

Texas Cosmology Center (TCC)

Eiichiro Komatsu

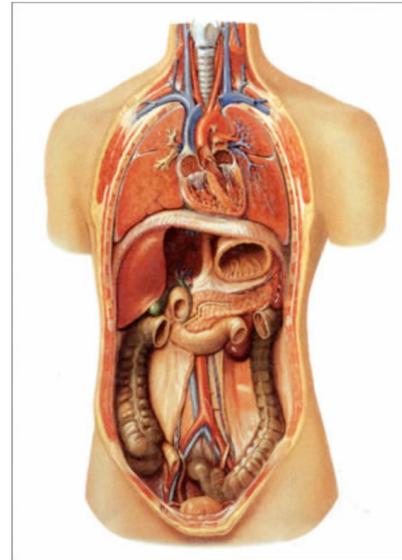
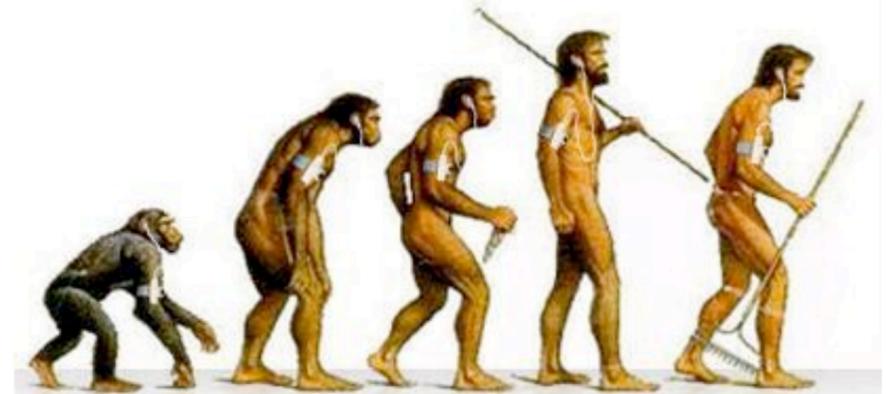
Foundation Advisory Council Meeting

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

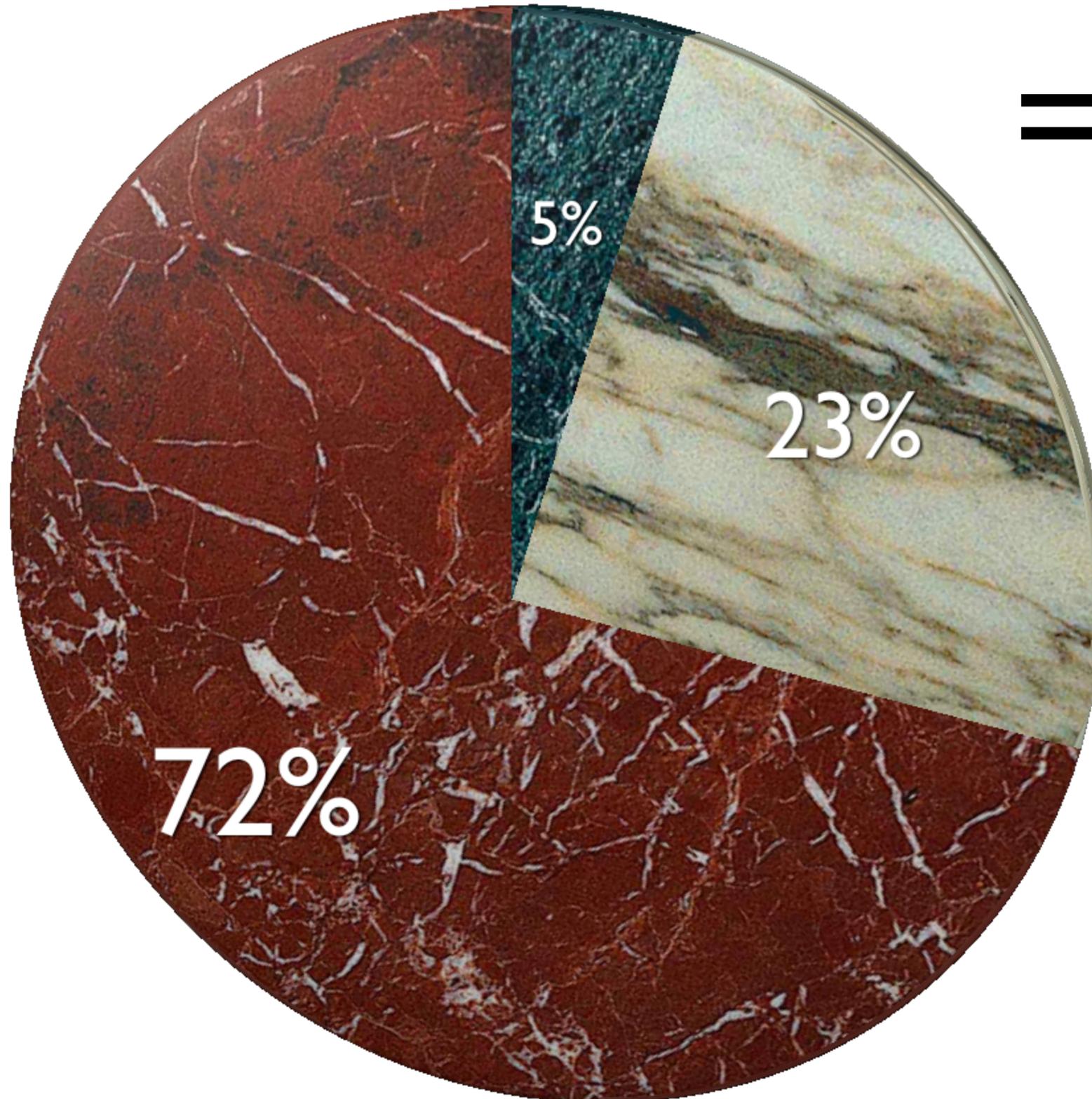
- **Why Golden Age?** Ask questions about our Universe. For most of them, we have good answers: the answers that were obtained over the last decade.
- *How old is our Universe?*
 - **13.7 ± 0.1 billion years old.**
- *What is the geometry of our observable Universe?*
 - **Flat** (Euclidean), to about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



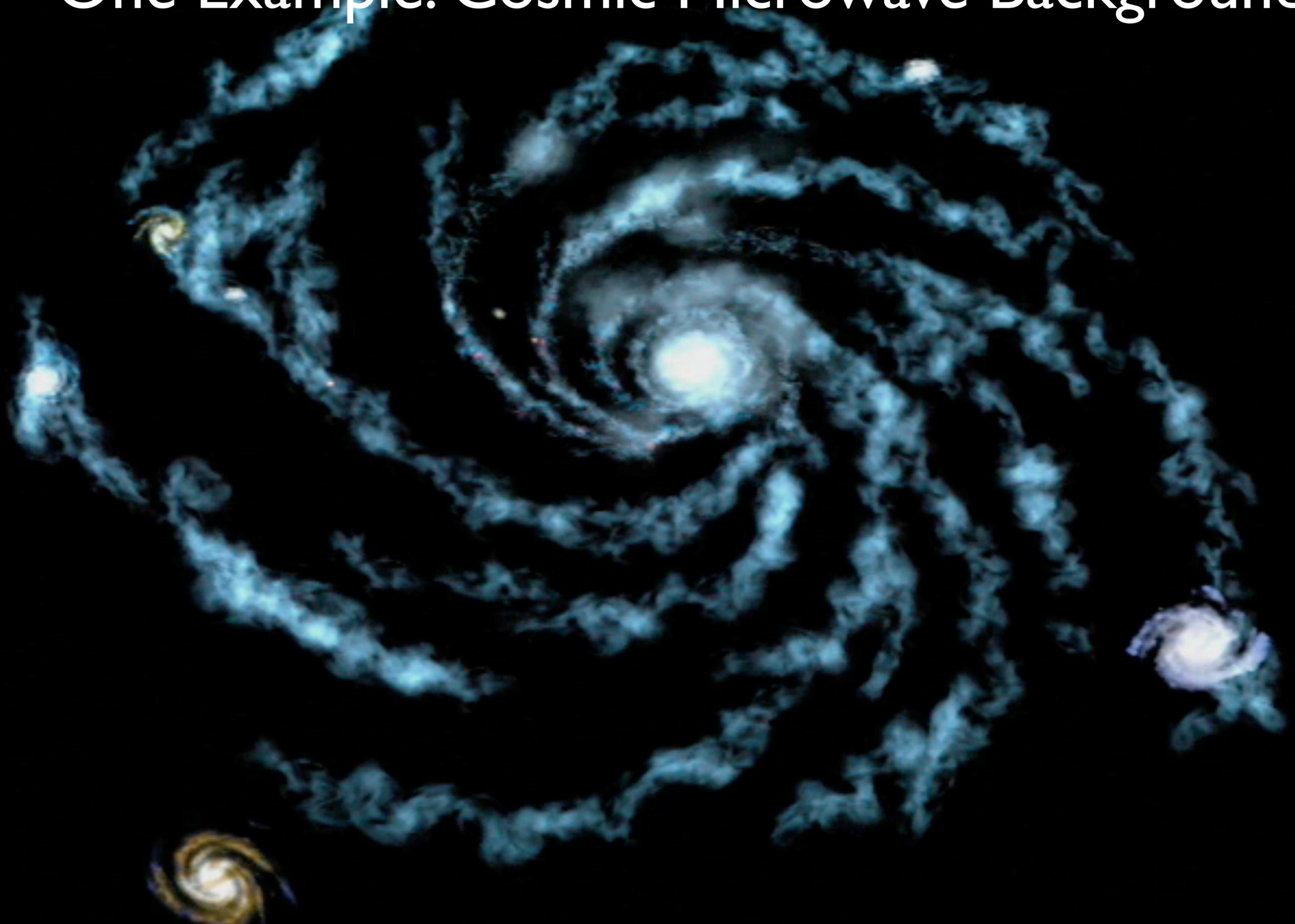
Golden Age of Cosmology

- **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?

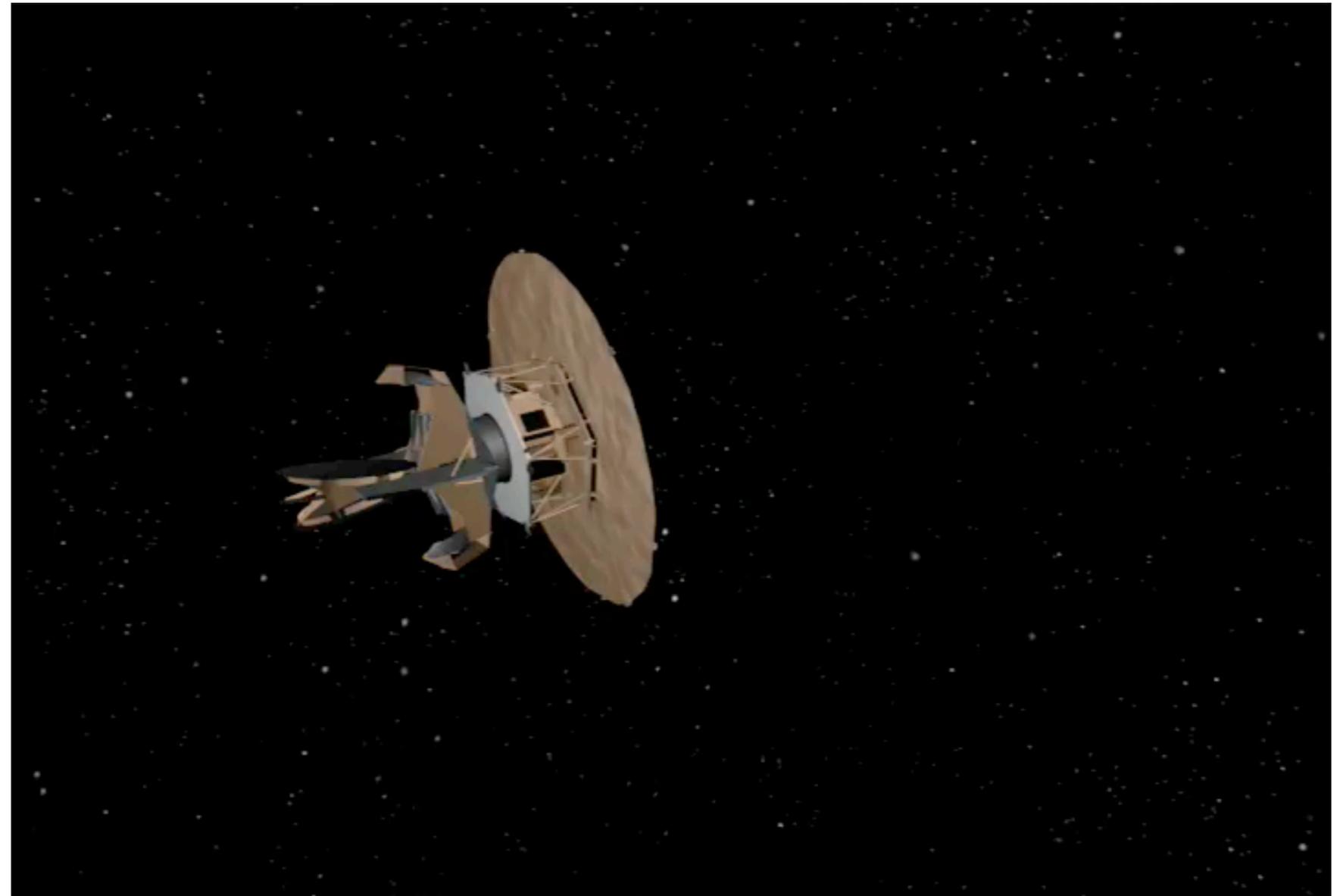
- An incredible collaboration between theory and observations in modern cosmology.
- **Both** theory and observations have experienced remarkable advances over the last decade.
- And, theoretical ideas and observations continue to collaborate and influence each other.
- **That's the heart of the Texas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

One Example: Cosmic Microwave Background



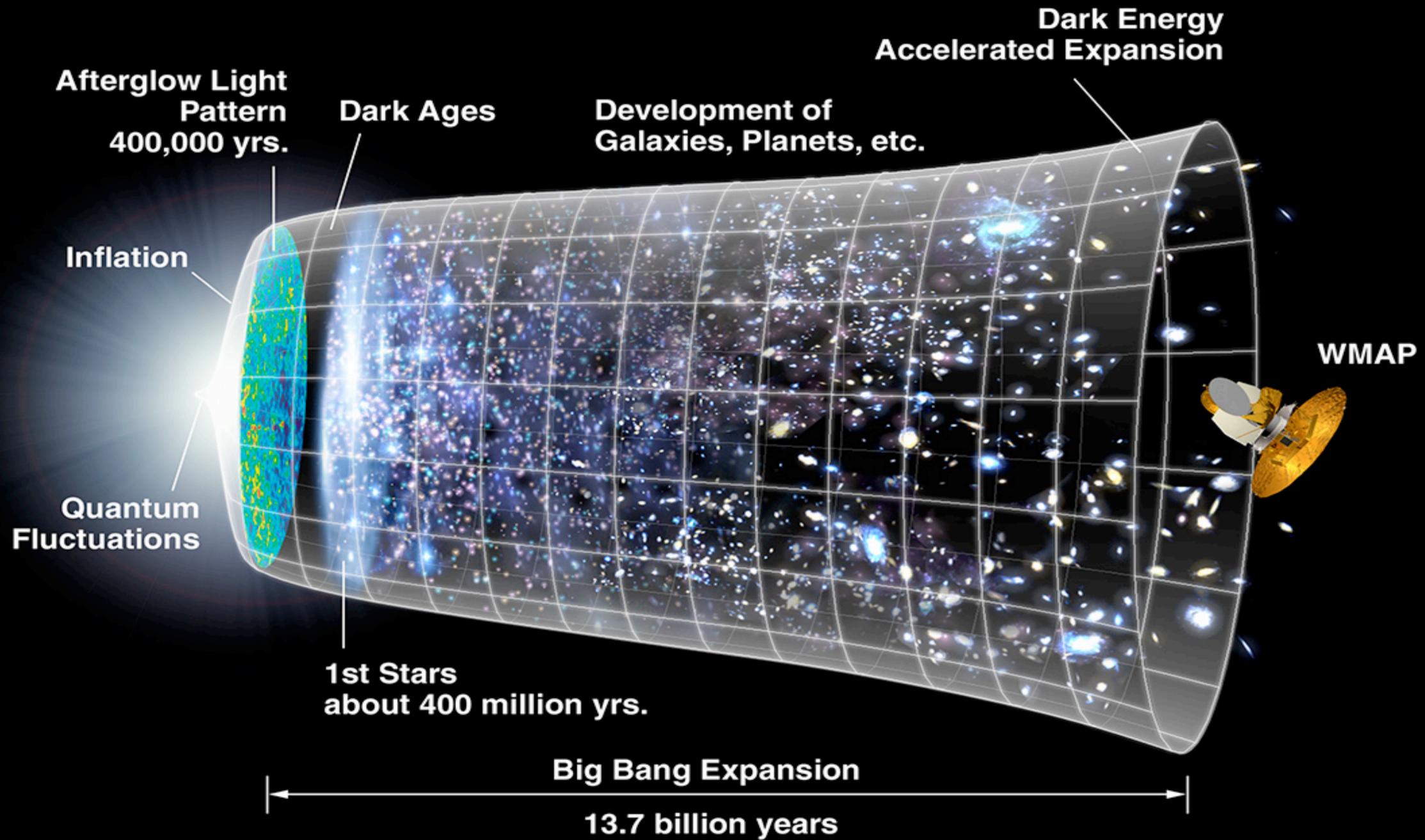
Journey Backwards in Time

- 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

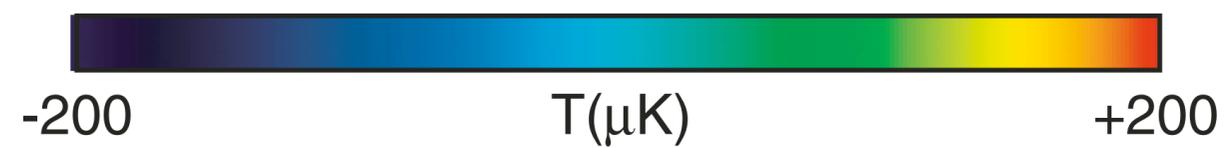
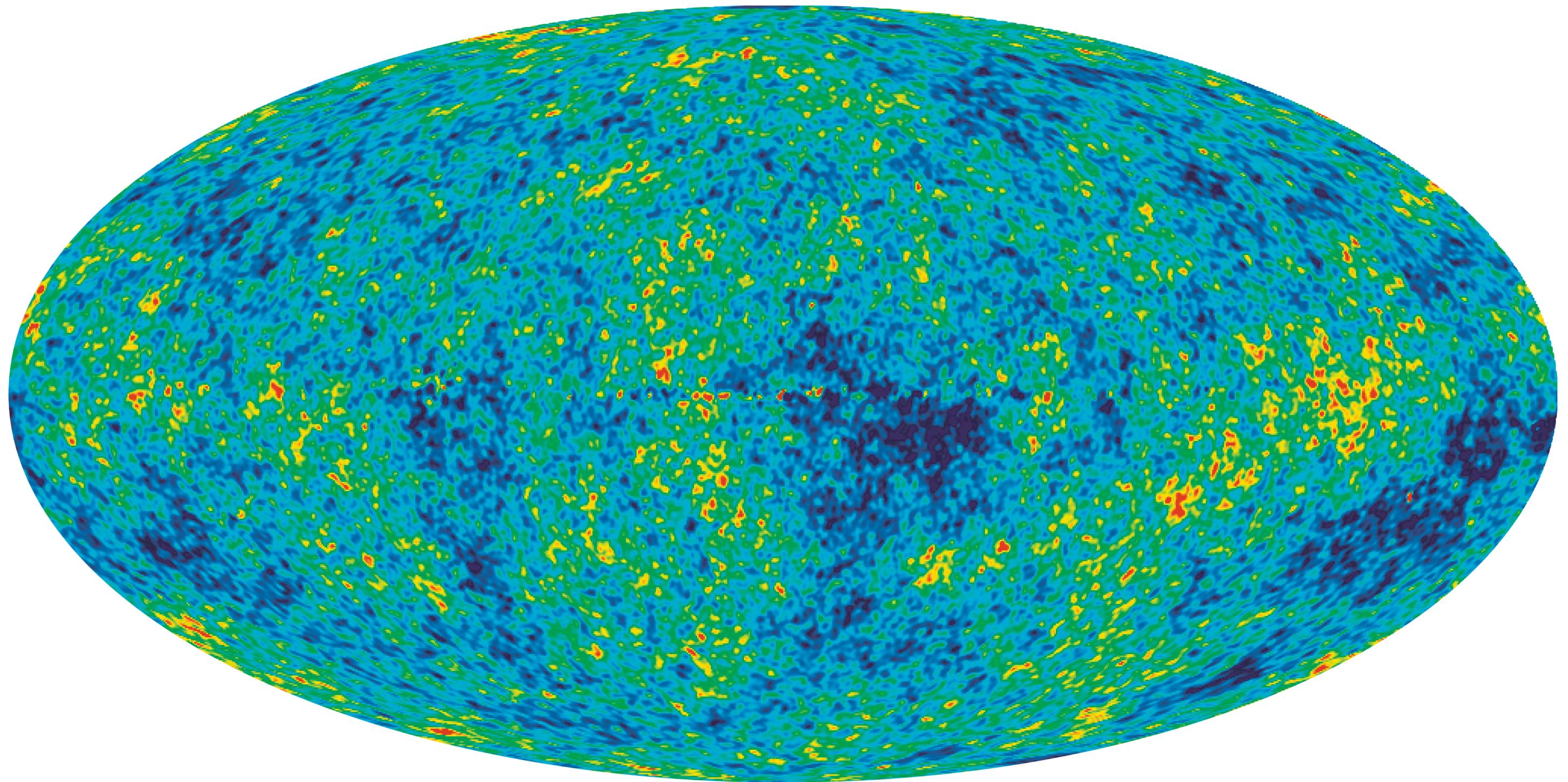


- CMB photons, after released from the cosmic plasma “soup,” traveled for **13.7 billion years** to reach us.
- CMB collects information about the Universe as it travels through it.

CMB: A Messenger From the Early Universe...



How were these ripples created?

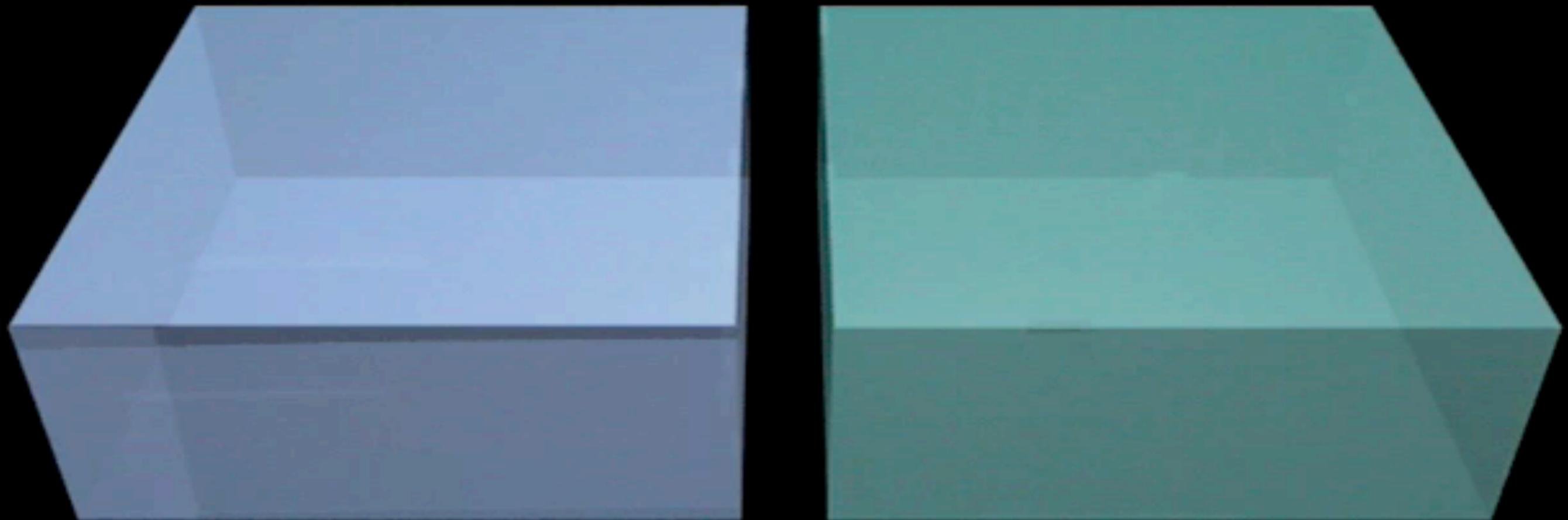


WMAP 5-year

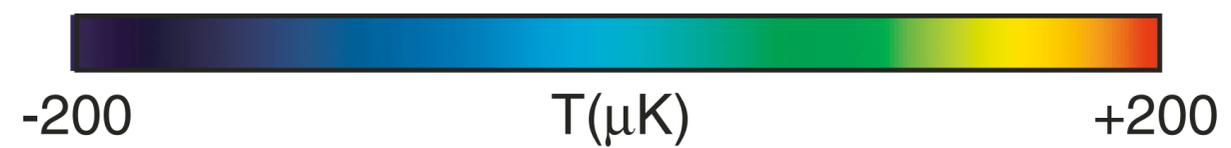
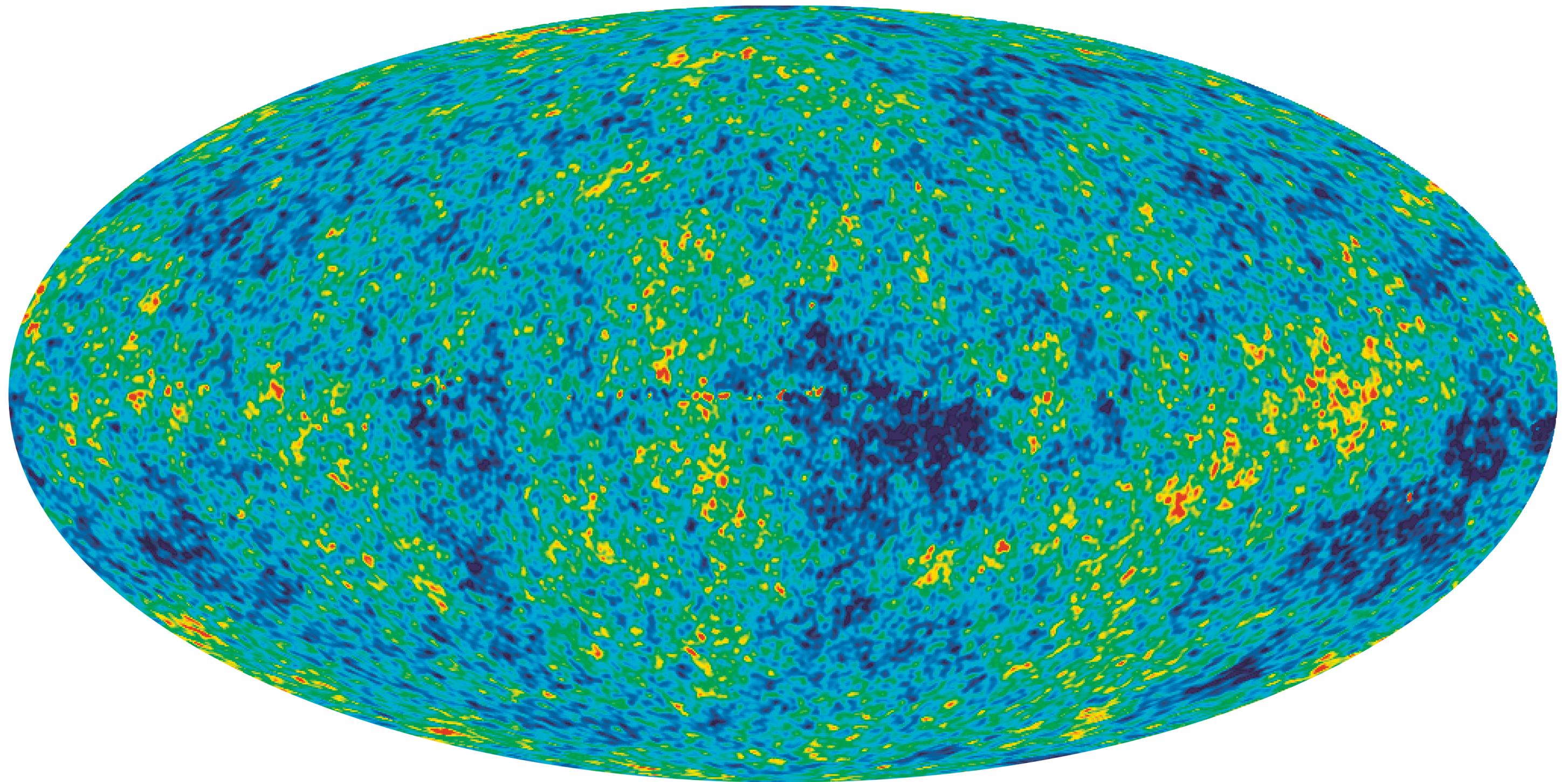
Here Comes the Power of *Theory*

- 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

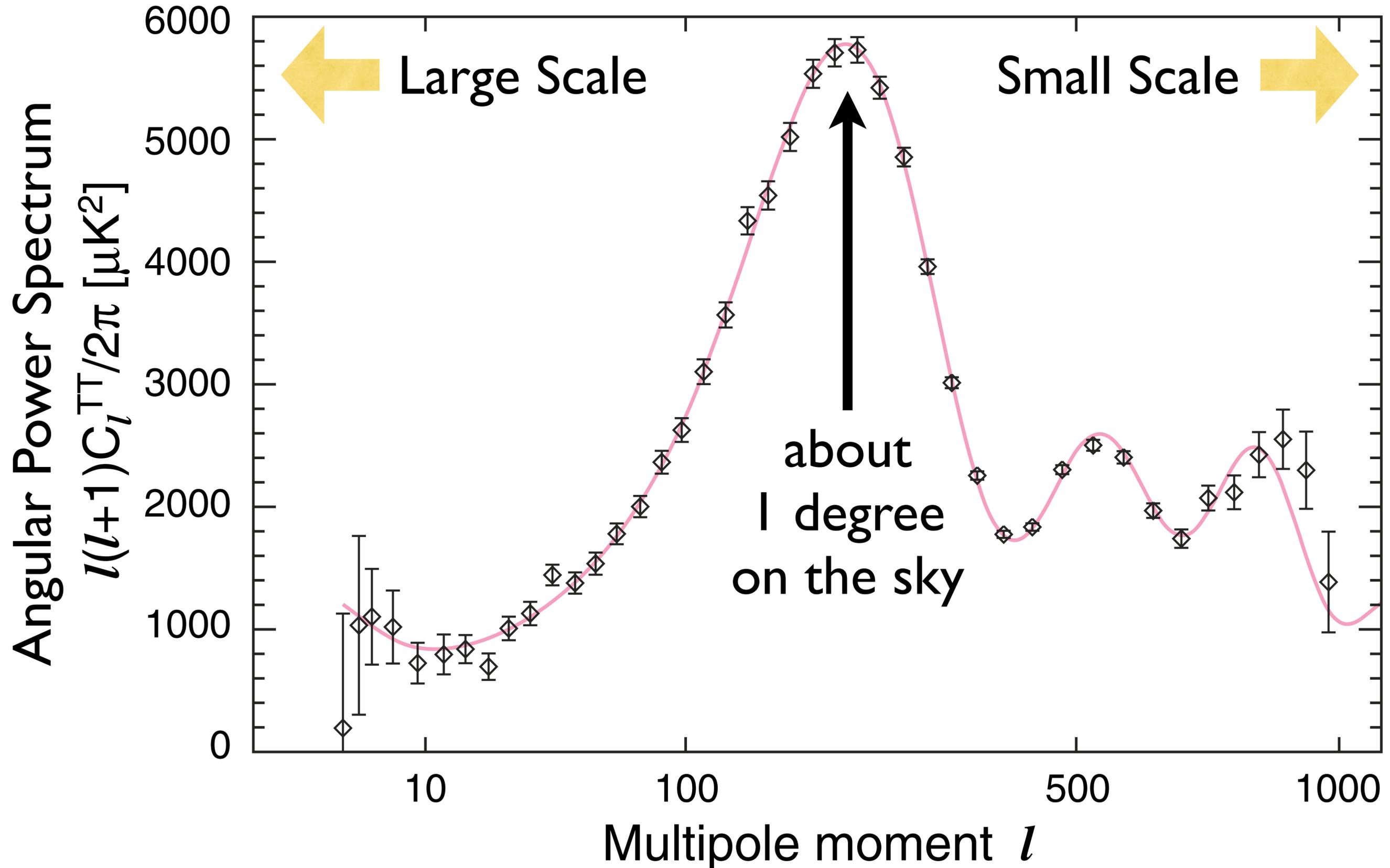


Can You See the Sound Wave?

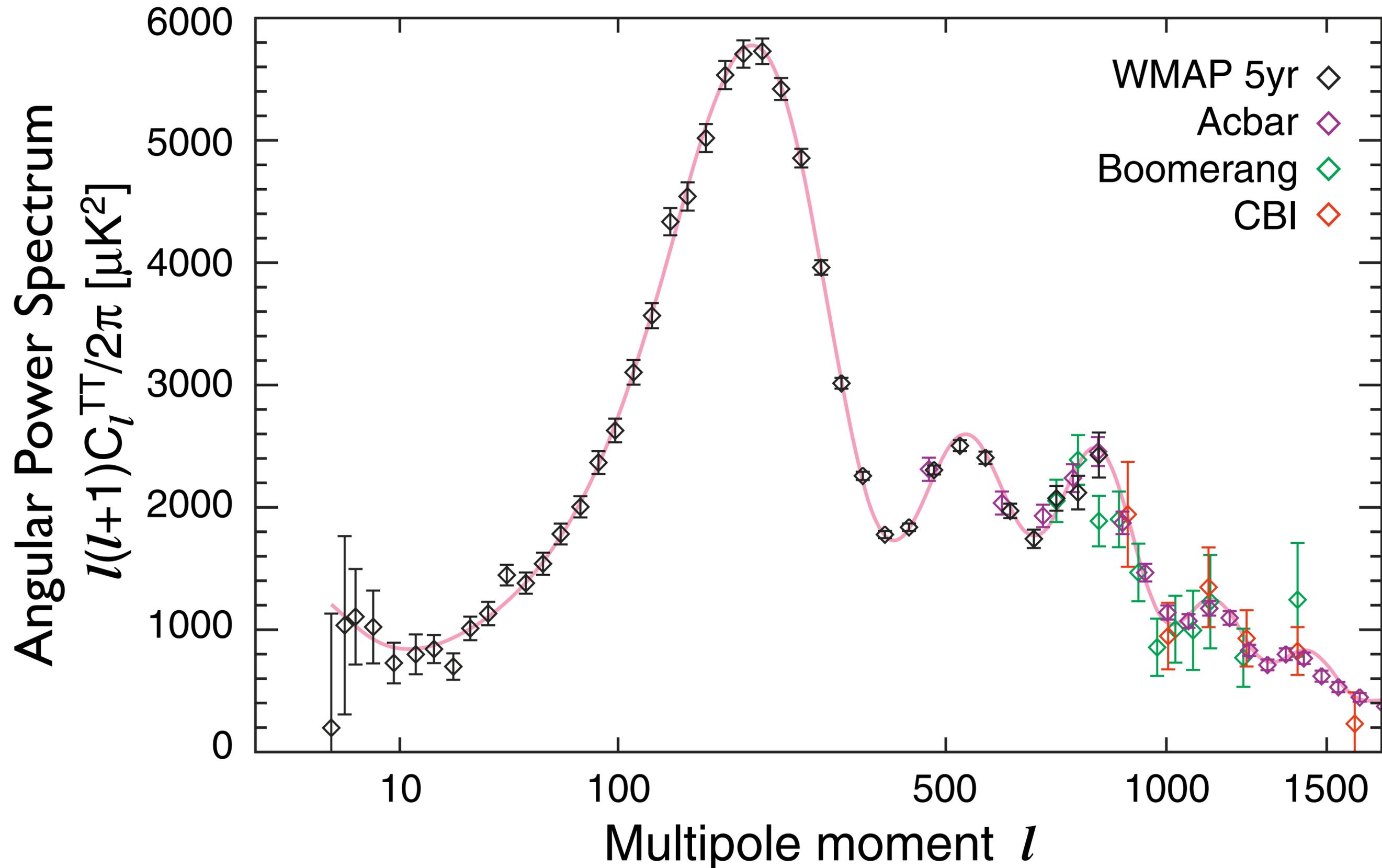


WMAP 5-year

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] ¹⁸

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

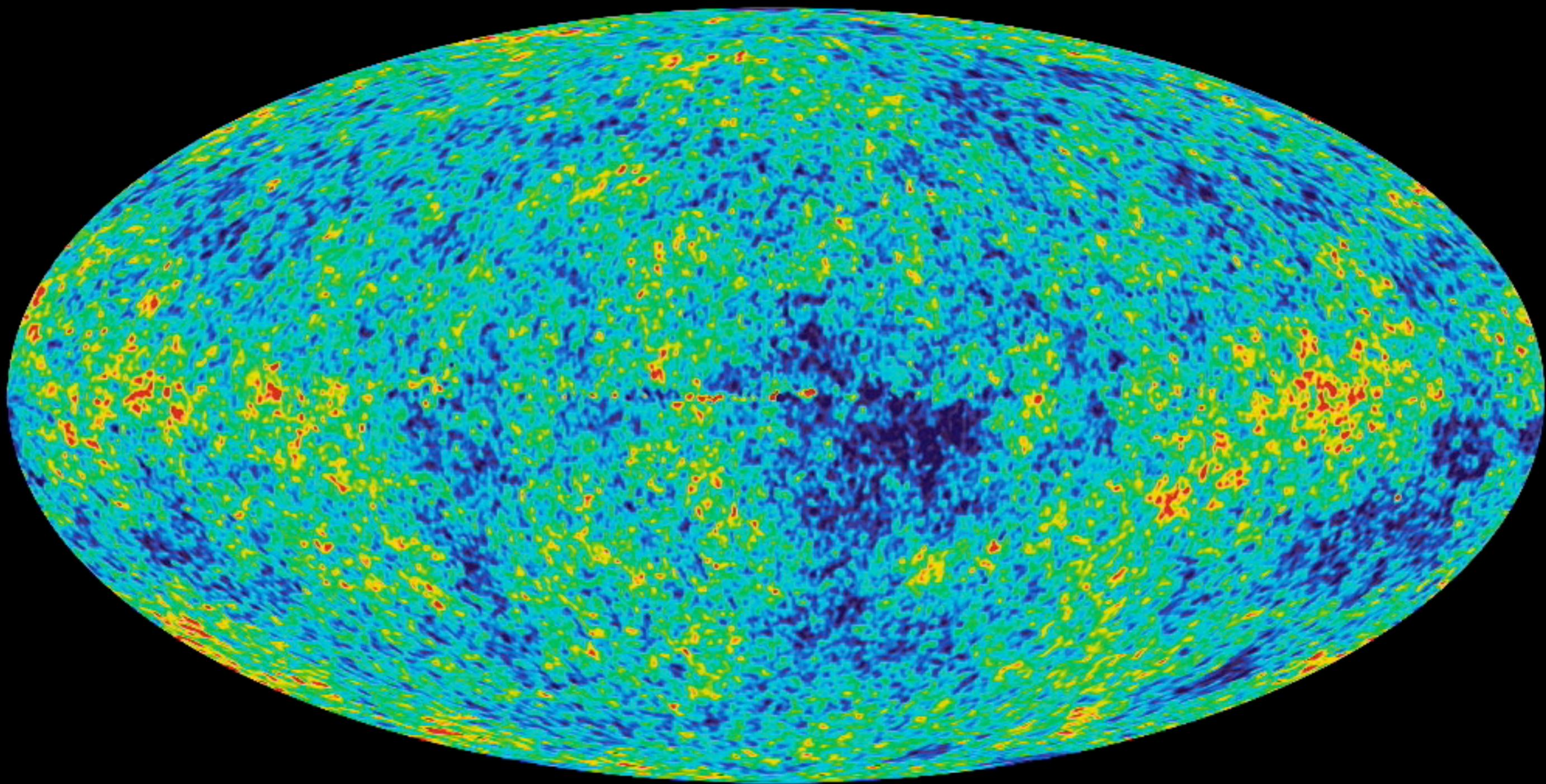
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- TCC was just established on January 1, 2009
 - 16 papers already published under TCC over 3 months!
- TCC is currently funded by the UT Provost's Office, CNS Dean's Office, Departments of Astronomy and Physics, and McDonald Observatory
- Hiring one 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)

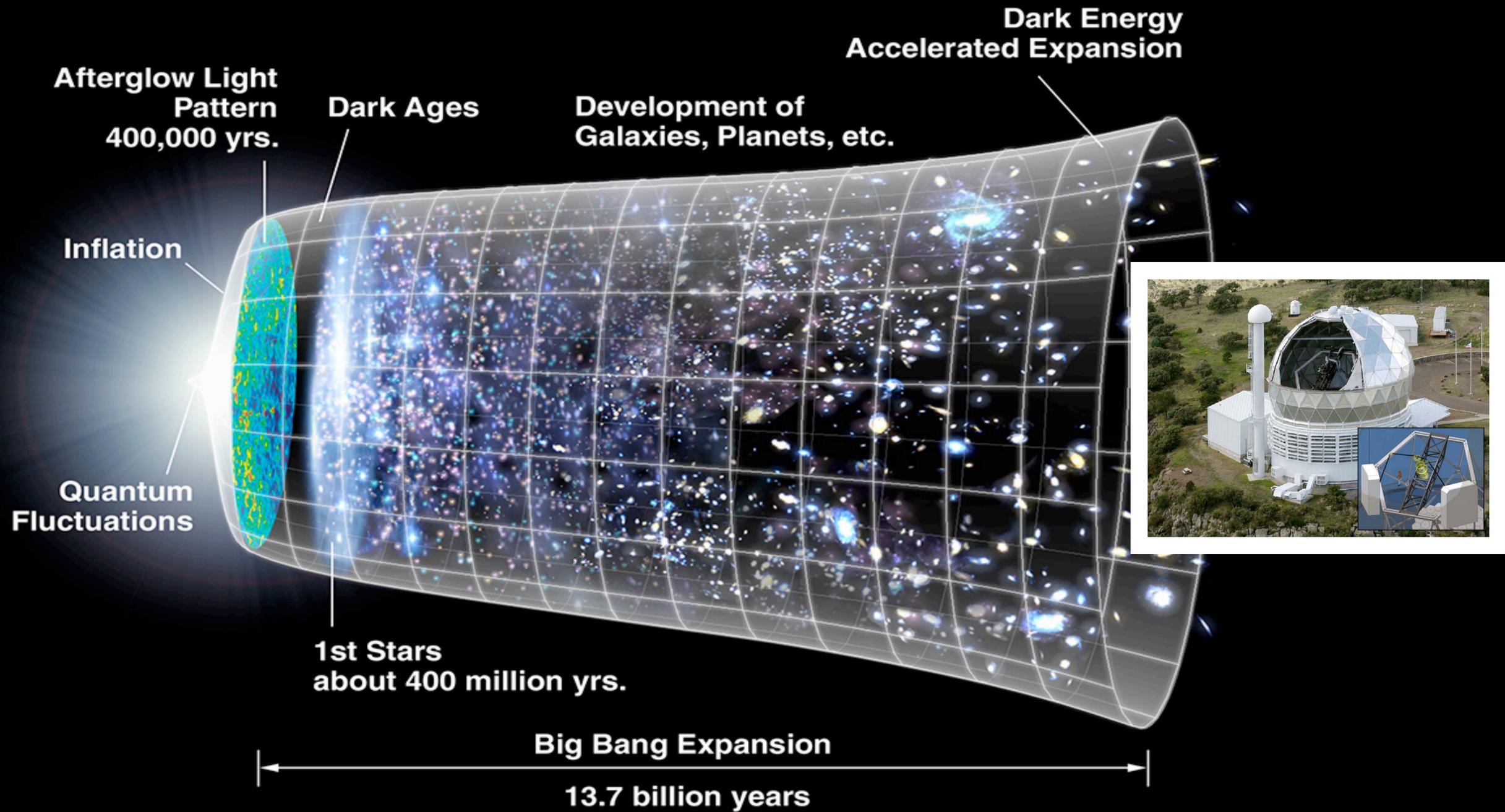
TCC: Next Steps

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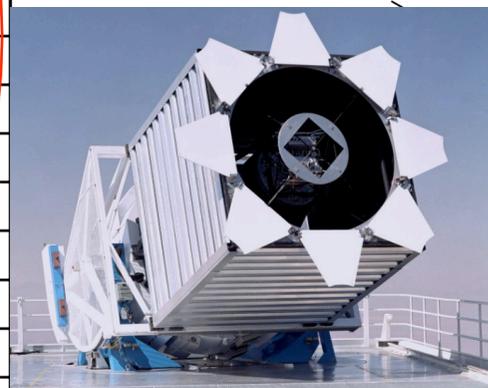
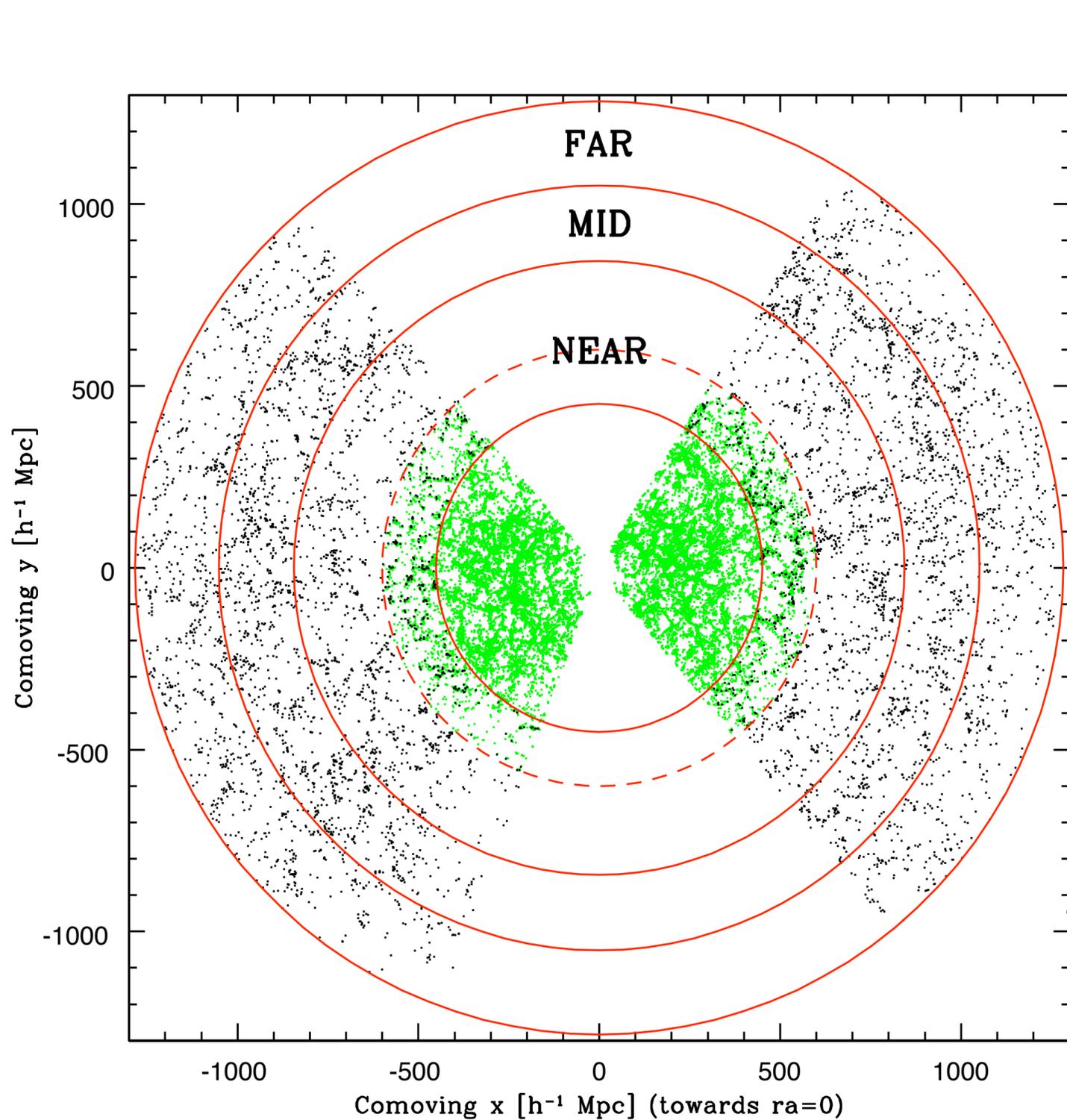
- We will organize meetings and conferences
- Seek external support: both federal (NSF, DOE) and private
- Immediate need is to double the number of postdocs from 4 to 8.
- Hire two more faculty members (one in astronomy and one in physics) to fulfill the Strategic Goal “*Vision Plan*”
- *And of course,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



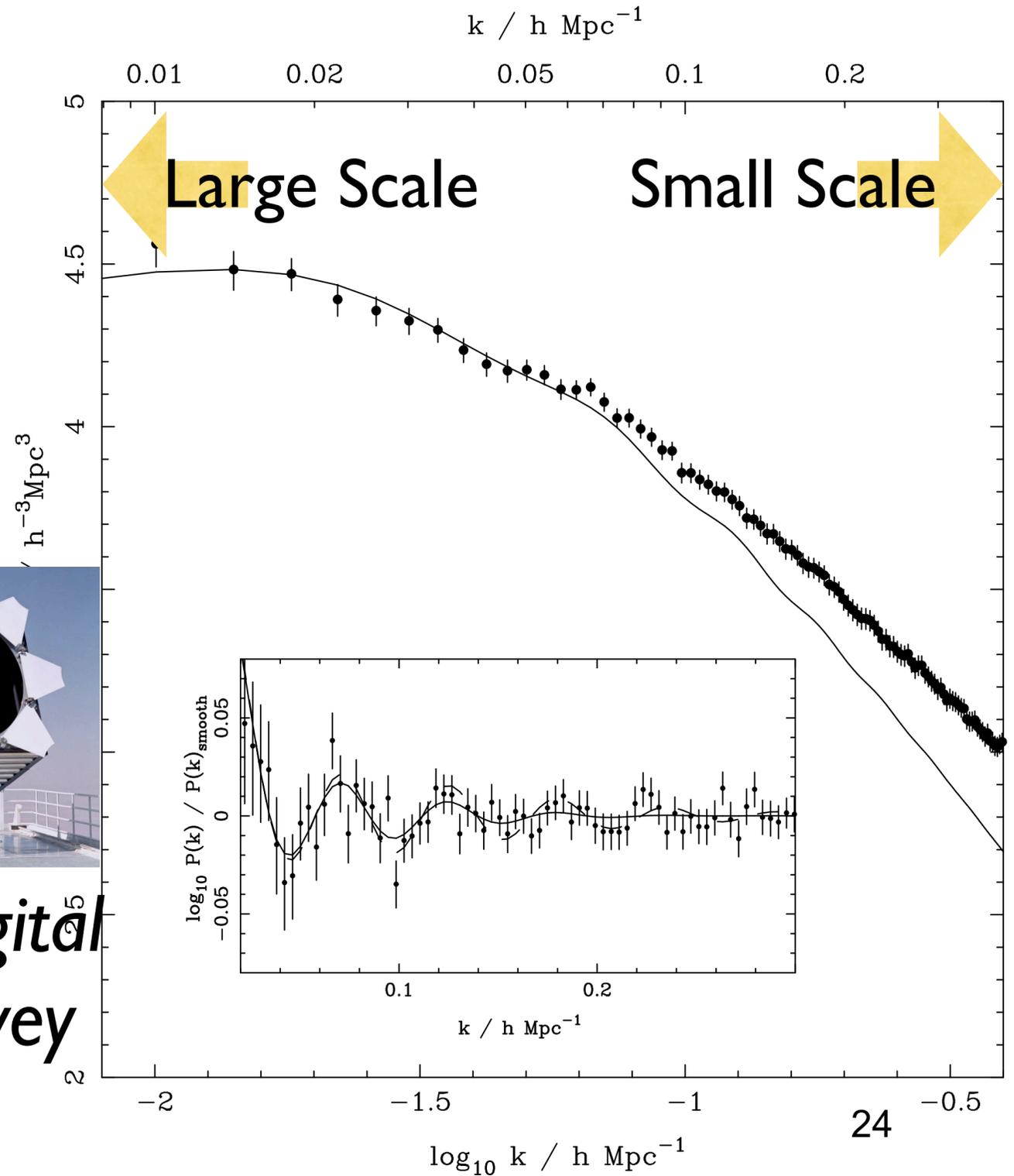
What Will HETDEX Do?



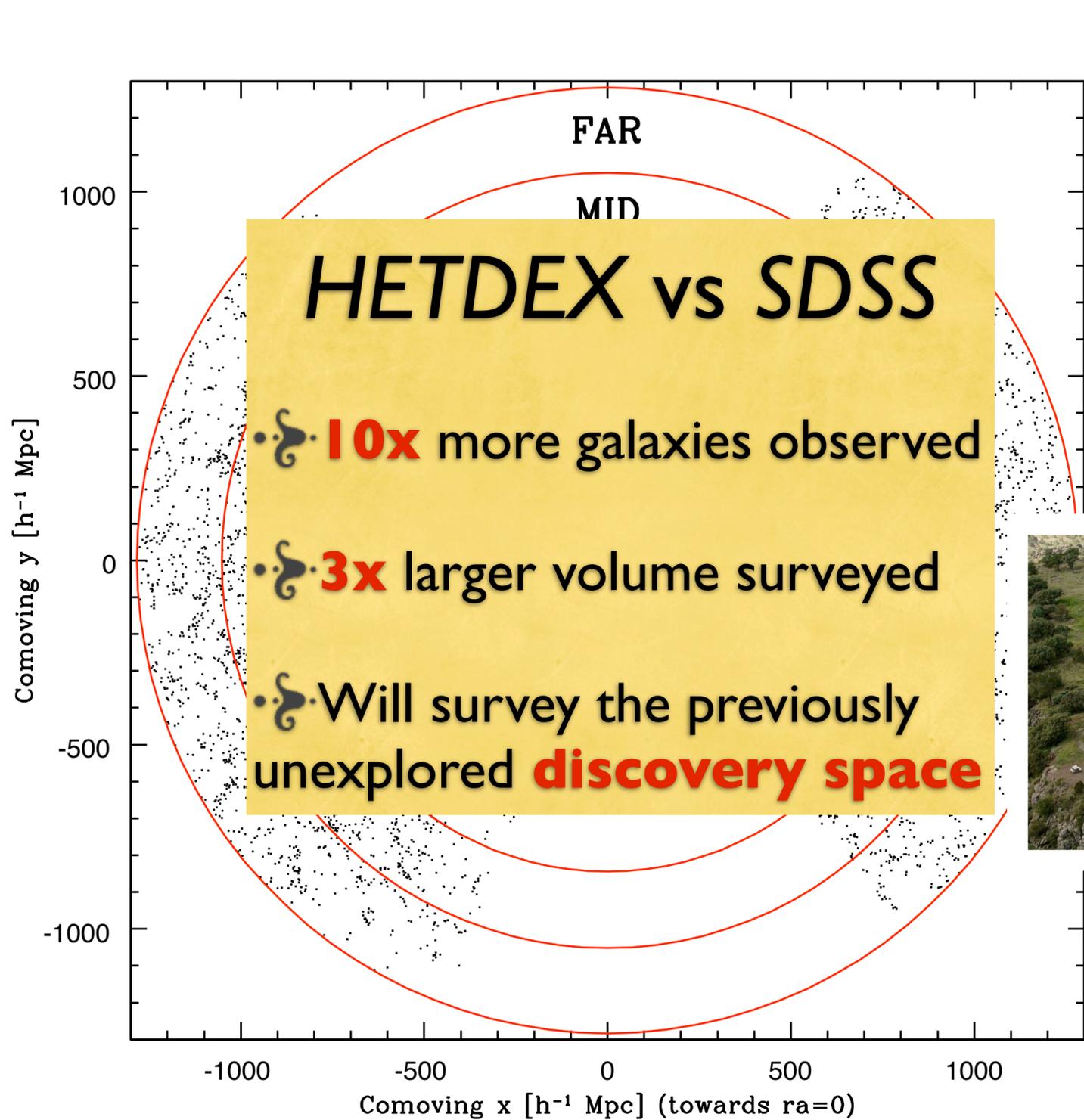
HETDEX: Sound Waves in the Distribution of Galaxies



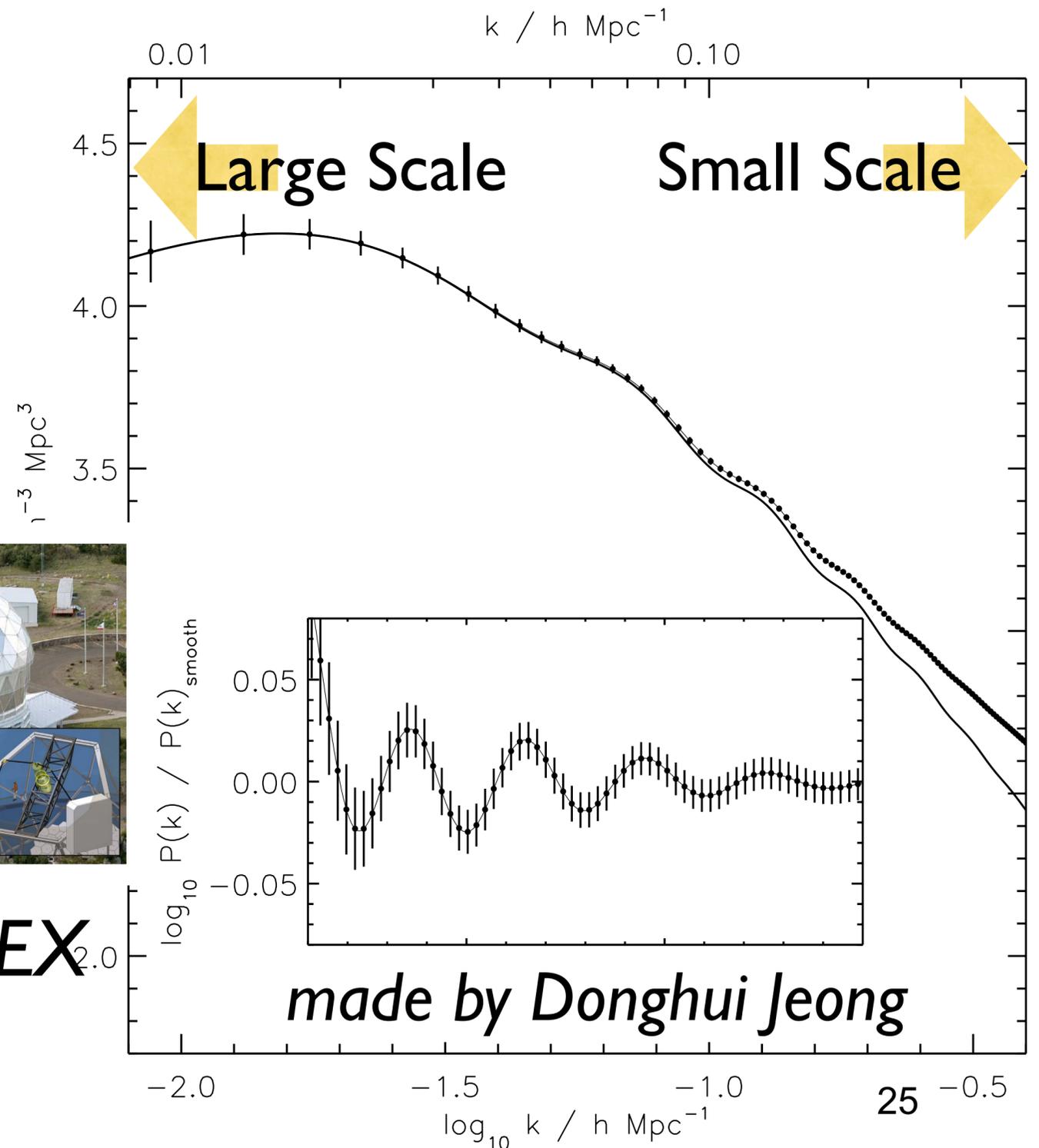
Sloan Digital Sky Survey



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...*