

ASTR/PHYS 109: Big Bang and Black Holes

Spring 2021

Course objectives: This course is designed to give an intuitive understanding of the Big Bang and Black Holes, without mathematics, and de-mystify it for non-scientists. The primary goal is for students to learn about the origin and evolution of the universe and communicate their understanding using their own words to a lay audience.

Prerequisites: None

Instructor: Prof. David Toback
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Email: toback@tamu.edu (office hours by appointment)
Course website: <http://tobackgroup.physics.tamu.edu/toback/109>

Textbook and Reading:

Required and recommended textbook information can be found at <http://tobackgroup.physics.tamu.edu/toback/109/textbooks.shtml>

The reading schedule can be found at <http://tobackgroup.physics.tamu.edu/toback/109/LecturesReading.pdf>

Course Work and Grading: The grades for the course will be assigned using the following weights, with more detail given below:

- Papers Assignments: 85%
- Assignments in eCampus: 15% (each with equal weight)
 - PLRQ Assignments
 - End of Chapter Quizzes
 - Feynman Diagrams

Frequently Asked Questions: Answers to frequently asked questions about grading and other parts of the class can be found at <http://tobackgroup.physics.tamu.edu/toback/109/CourseOrganization.pdf>. It is expected that all students have read this document.

Honors Sections (201): Students in the honors section attend the regular lecture, and have all the same requirements. However, there is an additional paper on a topic to be agreed upon between the student and the instructor. More information about it can be found at

<http://tobackgroup.physics.tamu.edu/toback/109/Honors/>

Description of the Writing Assignments: The bulk of the grade for this course is in the paper “assignments”. A premium will be placed on the ability to understand and convey the evidence for our topics (science, cosmology and the physical universe) to the lay reader.

The paper assignments are different in this course from in the typical course. Each assignment has three parts and is administered using the Peerceptiv system on eCampus. For more information see

http://tobackgroup.physics.tamu.edu/toback/109/WritingAssignments/Papers_and_Peerceptiv.pdf.

For those of you who have not used this system before, it means you will be

- 1) submitting a paper,
- 2) reviewing your peer’s papers and providing critiques, and
- 3) giving feedback to those who evaluate your paper.

The grade for the paper assignment is also unusual: while the grade is based on the text, you must pass the reviewing and back-evaluation portions to receive a score. If you do not, you will be required to revise those portions. If you don’t get the score you want you will be allowed to revise and resubmit your text (based on the feedback from your Reviewers), but you must repeat **all** parts of the assignment.

Many students find using Peerceptiv to be the most difficult and unpleasant portion of the course. The instructor believes evaluating and providing critiques of the quality and clarity of writing by others, as a way of learning to critique and improve your own work is the most important part of the class and one of the best ways to improve your thinking and writing. We will spend time discussing each paper in class.

We want to help all students get excellent grades. For this reason, before each paper is due, students may submit to a Peerceptiv Rough Drafts assignment. Any students using this option must do the full assignment

Small Assignments in eCampus: The rest of the grade will be in little assignments that will be done in eCampus.

- Pre-Lecture Reading Question (PLRQ) quizzes are designed to both help you be well prepared for lecture, as well as help you get good at thinking about what constitutes a good scientific questions
- End-Of-Chapter (EOC) quizzes are designed to consolidate learning after lecture
- Feynman Diagram drawings are designed to help you learn to write in the language of science

ADA Policy: Texas A&M University is committed to providing equitable access to learning opportunities for all students. If you experience barriers to your education due to a disability or think you may have a disability, please contact Disability Resources in the Student Services Building or at (979) 845-1637 or visit <http://disability.tamu.edu>. Disabilities may include, but are not limited to attentional, learning, mental health, sensory, physical, or chronic health conditions. All students are encouraged to discuss their disability related needs with Disability Resources and their instructors as soon as possible.

Honor Code: The Aggie Honor Code states, “An Aggie does not lie, cheat, or steal or tolerate those who do.” Further information regarding the Honor Council Rules and Procedures may be found on the web at <http://www.tamu.edu/aggiehonor>. The plagiarism statement for the course can be found at <http://tobackgroup.physics.tamu.edu/toback/109/WritingAssignments/plagiarism.shtml>

Title IX and Statement on Limits to Confidentiality: Texas A&M University and the College of Science are committed to fostering a learning environment that is safe and productive for all. University policies and federal and state laws provide guidance for achieving such an environment. Although class materials are generally considered confidential pursuant to student record policies and laws, University employees — including instructors — cannot maintain confidentiality when it conflicts with their responsibility to report certain issues that jeopardize the health and safety of our community. As the instructor, I must report (per Texas A&M System Regulation 08.01.01) the following information to other University offices if you share it with me, even if you do not want the disclosed information to be shared:

- Allegations of sexual assault, sexual discrimination, or sexual harassment when they involve TAMU students, faculty, or staff, or third parties visiting campus.

These reports may trigger contact from a campus official who will want to talk with you about the incident that you have shared. In many cases, it will be your decision whether or not you wish to speak with that individual. If you would like to talk about these events in a more confidential setting, you are encouraged to make an appointment with the Student Counseling Service (<https://scs.tamu.edu/>).

Students and faculty can report non-emergency behavior that causes them to be concerned at <http://tellsomebody.tamu.edu>.

Tentative Schedule for ASTR/PHYS 109, Spring 2021

Week #	Date	Lecture #	Chapter in Class	Online Quizzes	Reading and PLRO Assignments	Feynman Diagram Assignments	Paper 1 Evidence for Dark Matter	Paper 2 Evidence Stars are Made of Atoms	Paper 3 Evidence Universe Began with a Big Bang	Paper 4 Evidence for Black Holes	TAMU Notes	Honors
*****Tentative dates - In all cases, items are due before class, last updated 1/25/2021*****												
1	Monday, January 18, 2021										No class. MLK Day	
1	Wednesday, January 20, 2021	1	1								1st class	Stage 0 assigned (1st day of class)
1	Friday, January 22, 2021	2	2	Warmups 1 due								
2	Monday, January 25, 2021	3	2	Warmups 2 due							Add/drop Mon Jan 25th	Stage 0 idea submitted (2nd Week)
2	Wednesday, January 27, 2021	4	2	Warmups 3 due	Unit 1 Quiz due							
2	Friday, January 29, 2021	5	3	EOC 2 due								
3	Monday, February 1, 2021	6	3									Stage 0 reading selection check (3rd week)
3	Wednesday, February 3, 2021	7	4	EOC 3 due								
3	Friday, February 5, 2021	8	4									
4	Monday, February 8, 2021	9	5	EOC 4 due	Unit 2 Writing Due							Final draft of Stage 0 (4th week)
4	Wednesday, February 10, 2021	10	5									
4	Friday, February 12, 2021	11	5		Unit 2 Quiz due							
5	Monday, February 15, 2021	12	6	EOC 5 due			Mentioned					Stage 1 discussion (5th week)
5	Wednesday, February 17, 2021	13	6				Assigned					
5	Friday, February 19, 2021	14	7	EOC 6 due								
6	Monday, February 22, 2021	15	7	Warmups 4 due			Text & Reviews Due					Stage 1 draft due (6th week)
6	Wednesday, February 24, 2021	16	7	Warmups 5 due			Feedback due					
6	Friday, February 26, 2021	17	8	EOC 7 due		Assignment 1 Due		Mentioned				
7	Monday, March 1, 2021	18	8					Assigned				Stage 1 Final draft due (7th week)
7	Wednesday, March 3, 2021	19	9	EOC 8 due		Assignment 2 Due						
7	Friday, March 5, 2021	20	9						Text & Reviews Due			
8	Monday, March 8, 2021	21	10	EOC 9 due	Unit 3 Quiz due	Assignment 3 Due		Feedback due			Mid-term grades	Stage 2 discussion (8th week)
8	Wednesday, March 10, 2021	22	10									
8	Friday, March 12, 2021	23	11	EOC 10 due								
	Monday, March 15, 2021	24	11									
	Wednesday, March 17, 2021	25	12	EOC 11 due					Mentioned			
	Friday, March 19, 2021	26	12						Assigned		Spring Break- Class Thursday	
9	Monday, March 22, 2021	27	13	EOC 12 due	Unit 4 Quiz due							Stage 2 draft due (9th week)
9	Wednesday, March 24, 2021	28	13						Text & Reviews Due			
9	Friday, March 26, 2021	29	14	EOC 13 due					Feedback due			
10	Monday, March 29, 2021	30	14									Stage 2 Final Draft Due (10th week)
10	Wednesday, March 31, 2021	31	14									
10	Friday, April 2, 2021										Reading Day, no classes	
11	Monday, April 5, 2021	32	15	EOC 14 due	Unit 5 Quiz due	Assignment 4 Due						Stage 3 draft due (11th week)
11	Wednesday, April 7, 2021	33	15									
11	Friday, April 9, 2021	34	16	EOC 15 due								
12	Monday, April 12, 2021	35	16									Stage 3 Final draft due (12th week)
12	Wednesday, April 14, 2021	36	17	EOC 16 due						Mentioned	Q-drop date Thur April 15th	
12	Friday, April 16, 2021	37	17							Assigned		
13	Monday, April 19, 2021	38	18	EOC 17 due	Unit 6 Quiz due							Stage 4 draft due (13th week)
13	Wednesday, April 21, 2021	39	18								Text & Reviews Due	
13	Friday, April 23, 2021	40	19	EOC 18 due							Feedback due	
14	Monday, April 26, 2021	41	19									Stage 4 Final draft due (14th week)
14	Wednesday, April 28, 2021	42	20	EOC 19 due								Redefined Day Last day of Class
14	Friday, April 30, 2021	XX	XX	EOC 20 due								
15	Monday, May 3, 2021	XX	XX									Stage 5 First draft due (15th week)
15	Tuesday, May 4, 2021	XX	XX									Stage 5/Final Paper due (Last Day)
	Tuesday, May 4, 2021	XX	XX								No final	
	Monday, May 10, 2021	XX	XX								Degree candidate grades due	
	Wednesday, May 12, 2021	XX	XX								Final grades due	

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Dr. David Toback

Unit	Topics	Preliminary Reading Assignments (N.B.: BBBHNM is required, all other readings are recommended)
1	Introduction	
	- Course Introduction	BBBHNM: 1-4, BHOT: 1-3, SHU: 1-2, TOE: 1
	- The very big objects in the universe	(Same as above)
	- The very small objects in the universe	(Same as above)
	- Evidence, C10Scientific Models and questions we can answer with experiments	(Same as above)
	- Early Cosmology: From Aristotle to Newton	
2	The Physics we Need	
	- Light and Doppler Shifts	BBBHNM: 5, SHU: 3 (p55-69)
	- Gravity, General Relativity and Dark Matter	BBBHNM: 6, BHOT: 4-6
	- Atomic Physics and Quantum Mechanics	BBBHNM: 7, SHU: 6&7 (up-to page 153), BHOT: 9, 11 (117-122)
	- Nuclear Physics and Chemistry	BBBHNM: 8
	- Thermal Equilibrium and Temperature	BBBHNM: 9
3	The Evidence for the Big Bang	
	- The Exploding Universe	BBBHNM: 10, TOE: 2, TFTM: 1-3, BHOT: 7, SHU: 3(69-76), 4(77-86), 5(95-104)
	- Expanding Space-Time	BBBHNM: 11
	- Photons and Hydrogen in the Universe	BBBHNM: 12
5	Evolution of the Universe	
	- The Early Universe	BBBHNM: 13, TFTM: 4&5, SHU: 5 (104-114), 7 (154-158), BHOT: 8 (68-76)
	- After the first three minutes	BBBHNM: 14
4	Black Holes and Other "Big" Objects	
	- Galaxy Formation	BBBHNM: 15, SHU: 4 (87-93), TOE: 3, BHOT 8: (76-85)
	- Stars	BBBHNM: 16
	- Black hole formation and properties	BBBHNM: 17
6	Early Times and the Fate of the Universe	
	- Possible Fates of the Universe, Dark Matter and Dark Energy	BBBHNM: 18, SHU: 8 (159-164), BHOT 11 (122-137), Seeds Handout
	- Particle Physics, Dark Matter and the Very Early Universe	BBBHNM: 19
	- Inflation and the Earliest Moments in Time	BBBHNM: 20, BHOT 12

Primary Textbooks and Reading:

Big Bang, Black Holes, No Math (Toback): BBBHNM
 Briefer History of Time (Hawking): BHOT
 Stephen Hawking's Universe (Lufkin): SHU
 Theory of Everything (Hawking): TOE
 The First Three Minutes (Weinberg): TFTM
 Cosmology in the 21st Century (Seeds) - Download from Webpage