Astronomy 1304: Solar System

Summer 2019 Syllabus

Lecture
Meeting Times: — **Location:** Web

Instructor: Anirban Bhattacharjee
Email: anirbanbhattacharjeee@gmail.com — **Office Hours: appointment (TBA)**

Course Description:

ASTRO 1303 is an introductory course for non-science majors. It provides a broad introduction to Astronomy including: (1) daily, monthly and yearly patterns in the sky; (2) basic physics of gravity, light, and atoms; (3) stars and stellar evolution; (4) formation of the solar system; (5) galaxies, cosmology, and the evolution of the Universe; and (6) the fundamental tenets of science and the scientific process. The goal of this course is to cover most of the areas of modern astronomy at a level which requires only basic mathematics.

Resources:

Required:

Astronomy Notes (**AN**) by Nick Strobel (http://www.astronomynotes.com)
– Online textbook for pedagogical development of concepts

Occasionally, you will need a calculator in class. A basic scientific calculator will work well.

Various Wikipedia Articles (**WA**)
– Supplemental reading for additional declarative knowledge (specific pages to be determined by instructors – see **Tentative Schedule** section)

Lecture Tutorials for Introductory Astronomy (**LT**) by Ed Prather, Tim Slater, Jeff Adams, Gina Brissenden, & the CAPER team

Please try to always bring your book to lecture and particularly lab, as you may often need it.

Loose-leaf paper – for in-class assignments

Optional:

"Universe" (w/ Starry Night Enthusiast CD-ROM) (**UN**) by Roger Freedman & William Kaufmann III, 8th ed.(9th edition is ok too)

Course Objectives:

We will follow the guidelines set forth by the American Astronomical Society, the National Science Education Standards, the American Association for the Advancement of Science, and the in-class survey. The goals for this class are as follows:

- Appreciate the scientific process, how it works, the notion that physical laws are universal, the elements of scientific theories, what they do and do not tell us.
- Develop familiarity with the night sky and how its appearance changes with time and position on Earth.
- Describe how data is collected from astronomical objects, and what quantities can be measured/inferred.
- Understand basic - yet crucial - physical laws, and the processes that govern astronomical quantities.
- Integrate concepts from related subjects to explain relationships (e.g., physics and math) between astronomical quantities.
- Infer the nature, structure and evolution of the Universe, and objects therein.

Instructional Philosophy of the Course:

The overarching goals of this course are for you to understand the nature of science through the eyes of astronomy; to understand the big ideas in astronomy; and to develop a lifelong interest in astronomy and current events surrounding astronomy. To meet these three goals, the course instructors have carefully designed a sequence of learning tasks and assessment procedures as outlined below.

-*Active engagement with nearly daily group activities.* It is a demonstrated fact that you can only learn a limited amount of information from lecture alone, no matter how clear or entertaining. Therefore, this course is composed of a series of mini-lectures that will be augmented by collaborative classroom activities called Lecture Tutorials (LT).

– – To get the best out of this course, if you are having problems with understanding the course material, is by emailing me or texting me through a free messenger service called WhatsApp. My phone number that you will need to add in your contact list is +919007154465. PLEASE DO NOT TEXT ME DIRECTLY, I WONT BE ABLE TO RESPOND OR MIGHT NOT EVEN RECEIVE YOUR MESSAGE -*Carefully studying the text is REQUIRED.* The course mini-lectures are designed to focus on the really difficult aspects of astronomy or to provide structure for your out-of-class study. You are accountable for all material, concepts, and interrelationships presented in the mini-lectures, the text, and, most importantly, the Lecture Tutorials. Therefore, it is imperative to your success in this course that you complete the assigned readings prior to coming to class. Reading assignments should be completed BEFORE the date listed. Otherwise, the mini-lectures and tutorials will be less useful in helping you develop a deep understanding of the course topics. It is important to remember that the exams or questionnaires will cover material from the text readings that may or may not be discussed in class.

– *To get the best out of this course, if you are having problems with understanding the course material, is by emailing me or texting me through a free messenger service called WhatsApp. My phone number that you will need to add in your contact list is +919007154465. PLEASE DO NOT TEXT ME DIRECTLY, I WONT BE ABLE TO RESPOND OR MIGHT NOT EVEN RECEIVE YOUR MESSAGE*

Assessment and Grading:

In order to promote an active and collaborative learning environment, there will be no curve to assess grades. Each student will only be competing against themselves, and will be responsible for gaining the declarative knowledge and conceptual understanding for performance. This is a three credit class with three credits in the primary lecture section.

The exams will test your understanding of key concepts in astronomy. A list of these concepts can be found in this syllabus. Along with each exam, we will also ask for opinions regarding what you like, dislike, and ask for suggestions for improving the class.

As mentioned above in the **Instructional Philosophy of the Course** section, we will periodically ask you to write a short paragraph.The topic may be related to the assigned reading, to a current event in astronomy, or to a key concept covered in that class period. I will also assigning regular HW and quizzes. These will be collected and perused by the instructors. Answers demonstrating a command of the assigned reading or concepts will be given full credit. These will contribute to 20% of the final grade for the class. In cases of university-sanctioned excused absences (e.g., ROTC, university athletics, religious holidays), it is up to you to inform the me of the absence **well in advance of the date**, supplying both the dates and your name. If have done so and there are exams on those dates, you will not be penalized for missing them and accommodation will be arranged. Remaining 20% of the grade will be based on group projects/ term paper which is assigned in the syllabus and will be discussed in detail during the first two weeks of class.

		Grading Scheme	
		Total Points	Grade
Total points	$0.3 \times$ (Final Exam)	85–100	A
	$+0.4 \times$ (Midterm Total)	75–84.999...	B
	$+0.2 \times$ (# LT, HW and quizzes)	65–74.999...	C
		55–64.999...	D
		below 54.999...	F

From the total points, letter grades will be assigned according to the table on the right. There will be no plus or minus grades assigned.

Students with disabilities: If you require any special accommodations to participate in the class or complete assignments, please contact the instructor as soon as possible.

Academic Honesty:

University Student Conduct and Discipline defines Academic Dishonesty:

"The University expects all students to engage in all academic pursuits in a manner that is beyond reproach and to maintain complete honesty and integrity in the academic experiences both in and out of their classroom. The University may initiate disciplinary proceedings against a student accused of any form of academic dishonesty, including but not limited to, cheating on an

examination or other academic work, plagiarism, collusion, and the abuse of resource materials. 1. Cheating includes:

- a. Copying from another students test paper, laboratory report, other report, or computer files, data listings, and/or programs, or allowing another student to copy from same.
- b. Using, during a test, materials not authorized by the person giving the test.
- c. Collaborating, without authorization, with another person during an examination or in preparing academic work.
- d. Knowingly, and without authorization, using, buying, selling, stealing, transporting, soliciting, copying, or possessing, in whole or in part, the contents of an unadministered test.
- e. Substituting for another student; permitting any other person, or otherwise assisting any other person to substitute for oneself or for another student in the taking of an examination or test or the preparation of academic work to be submitted for academic credit.
- f. Bribing another person to obtain an unadministered test or information about an unadministered test.
- g. Purchasing, or otherwise acquiring and submitting as ones own work any research paper or other writing assignment prepared by an individual or firm. This section does not apply to the typing of the rough and/or final versions of an assignment by a professional typist.
- h. "Plagiarism" means the appropriation and the unacknowledged incorporation of anothers work or idea in ones own written work offered for credit.
- i. "Collusion" means the unauthorized collaboration with another person in preparing written work offered for credit.
- j. "Abuse of resource materials" means the mutilation, destruction, concealment, theft or alteration of materials provided to assist students in the mastery of course materials.
- k. "Academic work" means the preparation of an essay, dissertation, thesis, report,problem, assignment, or other project that the student submits as a course requirement or for a grade.
- l. "Falsification of Data" means the representation, claim, or use of research, data, statistics, records, files, results, or information that is falsified, fabricated, fraudulently altered, or otherwise misappropriated or misrepresented.

Procedures for discipline due to academic dishonesty shall be the same as in other disciplinary actions, except that all academic dishonesty cases shall be first considered and reviewed by the faculty member. If, after reviewing the case, the faculty member believes that disciplinary action is necessary, he/she may recommend a penalty but must notify the student of his/her right to appeal

to the academic department chair and, eventually, to the dean before imposition of the penalty. If the student does not accept the decision of the academic department chair or dean, the student may then follow the normal disciplinary procedures. No disciplinary action shall become effective against the student until the student has received substantive and procedural due process except as provided under Interim Disciplinary Action.

In addition, during the course of the semester, each student will be asked to carry out exercises in collaboration with other students. To nurture such an environment, we will consider any disruptive or disrespectful acts (such talking on a cell phone, or texting during class) to be a form of cheating. We consider academic dishonesty to be a serious offense and the maximum punishments allowed will be pursued in all scenarios. This includes completing any quizzes, or scantron forms with the help of another student or for scantron forms completed by another student who is not you. If similar work is submitted, all parties involved will receive a zero for their assignment. Make your work your own, be original. Good luck and enjoy your semester!

Key Concepts:

Ideas related to gravity:

- Gravity is the force that keeps planets in orbit around the Sun and governs the rest of the motion in the Solar System. Gravity alone holds us to the Earth's surface
- Gravitation is a universal force that each mass exerts on any other mass. The strength of the gravitational attractive force between two masses is proportional to the masses and inversely proportional to the square of the distance between them.

Ideas related to electromagnetic radiation:

- Light interacts with matter by transmission (including refraction), absorption, or scattering (including reflection). To see an object, light from that object–emitted by or scattered from it–must enter the eye.
- Electromagnetic waves result when a charged object is accelerated or decelerated. Electromagnetic waves include the electromagnetic spectrum from radio waves to gamma rays. The energy of electromagnetic waves is carried in packets whose magnitude is inversely proportional to the wavelength.
- Each kind of atom or molecule can gain or lose energy only in particular discrete amounts and thus can absorb and emit light only at wavelengths corresponding to these amounts. These wavelengths can be used to identify the substance.

Ideas related to fusion:

- Stars produce energy from nuclear reactions, primarily the fusion of hydrogen to form helium. These and other processes in stars have led to the formation of all the other elements.
- Fusion is the joining of two nuclei at extremely high temperature and pressure, and is the process responsible for the energy of the sun and other stars.

The evolution of the universe

- The origin of the universe remains one of the greatest questions in science. The "big bang" theory places the origin between 10 and 20 billion years ago, when the universe began in a hot dense state; according to this theory, the universe has been expanding ever since.
- Early in the history of the universe, matter, primarily the light atoms hydrogen and helium, clumped together by gravitational attraction to form countless trillions of stars.

Stars and stellar evolution

- Billions of galaxies, each of which is a gravitationally bound cluster of billions of stars, now form most of the visible mass in the universe.

The evolution and structure of the solar system

- The sun, the earth, and the rest of the solar system formed from a nebular cloud of dust and gas 4.6 billion years ago. The early earth was very different from the planet we live on today.
- The Earth is the third planet from the Sun in a system that includes the Moon, the Sun, other planets and their moons, and smaller objects, such as asteroids and comets. The Sun, an average star, is the central and largest body in the Solar System.

The Sun and Earth's seasons

- The Sun provides the light and heat necessary to maintain the temperature of the Earth.
- The Sun is the major source of energy for phenomena on the Earth's surface. Seasons result from variations in the amount of the Sun's energy hitting the surface due to the tilt of the Earth's rotation on its axis and the length of the day.

Yearly patterns, daily patterns and moon phases

- The Sun, Moon, stars, clouds, birds, and airplanes all have properties, locations, and movements that can be observed and described.
- Objects in the sky have patterns of movement. The Sun, for example, appears to move across the sky in the same way every day, but its path changes slowly over the seasons. The Moon moves across the sky on a daily basis much like the Sun. The observable shape of the Moon changes from day to day in a cycle that lasts about a month.
- Most objects in the Solar System are in regular and predictable motion. Those motions explain such phenomena as the day, the year, the phases of the Moon, and eclipses.

Tentative Schedule of Topics, Assignments, and Exams

Date	Topic/Assignments
	Week 1
	Introductions, Astronomy Survey,Pre-assessment, Office Hours, Tour of Universe Discussion of Syllabus, Popsicles, Day-to-day class structure Watch *Cosmic Voyage*: https://www.youtube.com/watch?v=qxXf7AJZ73A AN: Math Review, Section 3 — http://www.astronomynotes.com/mathrev/s3.htm AN: Chapter 1, all sections — http://www.astronomynotes.com/chapter1/ WA: http://en.wikipedia.org/wiki/Scientific_notation WA: http://en.wikipedia.org/wiki/Names_of_large_numbers LT: Sun size (105-107), Milky Way Scales (123-125)
	Week 2 – Patterns in the Sky
	AN: Chapter 3, all sections EXCEPT Angles, Coordinates, Planetary Motions AN: – http://www.astronomynotes.com/nakedeye/chindex.htm WA: http://en.wikipedia.org/wiki/Celestial_sphere WA: http://en.wikipedia.org/wiki/Circumpolar_star LT: Position, Motion LT: Seasonal Stars
	WA: http://en.wikipedia.org/wiki/Sidereal_day ("Sidereal time and solar time" section only) LT: Solar vs. Sidereal Day, Ecliptic WA: http://en.wikipedia.org/wiki/Moon_phases LT: The Cause of Moon Phases, Predicting Moon Phases LT: Path of the Sun
	WA: http://en.wikipedia.org/wiki/Seasons LT: Seasons AN: Chapter 4, section on Kepler's Laws of Planetary Motion AN: – http://www.astronomynotes.com/history/s7.htm#A5 LT: Kepler's Second Law LT: Kepler's Third Law
	Week 3 – Gravity, Light, Midterm Exam
	AN: Chapter 5, all sections – http://www.astronomynotes.com/gravappl/chindex.htm (AN: Chapter 6, all sections – http://www.astronomynotes.com/relativity/chindex.htm)

Date	Topic/Assignments
	LT: Newton's Laws and Gravity
	Review Session
	Midterm Exam 1 – Scales, Patterns in the Sky, Gravity
	AN: Chapter 11, section 4 only – http://www.astronomynotes.com/starprop/s4.htm
	WA: http://en.wikipedia.org/wiki/Magnitude_(astronomy)
	WA: http://en.wikipedia.org/wiki/Apparent_magnitude
	WA: http://en.wikipedia.org/wiki/Absolute_magnitude (Introduction and prologue to
	WA: Stars and Galaxies sections only)
	LT: Apparent and Absolute Magnitudes of Stars
	AN: Chapter 7, sections 1–3 – http://www.astronomynotes.com/light/chindex.htm
	LT: Electromagnetic Spectrum of Light
	LT: Telescopes and Earth's Atmosphere
	AN: Chapter 7, section 4 – http://www.astronomynotes.com/light/s4.htm
	LT: Blackbody Radiation
	LT: Types of Spectra
	AN: Chapter 7, sections 7–10 – http://www.astronomynotes.com/light/chindex.htm
	LT: Light and Atoms
	Week 4 – Nature of Light, Evolution and Structure of the Solar System,Stars, exam
	LT: Analyzing Spectra
	LT: Doppler Shift
	LT: Observing Retrograde Motion
	WA: http://en.wikipedia.org/wiki/Solar_system
	WA: http://en.wikipedia.org/wiki/Portal:Solar_System
	LT: Temperature and Formation of Our Solar System
	WA: http://en.wikipedia.org/wiki/Extrasolar_planets (esp. Detection Methods section)
	LT: Motion of Extrasolar Planets
	AN: Chapter 9, section 1-12
	Watch *"The Great Planet Debate"* between Niel DeGrasse Tyson and Mark Sykes, moderated by Ira Flato
	Review Session
	Midterm Exam 2 – Nature of Light, Solar System
	AN: Chapter 11, sections 1–11 – http://www.astronomynotes.com/starprop/chindex.htm
	LT: Luminosity, Temperature, and Size

Date	Topic/Assignments
	Week 5 – Stellar Evolution, Galaxies
	AN: Chapter 11, sections 12–15 – http://www.astronomynotes.com/starprop/chindex.htm
	LT: H-R Diagram
	AN: Chapter 12, all sections – http://www.astronomynotes.com/starsun/chindex.htm
	LT: Star Formation and Lifetimes
	AN: Chapter 13, all sections – http://www.astronomynotes.com/evolutn/chindex.htm
	LT: Stellar Evolution
	Week 6 – Evolution of the Universe, Exams
	LT: Parallax and Distance
	AN: Chapter 15, all sections – http://www.astronomynotes.com/galaxy/chindex.htm
	LT: Galaxy Classification
	AN: Chapter 16, all sections – http://www.astronomynotes.com/cosmolgy/chindex.htm
	LT: Looking at Distance Objects
	LT: Expansion of the Universe
	Big Bang
	Dark Matter
	Dark Energy
	Finals Week