

COMPUTATIONAL COSMOLOGY

WITH DR SOWNAK BOSE

Talking points

KNOWLEDGE

1. What is dark matter?
2. What is the LambdaCDM model?

COMPREHENSION

3. Why does cosmological understanding depend on both observational and computational data?
4. Why does Sownak's work need to involve such high-powered (and very expensive!) supercomputers?
5. Why does Sownak's team put an 'observer' at the location of the Sun?

APPLICATION

6. The article explains the process for revealing the influences and properties of dark matter. How do you think this process changes – or stays the same – when investigating dark energy?
7. What questions would you ask Sownak to find out more about the properties of dark matter and the early Universe?

ANALYSIS

8. Why was the launch of the James Webb Space Telescope met with such excitement by the scientific community?

EVALUATION

9. Are we all living in a simulation? Some thinkers have suggested that our Universe and everything in it, including ourselves, may actually be an ultra-sophisticated simulation, perhaps created by scientists from the 'real' Universe in an attempt to understand their own. Do you think this theory is worth entertaining, or belongs in the realms of science fiction?

More resources

- Listen to *The Open Universe*, the podcast created by Sownak and his colleague, Ana Bonaca, that takes you on "an unbounded journey through the archives of astronomy": www.theopenuniverse.org
- This article from NASA gives more details about dark matter and dark energy, and also includes links to the latest discoveries: science.nasa.gov/astrophysics/focus-areas/what-is-dark-energy
- This presentation provides an overview of the MilleniumTNG simulations and what they can reveal about galaxy formation: www.youtube.com/watch?v=CKUiPpZ7Xn8

Activities

1. Explore cosmological instruments

Sownak mentions the importance of observational data to compare against simulated scenarios. Below is a selection of the world's most sophisticated cosmological instruments, past and present. Fill in the table below, using the internet to learn more.

2. Create your own virtual Universe

Sownak's team has created a website where you can create virtual universes in a similar manner to the team's simulations, changing their properties and comparing them with real data: www.galaxymakers.org

Experiment with different starting conditions. What sorts of universes can you create when you change factors such as the amount of dark matter and the mass of stars? What conditions lead to a Universe like our own?

Instrument	What does it measure?	What can it tell us about the Universe?
James Webb Space Telescope		
Euclid		
Dark Energy Spectroscopic Instrument (DESI)		
Hubble Space Telescope		
Arecibo Telescope		
Solar and Heliospheric Observatory		
Extremely Large Telescopes (ELTs)		