

# ASTR 12620 1 (Spring 2019) The Big Bang

## Physical Science 12620: The Big Bang

Spring 2019, Professor Dan Hooper (dhooper@uchicago.edu), ERC 483

Tuesdays and Thursdays, 9:30-10:50 AM, Swift Hall 106

### Lab Manager:

Brent Barker (bbarker@uchicago.edu)

### Teaching Assistants:

Samantha Usman (samanthausman@uchicago.edu)

Cory Cotter (cotter@astro.uchicago.edu)

### Topics to be Covered:

- Relativity and the expansion of the Universe
- Tests of and evidence for the Big Bang
- The formation of the light chemical elements
- The cosmic microwave background
- The early universe
- The large scale structure of the universe
- Dark matter
- Dark energy and the fate of the universe
- Cosmic inflation
- A universe or a multiverse?

### Grades:

- Participation: 10%
- Homework Assignments: 20%
- Midterm: 25%
- Final: 25%
- Labs: 20%

Homework will be assigned approximately weekly, and will be due one week from the date assigned.

I will not be using a textbook for this course, but I will be assigning some readings throughout the quarter. Expect a book and several articles to be assigned.

Labs are held for 1 hour, 50 minutes, weekly, beginning next week, and are mandatory. You should read all written materials prepared for a lab prior to coming. After the lab, you will prepare a lab report, according to the guidelines laid out by your TA. Missing one or more lab will reduce your lab grade by

20% each, in addition to the loss of points for the lab report(s) in question. Opportunities will be given to make up labs missed for unavoidable reasons. Please make arrangements to make up labs with your TA.

Exams will include materials covered in the lectures, homework, labs, and assigned reading.

Office hours can be arranged by appointment. Please email me if you'd like to meet outside of class.

### **Projected Course Summary**

**Note:** This summary of topics is a projection and will likely change as the quarter advances.

#### **Week 1:**

The state of astronomy in 1900-1920 (the Great Debate of 1920) Outstanding issues/questions in physics in 1900

Distance ladder (parallax, main sequence fitting, cepheid variable stars)

The structure of the Milky Way

Hubble's Law and the expansion of space

Special relativity

Lorentz Transformations

Length contraction

#### **Week 2:**

Time dilation

General relativity

Curved space and non-Euclidean geometry

Black holes

Friedmann equations

#### **Week 3:**

Static solutions to the Friedmann equations?

The cosmological term/cosmological constant  
Non-static solutions to the Friedmann equations  
Big Bang vs steady state models  
Stellar Nucleosynthesis  
Big Bang Nucleosynthesis

**Week 4:**

Radio source counts  
Formation of atoms  
The Cosmic Microwave Background

**Week 5:**

Dark matter  
Stellar Evolution, MACHOs, Gravitational Lensing  
Crash Course in Quantum Physics

**Week 6:**

Particles and Forces  
WIMPs as Dark Matter

**Week 7:**

Accelerating Expansion and Dark Energy  
Precision Cosmology and Modern CMB Measurements

**Week 8/9:**

The Early Universe  
Particle Accelerators  
Matter and Antimatter  
Cosmic Inflation  
A Multiverse?

