

**SYLLABUS**  
**GENERAL ASTRONOMY - PHYS 1700 90**

JASON KENDALL, WILLIAM PATERSON UNIVERSITY

1. THE MOST CHALLENGING CLASS YOU'LL EVER LOVE.

The science of astronomy is without a doubt the most interesting and fascinating thing you'll ever work on. We will deal with the origin of the Earth, the Sun and the Universe. We'll learn the names of stars, and how to find them in the sky. We'll learn about ancient oceans on Mars and planets around other stars. We'll glimpse the madness of the surface of a neutron star, where you would weigh as much as a mountain if you stood on it. We'll witness the gossamer beauty of interstellar clouds, which are the birthplace of stars. We'll dive into a black hole where space and time crush together into a maelstrom of destruction. We'll learn what a shooting star is, and how you can find them. We'll see distant galaxies, all homes to billions of stars and countless planets. We'll tour Saturn's rings, and Jupiter's Great Red Spot. We'll even take a trip with a spacecraft all the way out to distant Pluto.

In so doing, we'll learn how the physical laws that we measure in the laboratory here on Earth apply to the Moon, the stars and places far beyond. We'll learn how to link physical arguments together to see why things work the way they do. The universe is filled with mysteries, but they are unlocked and made even more mysterious in that we can actually understand them.

Natural Philosophy is the study of how logic and evidence links ideas together to come up with explanations for how things work in the real world. We don't have to rely on demons or gods to tell us how things work, and why they go the way they do. We rely on Newton's Laws of Motion, Einstein's Relativity, Maxwell's Laws of Electromagnetism, and the wildly counterintuitive world of quantum mechanics. For many centuries of human existence, we looked at the sky wondered how it all came to be. Now, in this golden era of knowledge and exploration, humanity is coming close to truly understanding the origin of the universe, and discovering whether or not life could actually have arisen more than once in our Solar System.

Don't get me wrong, the ideas are quite challenging, the vocabulary is odd, and the logic that links things together can take serious mental gymnastics, and you'll have to do more reading than you thought you would ever have to for an intro course. But the rewards are great, with this liberal art class that merges science with the greatest aspirations of human thought.

This class will feed and water your inner 6-year-old, and inspire you with wonder. Every kid loved dinosaurs and planets. Now you get to go back and be that kid again.

## 2. SCHEDULE

## COURSE SYLLABUS

(4 Credits)

Spring 2016

Instructor: Jason Kendall

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William Paterson University

Department of Physics

Lecture	Saturdays: 2:00 pm - 4:30 pm	Science Hall East 2063	Jan. 23, 2016 - May 7, 2016
Laboratory	Saturdays: 5:00 pm - 7:30 pm	Science Hall West 112	Jan. 23, 2016 - May 7, 2016

SPECIAL NIGHT-TIME STARGAZING LABS on the following dates. We will reserve *every night in April* for clear-sky observing, with one being off-campus for a 45 mile trip.

## 3. ON EXCELLENCE

William Paterson University is known for its excellence among its alumni. Excellence is not easily achieved, and takes hard work and significant time. This class and your participation in it are part of WPU's tradition of excellence.

## 4. COURSE OBJECTIVES

This course is an introduction to astronomy. We'll learn about the concepts of stars, the solar system, and the universe. It will be done in the context of current news in the world of astronomy. We will use not only the text, but will also dig into NASA and astronomy web sites to understand today's amazing discoveries. It is truly a Golden Era of Astronomy, and you'll be exposed to it all. Historical developments in astronomy from ancient mythology to modern science will be covered. Topics include: History of Astronomy, Gravity and Light, The Solar System, our Sun, the Formation and Evolution of Stars, Galaxies, and Frontiers of Exploration.

## 5. TEXT AND SOFTWARE

Required text #1

"Astronomy: A Beginners Guide to the Universe," Seventh Edition. By Eric Chaisson and Steve McMillan.  
<http://www.amazon.com/Astronomy-Beginners-Guide-Universe-Edition/dp/0321815351>

Required text #2:

"Guide to the Stars" Map by Ken Graun.

<http://www.amazon.com/exec/obidos/ASIN/1928771017/skymaps>

Required software #1:

"Stellarium" This is a free planetarium software. It is installed on the computers at the Science Enrichment Center in Science Hall East. Install it on your laptop.

<http://www.stellarium.org>

Required website #1:

"Astronomy Picture of the Day"

<http://apod.nasa.gov>

## 6. STUDENT LEARNING OUTCOMES

Students will be able to...

- (1) Effectively express themselves in written form. Writing is a key component of this class.
- (2) Do required mathematics of the class. There will be problem sets where you'll need to show your work.
- (3) Demonstrate ability to think critically about new ideas and topics.
- (4) Demonstrate ability to integrate knowledge and ideas in a coherent and meaningful manner.
- (5) Understand fundamental physical principles, theories, and methods of modern science as practiced in astronomy.
- (6) Learn the basic observable phenomena of astronomy, and how these have had both practical applications and played a key role in advancing our understanding of the Universe.
- (7) Explain the role of modern technology in the investigation of astronomical phenomena, and the crucial role played by technological advances in extending our knowledge of origin and behavior of the Universe.
- (8) Explore how discoveries in astronomy have implications for how we have come to view our place in the Universe, and by comparing the Earth to other planets in our Solar System provide a physical framework for understanding the possible impacts of our activities on the Earth.
- (9) Learn and know certain basics of the night sky, including star names, constellations, and how to find astronomical objects using a small telescope.
- (10) Finally, it's a LOT of fun. I really hope that you'll become a habitual astronomy buff, looking at Astro stuff frequently, hopefully going to star parties and taking trips out of the City just to see the stars and planets. In short, we hope to add astronomy into your daily life.

## 7. PEDAGOGICAL METHOD

You come to class not to sit and listen to the instructor talk, but to engage the ideas presented in the course. You'll be asked questions, you'll be challenged to answer in person. You'll also need to learn how to listen actively, and how to read actively. Reading the textbook is central to the class. The class will rely heavily on the reading of the book, writing, web site reading and lab work. I will use the online discussion sessions as an open format. I won't be lecturing, and it's there for you to ask questions and participate. I look VERY favorably on those who read ahead and are ready with questions. The idea with these discussions is to show where you're not sure about something, or what you found exciting and different; or to chat something about something that really doesn't seem right, or is way outside your comfort zone of thinking. There are a lot of hard ideas in the class and in the reading. It will really help if you read it in advance, then bring something to the table. I'll expect a bit of chatter on the discussion events. You'll need to keep up with the reading, because your grade is strongly dependent upon it. Writing and reading are core elements of the class. Talking to your colleagues and friends and family about the topic will not only improve your grade, but help you to truly enjoy astronomy. There are vast astronomy resources online, and we will use them. I can't stress enough how important it is for you to do reading. The laboratory portion will feature hands-on physics exercises as well as active astronomy lab activities that you'll be able to do at home. You will see through a telescope and how to find things in the sky. We will also do a class trip to a nearby observatory.

## 8. USE OF ELECTRONIC DEVICES IN THE LECTURE AND LAB SESSION

Texting and other distractions are not allowed during the lecture session, unless I specifically state to take out your laptop. I do not agree that you take better notes with your laptop. The light and inevitable internet access that comes with any mobile device is distracting not just to you but to everyone behind and near you. So, if you are asked for any reason to put away any electronic device, and you find that you cannot, you'll be excused from class. So, no. Not during the lecture. In the lab sessions, you will definitely need your laptop.

## 9. CLASSROOM AND TEACHING METHODS

First, I assume that everyone wants to do the work that will get you an A. So, we read. We chat about it. I answer your questions. I get your classmates to answer your questions. I call on people to talk about a topic. There are special challenges to a Saturday class. When you're done, you will want to just put it down for the whole week, and scabble your reading and homework on Saturday mornings. That's going to cause problems. You'll be cramming ideas in all at the last minute. This won't help you get an A. When I call on you to talk about something, I'm just trying to see if my teaching technique is working, and that you're doing work on your own. In the end, students learn things because they put in the time to learn them. So, reading the textbook is critical to the class. The class will be a combination of lecture, reading, writing, web site reading and lab work. I use the lecture sessions to introduce important ideas and to highlight topics of notable importance in the current field of astronomy. The reading will be independent from the lectures, but of equal important. You'll need to keep up with the reading, because you'll be tested on it weekly. I strongly feel that writing and reading are core elements of the class. Every class I'll give a homework to be returned at the start of the next class. I strongly feel that talking to your colleagues and friends and family about the topic will not only improve your grade, but help you to truly enjoy astronomy. There are vast astronomy resources online, and we will use them. Major testing and assignments will be done on-site and in the classroom. The laboratory portion will feature hands-on physics exercises as well as active astronomy lab activities. You will learn how to use a telescope and how to find things in the sky. You will learn the names of stars and their locations. We will hopefully also do a class trip to a nearby observatory.

## 10. GRADING

- “A” students go above and beyond the assignments, achieving mastery over knowledge with enthusiasm. They also challenge themselves to learn something really new for them.
- “B” students essentially do what they've been assigned and do it well.
- “C” students get some and miss some, but know the core concepts.
- “D” students don't understand most of the material, and don't turn in some or most of the assignments.
- “F” students participate only marginally, and what they happen to do shows no understanding or effort.

The following grade scale will be used to assign final grades for this course. All points will be added together for each section, and scaled to their percentage out of 100. However, points can be deceiving. I generally will follow this real formula: A students go above and beyond the requirements of the class and show understanding of all topics. B students do well and what is required of the class. C students get some and miss some, but get most of what's going on in the class. D students do not get most of what is going on in the class. F students do not make any effort at all, or actively disrupt the class. Grubbing for points won't work. If you're borderline, that's where the above comes in. It is always to your advantage to show up on time and talk about the topics in the class. They will be hard, but you'll get them.

Cumulative final grade letter grade: 90-100: A ; 80-89: B ; 70-79: C ; 60-69: D ; 59 and less: F

## 11. ATTENDANCE

There are only 13 sessions. Be in class. Miss two classes and your maximum possible grade is a C. Miss three classes and you fail the class. Miss March 12 class or April 2, you will be considered to have missed two classes and your maximum class grade is a C.

## 12. BLACKBOARD

WPU uses Blackboard for all grading purposes. Everything that is turned in shall have a grade. I'll also assess an in-class participation grade on Blackboard. It will formalize how you're doing in that regard. The more you interact in class the better.

## 13. OFFICE HOURS

Office Hours are 12:30 PM to 1:30 PM on Saturday. I will either be in the lab or in the classroom. Because I live in Manhattan, I will do most conversations over email. All email communications must go through your WPU email address. I won't respond to any other email service provider other than to tell you to that you need to email me back on your WPU account. Your student email contains your official documents for the class.

## 14. STARGAZING OUTINGS ON CAMPUS AND AT JENNY JUMP STATE PARK

On the following nights, we reserve these evenings for stargazing remote and local sessions.

*The last three weekends in April, with a guarantee go on April 16.*

On any of these nights, the normal lab after the lecture may be cancelled and instead, we will go outside for stargazing using our telescopes. At least ONE of the nights, we will drive out to Jenny Jump State Park to the observing location of the United Astronomy Clubs of New Jersey. The other nights, we will stay local on campus and use our telescopes to learn the night sky. Here is their website for more information:

<http://www.uacnj.org/>

Attendance is required. We will do the lecture and observing lab there. The location is about an hour drive away. I will be able to drive up to 12 students in a van, therefore, we will need to recruit student vehicles for the trip. We will leave campus at 4:30 PM, after the lecture, stop for a short dinner at a nearby diner, and arrive at around 7:30 PM. The lab that evening will require you to stay at this remote location until after 11pm. On this night, we won't be arriving back on campus until about midnight. Please plan all work and class schedules accordingly.

Prepare to wear appropriate clothing. We will not go out only in the event of cloudy or rainy weather. Cold, heat and bugs are all part of the observing component of the class. Absence due to illness will need to be made up. Absence due to inability to go outside must be made up. Please discuss with the instructor immediately if you are unable to be outside on your feet for 2-3 hours. We may possible recruit class members for the use of their car to get to an observatory off-campus.

## 15. STELLARIUM

We will use Stellarium extensively for our class. You need to download it to your laptop or home computer. Please become familiar with its operation. <http://www.stellarium.org> This application is free and works on Linux, Mac and Windows. It will take up about 300MB on your computer, but will be important for many laboratory activities, as well as homework.

## 16. LABORATORY ACTIVITIES

It's important in science to actually do stuff. What we'll talk about in class is based on experiment and observation. The interpretations of these experiments and observations are the core of all science. There will be a different lab each week that will get you up and out of your chair to actually take measurements, learn about error analysis, and see what we see. On every night, you'll need to complete at least one lab activity in your lab manual. You may work on them outside of class, but I'll only grade it in the lab itself, and I will accept only the lab manual for items to grade. The process for getting your points for your lab activities is as follows. You complete the work in your lab manual, writing out the answers to the questions in it. Once you're ready, then you'll bring it to me to check. I'll check it over. If what's in the lab manual is good, then I'll ask you two or three questions about the lab from the work presented. If you're able to answer them all, then you get your points. So, it doesn't hurt to work in groups, but you'll need to answer the oral questions on your own. Here's the catch, even if you don't get the points in the lab, it will still be on the final. So, it is your best interest to get the "A" in the lab. Notice also, it is not possible to get an "A" or "B" in the lab if you don't go to the UACNJ trip. Since this is almost half your grade in the class, if you wish to pass the class, getting an "A" is the best thing you can do. These differ from the tests in that you know exactly what's on them, and you can work on them together and at home. You may complete no more than 3 activities on any given day, except the last day, when you can finish any outstanding activities.

To get an "A" in your lab section, you need exactly 100 lab points. To get a "B" it is 90-99 lab points. To get a "C" it is 80-89 lab points. A "D" is 70-79 lab points. Not passing the lab is under 70 points.

15 points:

- (1) Class trip to UACNJ

3 points each. 2 points for completing the written work, 1 point for answering the verbal questions.

- (1) Stellarium: Constellations and star movements
- (2) Stellarium: Solar eclipse 2017
- (3) Stellarium: Mars in Retrograde
- (4) Stellarium: Moons of Jupiter
- (5) Stellarium: Your First Observing Run
- (6) MicroObservatory: Standard Set
- (7) MicroObservatory: Do Your Own

4 points each. 3 points for completing the written work, 1 point for answering the verbal questions.

- (1) Solar System Size Scales
- (2) Hubble Classification

7 points each. 4 points for completing the written work, 3 points for answering the verbal questions.

- (1) Stellarium: Galileo and Venus
- (2) Spectroscopy
- (3) HR Diagram
- (4) Milky Way Objects
- (5) Stellar Spectra
- (6) Galaxy Match-Up
- (7) Galaxy Spectra
- (8) Galaxy Clusters

## 17. ASSIGNMENTS AND EXAMS

**Lab Work:** (40% of your in-class grade) The Lab work is mostly self-driven, and you'll be using a standard lab manual to keep track of all your work. Since there will be questions on the Final from the lab, you'll be allowed to take home your lab book at the end of the last session to use for studying. The labs are a major focus of the course, and will take involve a lot of your time, so they are weighted accordingly.

**Reading Quizzes and Homework.** (15% of your total grade) Each week, you'll have a short homework assignment to turn in at the beginning of class. There will also be a short quiz on the reading. The homework will primarily be problems related to material in the textbook. You are encouraged to work together on them. They must be turned in written by hand, and must be legible. For all problems, make sure you show your work. The weekly quiz will span all the reading for that week. Half of the quiz will simply be vocabulary definitions, the other half will be concepts from the reading.

**Test #1:** (5% of your in-class grade) This is the first test of three. It will cover material in the class up to that point in the reading, homework and lecture. It will be an hour exam.

**Midterm Exam:** (10% of your in-class grade) The midterm is a comprehensive multiple-choice and essay exam covering all topics in the course. You will be allowed to bring in one sheet of written notes to the final. No photocopies or digital equipment will be allowed in the final.

**Take Home Test:** (5% of your in-class grade) Since we will have 2 consecutive weeks lost, due to Easter and to Spring Break, I will be giving a short take-home exam that will require you to look at many NASA and amateur astronomy websites to find the answers. It will be handed to you as you leave before Spring Break on March 12, and will be due at the start of class when you return. No late papers accepted. The take-home test won't take a long time to do, about an hour.

**Final Exam:** (25% of your total grade) The final exam is a comprehensive multiple-choice and essay exam covering all topics in the course. You will be allowed to bring in one sheet of written notes to the final. No photocopies or digital equipment will be allowed in the final.

**Attendance:** Each day you miss without a valid excuse is reduces your total grade by 5%. Valid excuses include: doctor's appointments, verified illness, family deaths or illness. All of these must be confirmed by the Dean of Students.

## 18. SPRING 2016 CLASS CALENDAR

See the WPU Calendar here: <http://www.wpunj.edu/dotAsset/bc1da425-7188-43ce-a750-9826d375a751.pdf>

January 23:	First day	
January 30:	Homework and reading quiz	
February 6:	Homework and reading quiz	
February 13:	Test #1, 60 minutes	
February 20:	Homework and reading quiz	
February 27:	Homework and reading quiz	
March 5:	Homework and reading quiz	
March 12:	Midterm Examination, 60 minutes	
March 19:	Spring Break	Class dismissed
March 26:	Easter	Class dismissed
April 2:	Take Home Test is due	
April 9:	Homework and reading quiz	
April 16:	Homework and reading quiz	UACNJ OBSERVATORY TRIP
April 23:	Homework and reading quiz	UACNJ OBSERVATORY TRIP
April 30:	Homework and reading quiz	UACNJ OBSERVATORY TRIP
May 7:	FINAL EXAM.	

## 19. CLASS TOPICS: NOT NECESSARILY IN ORDER, AND SOME MAY BE DROPPED

**FOUNDATIONS - FROM ANCIENT TO MODERN ASTRONOMY:** We will trace the development of astronomical thought from the geocentric view of the universe to modern astronomy covering the contributions made by Copernicus, Tycho Brahe, Kepler, Galileo, and Newton. Other topics include: The significance of Newton's laws of Motion and Universal Law of Gravitation; our view of the sky from the planet Earth and the apparent motion of celestial objects; the diurnal paths of stars; and the apparent annual motion of the sun and planets.

**SPACESHIP EARTH: OUR HOME IN SPACE:** We'll also cover the three basic motions of Earth – rotation, revolution and precession from a heliocentric point of view and the adoption of Newton's laws; proofs for the Earth's motion. Other topics include: what causes seasons; our view of the sky from different places on Earth; circumpolar stars; and the midnight sun.

**LIGHT THE COSMIC MESSENGER & TOOLS OF THE ASTRONOMER:** We'll learn about the basic properties of light and matter that enables astronomers to understand so much about the universe. Other topics include: astronomical twilight; how the atmosphere affects the observation of celestial objects; astronomical instruments; reflecting and refractor telescopes; and radio telescopes.

**THE MOON:** We'll study of the Moon as viewed from Earth and concludes with what we know about our nearest neighbor in space. Among the topics covered are: aspects of the Moon; lunar phases; sidereal and synodic months; lunar tides; solar and lunar eclipses; physical properties of the Moon; lunar surface features; the geology of the Moon; origin of the Moon; unmanned and manned expeditions.

**EXPLORING THE SOLAR SYSTEM - THE TERRESTRIAL PLANETS:** Looking at the four innermost planets of the Solar System: Mercury, Venus, Earth, and Mars. Among the topics covered are: physical properties of the terrestrial planets; classifying planets; and spacecraft missions .

**EXPLORING THE SOLAR SYSTEM - THE JOVIAN PLANETS:** We'll cover the study of inner gas giants of the Solar System, Jupiter and Saturn. Among other topics covered are: physical properties of the Jovian planets; and spacecraft missions to the outer Solar System planets. The moon systems of Jupiter and Saturn; and planetary ring systems. Other topics include the study of the outer gas giants of the Solar System, Uranus and Neptune; the physical properties of the minor Jovian planets; and spacecraft missions to the outer regions of the Solar System; and ring systems.

**SOLAR SYSTEM VAGABONDS - EXOPLANETS, COMETS, AND DEBRIS:** Not to be left out, we'll study the myriad other objects, including comets, that were left over from the origin of the Solar System. Among the topics covered: meteors and asteroids; the mystery of Pluto; trans-Neptunian and Kuiper belt objects.

**ORIGIN OF THE SOLAR SYSTEM AND EXOPLANETS:** How did the Solar System form?

**THE SUN: OUR NEAREST STAR IN SPACE:** We'll learn about the structure of the Sun and its effect on the planet Earth. Among the topics covered: The origin of the Sun; What makes the sun shine? The sun's visible surface; and sunspots.

**STELLAR PROPERTIES: CHARACTERIZING THE STARS:** We'll cover the distances and motion of stars; stellar parallax and proper motions; stellar magnitudes; spectral classification; color-temperature relationships; stellar masses and binary stars.

**STELLAR EVOLUTION: BIRTH, LIFE, AND DEATH OF STARS:** We'll learn about the lives of stars from birth to death. Among the topics covered: The HR diagram; giant and super giant stars; dwarf and neutron stars; pulsars; nova and super nova explosions; mysterious black holes in space.

**THE MILKY WAY GALAXY - AN ISLAND AMONG ISLANDS:** We'll analyze the structural features of the Milky Way Galaxy. Other topics include: rotation of the Galaxy; stellar populations; and radio view of our home galaxy; and nebulae and star clusters.

**THE GALAXIES: OTHER ISLAND UNIVERSES:** We'll learn about the structure of other galaxies in the universe. Other topics include: classification of galaxies; distribution of galactic systems; the local group; clusters of galaxies; Quasars; and active and radio galaxies; and Dark Matter.

**COSMOLOGY: THE ORIGIN AND EVOLUTION OF THE UNIVERSE:** We'll also learn about the theories for the origin of the universe. Other topics include: evolution of galaxies; the cosmological principle; the age of the universe; the red-shift; Big Bang Theory; dark energy; space and time.