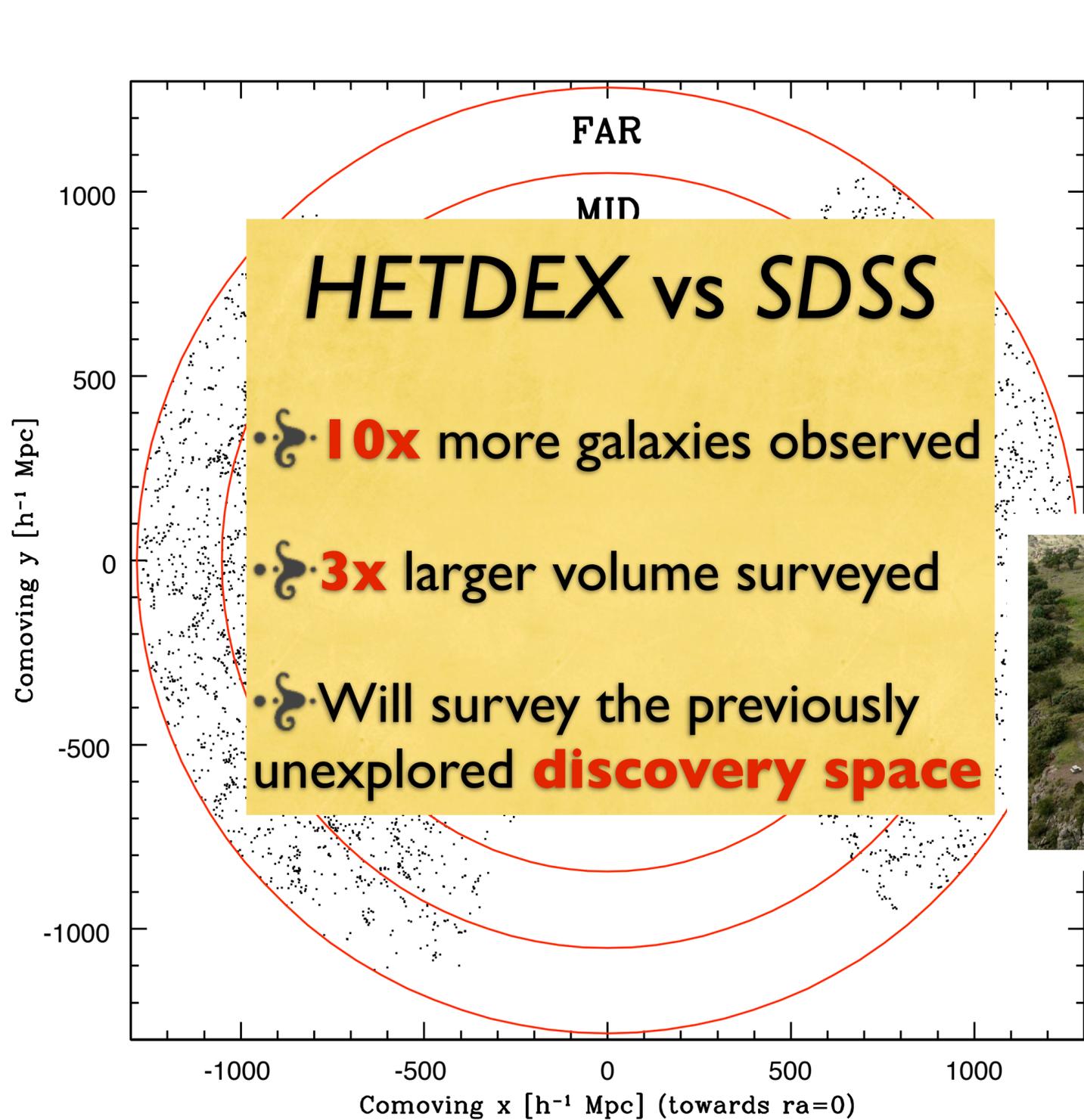
# HETDEX: Sound Waves in the Distribution of Galaxies



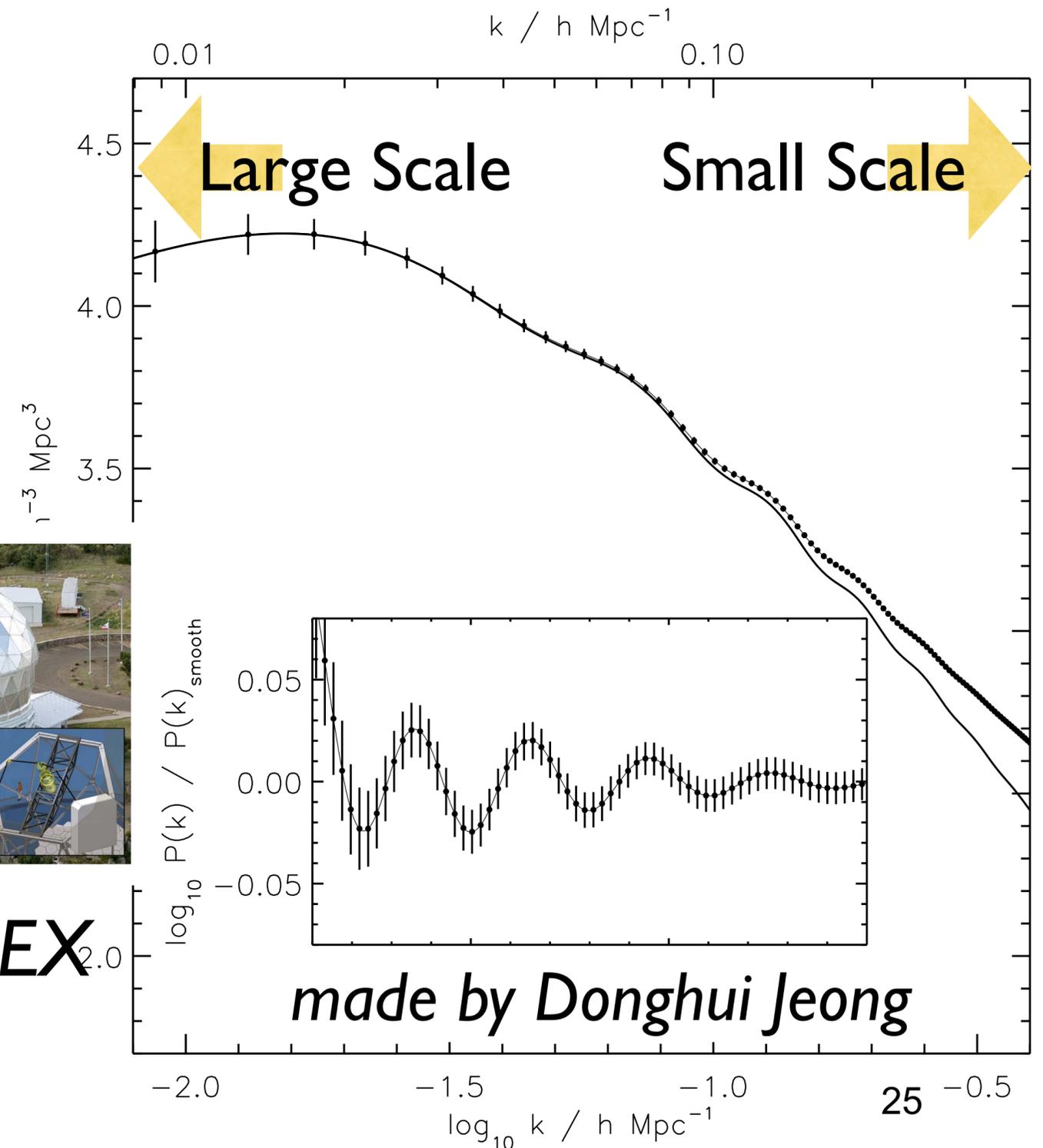
*Sloan Digital Sky Survey*



# HETDEX: Sound Waves in the Distribution of Galaxies



**HETDEX**



# Frontiers in Cosmology

- Four Key Science Questions in Cosmology:
  - What powered the Big Bang?
  - What is Dark Matter?
  - What is Dark Energy?
  - How did the Structure emerge and evolve?
- Undoubtedly, a close collaboration between theory and observations will be necessary for solving these outstanding questions in modern cosmology.
- *And, Golden Age of Cosmology continues...*