

# Cosmos in the Med

A cosmic background image featuring a dark, starry space with a prominent, glowing orange and yellow nebula or galaxy structure on the right side. The text and speech bubble are overlaid on this image.

You will learn the fundamental concepts of cosmology

You will make a video explaining to other students a concept you've learned during this workshop

What did we learn today?



# You will learn about

The **Big Bang** and the **first light** in the Universe (George Smoot)

The **expanding Universe** and **Dark Energy** (James Rich)

**Galaxies, clusters** and how we observe them (Chiara Ferrari)

**General Relativity, black holes and gravitational waves** (Edward Porter)

Science **communication** (Liz Smith)

**Statistics** in cosmology (Ivan Debono)

**Dark matter** (Kris Zarb Adami)

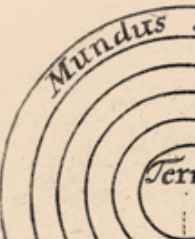






# You will learn

# Concept Map

- Why we believe the Big Bang theory is correct.
  - How we observe the Universe.
  - How we go from observations to theories. And back again.
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- A decorative graphic in the bottom right corner consisting of several concentric circles. The word "Mundus" is written in a serif font along the top arc of the outermost circle, and the word "Tern" is written along the top arc of an inner circle.

“The first principle is that you must not fool yourself – and you are the easiest person to fool.”



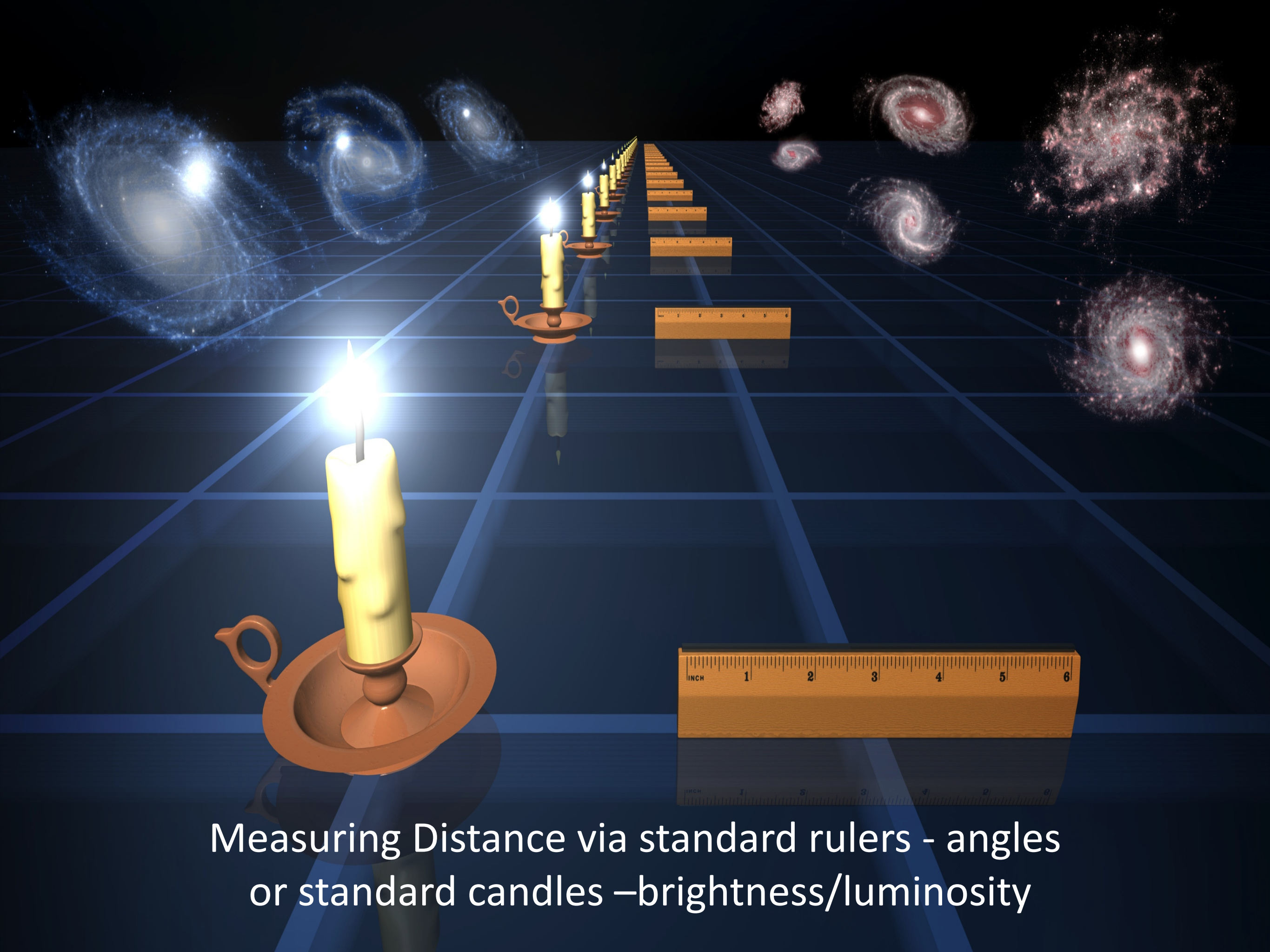




# You will

- Measure distance by angles and brightness - luminosity
- Measure the geometry of space
- Test the strength of the fundamental forces of nature
- Use randomness to measure a constant
- Test a principle of General Relativity

“Know how to solve every problem that has been solved.”



Measuring Distance via standard rulers - angles  
or standard candles –brightness/luminosity

# **Exercise worksheet (a.k.a. how to get your hands dirty)**

## **1. Measuring distances using angles**

How do we measure the distance to astrophysical objects? We cannot stretch a tape measure between the Earth and the nearest star. But we can measure angles.

You have a short ruler and a protractor. Just like astronomers, you cannot move out of your corner of the Universe. Your task is to measure the distance to an object in the middle of the room.

## **2. Measuring distances using angles**

At larger distances, the angles get smaller and smaller, and hard to measure. So astronomers must use other methods.

Your task is to measure the distance to a second object. The object in Experiment 1 is now replaced by a light source, with a 1/4 brightness filter. There is an identical source at twice the distance. Measure the distance to the second source.

## **3. Measuring the geometry of spacetime (or a slice through space)**

Think again about Experiment 1. What principles did you use from geometry?

You now have a piece of string and a protractor. Prove that the floor of the room is flat. How would your results in Experiment 1 change if this wasn't true?

## **4. Measuring the relative strength of the fundamental forces of nature**

Drop a coin to the floor. What makes it fall? Easy – it's gravity.

What makes it stop? Why didn't the coin break? Why didn't it go right through the floor?

## **5. Using randomness to measure constants**

You have a circle inside a square. You also have a small coin. Your task is to measure Pi. How can you make your measurement more accurate?

## **6. How to test a principle of General Relativity without going to outer space**

Build a simple pendulum. Time the period of the pendulum. Now imagine you were inside a spaceship travelling at 99% of the speed of light. Would the period of the pendulum change?



# *Summary*

- Our Understanding of the Universe has improved greatly.

You will be ready to keep up with the great activity in the field

Let us begin our continued learning of Cosmology