Physics and Astronomy 340: The Big Bang
Thornton 425, San Francisco State University
Spring 2017, TuTh 5:00PM

Contact Information

Instructor: Andisheh Mahdavi
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Office: Thornton Hall 527
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Office Hours: Tuesday 4-5PM

Audience

Those with at least a background in special relativity and quantum mechanics at the level of PHYS 320.

Course Description

A historical introduction to cosmology, from earlier human conceptions of the universe, through the hot big bang and inflation; early universe, nucleosynthesis, dark matter, dark energy, photon and neutrino backgrounds, and observational tests of cosmology.

Expected Student Learning Outcomes

We will treat the fiery birth of the universe (the “Big Bang”) using elementary physics. The Big Bang will be considered in the context of earlier human efforts to understand the cosmos, as well as the latest research both in experimental physics (e.g., the Large Hadron Collider) and astrophysics (e.g., observations of the cosmic microwave background). By the end of the course, students should be able to

1. Write the history of cosmology from premodern times, through the Shapley-Curtis debates, to the present day, with a focus on conceptions of the origin and arrangement of the cosmos.

2. Recite and calculate the chain of reasoning and observation that led to the success of the hot big bang theory. This includes the temperature of the cosmic microwave background, the observed expansion of the universe, and the abundance of the light elements in stars.

3. Compare the roles played by various species of particles in the early universe, from the quark-gluon plasma, to cosmic neutrinos, the protons and electrons involved in reionization, and the possible candidates for dark matter.

4. Calculate the forging of the light elements using existing Big Bang Nucleosynthesis computer codes, and be able to write down the underlying physics.

5. Identify the connection between inflation, dark energy, parallel universes, and the values of the fundamental physical and cosmological parameters, including arguments based on the anthropic principle

Textbooks, Materials, and Other Requirements and Fees

- **Textbooks.** All textbooks are available online; the SFSU bookstore carries only Liddle and Sproul.
  - Andrew Liddle, *An Introduction to Modern Cosmology*
  - Helge Kragh, *Conceptions of Cosmos: from Myths to the Accelerating Universe*
  - Barbara Sproul, *Primal Myths: Creation Myths Around the World*

- **Computing & Software.** Required as follows:
  - Mathematica, a computer program for symbolic calculus, will be used throughout the course. It is free to use for SFSU students enrolled in courses within the college of science and engineering. Students are expected to familiarize themselves with Mathematica using available online tutorials such as [http://www.wolfram.com/broadcast/screencasts/handsonstart/](http://www.wolfram.com/broadcast/screencasts/handsonstart/)
  - Course-related messages will be sent to students’ @sfsu email addresses; students should check for messages at least daily.
Grading Policy

ASTR/PHYS 340 fulfills the Graduation Writing Assessment Requirement (GWAR). It is university policy that GWAR courses cannot be taken CR/NC. Instead, the only possible grades are A, A-, B+, B, B-, C+, C or NC. All grades of C- or below are automatically converted to a NC (no credit).

- Three papers, with revisions: 60% Late papers receive no credit
  - Length should be 6-12 pages (double-spaced, 11pt font).
  - All papers must be emailed to the instructor in Word or PDF format.
  - All papers need to be revised based on feedback from the instructor.
  - Half of the grade on a paper will be based on the draft version; the other half will be based on the revised version.
  - Plagiarism will be taken seriously and result in a score of 0 for the paper.

- Four problem sets: 16% Late homeworks receive no credit
- One 10-minute presentation: 8%
- Final exam: 16%

Scale: A: 90-100%; A-: 85-90%; B+: 80-85%; B: 75-80%; B-: 70-75%; C+: 65-70%; C: 60-65%; no credit (NC) otherwise.

Students with Disabilities

Students with disabilities who need reasonable accommodations are encouraged to contact the instructor. The Disability Programs and Resource Center (DPRC) is available to facilitate the reasonable accommodations process. The DPRC is located in the Student Service Building and can be reached by telephone (voice/TTY 415-338-2472) or by email (dprc@sfsu.edu)

Student Disclosures of Sexual Violence

SF State fosters a campus free of sexual violence including sexual harassment, domestic violence, dating violence, stalking, and/or any form of sex or gender discrimination. If you disclose a personal experience as an SF State student, the course instructor is required to notify the Dean of Students. To disclose any such violence confidentially, contact:
The SAFE Place - (415) 338-2208 [http://www.sfsu.edu/safe_plc/]
Counseling and Psychological Services Center - (415) 338-2208 [http://psyservs.sfsu.edu/]
For more information on your rights and available resources: [http://titleix.sfsu.edu]

Tentative, Subject to Revision Physics and Astronomy 340 Course Calendar

<table>
<thead>
<tr>
<th>Week of</th>
<th>Topics</th>
<th>Reading</th>
<th>Comments</th>
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</thead>
<tbody>
<tr>
<td>1/23</td>
<td>Review of special relativity; Planck spectrum</td>
<td>Liddle 1-2</td>
<td>1st Homework due 2/2;</td>
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<tr>
<td>1/30</td>
<td>Doppler Shift; Overview of Big Bang and Standard Model</td>
<td>Liddle 1-2</td>
<td>2/10 is last day to drop</td>
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<tr>
<td>2/6</td>
<td>Past conceptions of the cosmos</td>
<td>Kragh 1</td>
<td>1st Paper draft due 2/16;</td>
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<tr>
<td>2/13</td>
<td>Greek and Medieval cosmology</td>
<td>Kragh 2</td>
<td>1st Paper final due 2/23;</td>
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<tr>
<td>2/20</td>
<td>The Enlightenment and the Nebulae</td>
<td>Kragh 3; Liddle 3-4</td>
<td>2nd Paper final due 3/2;</td>
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<tr>
<td>2/27</td>
<td>The Friedman equation; Open and closed universes</td>
<td>Liddle 4-6; Kragh 4</td>
<td>2nd Homework due 3/2;</td>
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<tr>
<td>3/6</td>
<td>The cosmological constant</td>
<td>Liddle 7; Kragh 4</td>
<td>2nd paper draft due 3/16</td>
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<tr>
<td>3/13</td>
<td>Redshift, Age, and Distances</td>
<td>Liddle 8; Kragh 4</td>
<td>3rd homework due 4/7</td>
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<tr>
<td>3/20</td>
<td>Spring break</td>
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<td>4th homework due 4/13</td>
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<tr>
<td>3/27</td>
<td>Cosmic Microwave Background</td>
<td>Liddle 10; Kragh 5</td>
<td>2nd Paper final due 3/30</td>
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<tr>
<td>4/3</td>
<td>The Early Universe</td>
<td>Liddle 11-12 and handouts</td>
<td>3rd homework due 4/13</td>
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<tr>
<td>4/10</td>
<td>Nucleosynthesis I</td>
<td>handouts</td>
<td>4th homework due 4/13</td>
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<tr>
<td>4/17</td>
<td>Nucleosynthesis II</td>
<td>handouts</td>
<td>4/24 last day to withdraw</td>
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<td>4/24</td>
<td>Nucleosynthesis III</td>
<td>Liddle 13-14; handouts</td>
<td>3rd paper draft due 5/4</td>
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<tr>
<td>5/1</td>
<td>Neutrino backgrounds, dark matter, and Inflation</td>
<td>Liddle A3 and handouts</td>
<td>3rd paper final draft due 5/11</td>
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<tr>
<td>5/8</td>
<td>Overlap of cosmology with philosophy and creation myths</td>
<td>Kragh 5; Sproul</td>
<td>3rd paper final draft due 5/11</td>
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5/15-5/20 Presentations and review session (date/time to be determined)
5/23 Final exam 4-7PM location TBD