Spring 2015 CCNY, Astronomy 30500, class # 16174, section ST Prof. David Kiefer
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Tuesdays 5-6:20 PM NAC 1/214	Thursdays 5-7 PM MR 3	Topics
Jan. ---	29	Celestial observations & explanations 1
Feb. 3	5	Celestial observations & explanations 2
10	---	
17	19	Celestial observations & explanations 3
24	26	Celestial observations & explanations 4
March 3 test		→ Test #1 (30% of grade)
	5	Early history, Kepler's Laws, Galileo
10	12	Newton's Laws, Gravitation
17	19	Planet survey
24	26	Light, wave properties, E/M waves, spectra
April 31	2	Inverse square law. Stars: m&M…and L
--------Spring recess-------		
14 test		→ Test #2 (30% of grade)
	16	The sun
21	23	H-R diagram; star classes, life, death
May 28	30	Galaxies, Distance measurement
5	7	Hubble's Law, Big Bang, Cosmology
12	14	Life in the universe? Exoplanets.
---	21 (6 – 8:15 PM)	→ Final exam (40% of grade)

• Astronomy is fascinating, beautiful, and in the news. Regardless of their beliefs and philosophy, intelligent people must consider where we are in the vast universe and what's happening "out there." Hope you'll learn a lot, enjoy the view, and grow from it. This class will definitely change and expand your world-view. You'll see things differently. Welcome.

• Text: Explorations. An Introduction to Astronomy, 7E, Arny & Scheider, 2012, McGraw-Hill

• A calculator is needed. Some math does appear. Inexpensive is fine. If it has an X^Y or Y^X button it has everything else you'll need for most science, math, and business classes.

• Lecture is meant to introduce the textbook readings. Even the book's photographs, diagrams, graphs, and math examples are to be studied. Many test questions are based on book readings besides lecture notes. The lecture is generally via a Power Point presentation which is posted onto BlackBoard just before the lecture so you can preview it and review it.
• **BlackBoard is vital!** It's used for announcements, Power Point lectures, downloads, and your grade record. You must learn how to enter it and to navigate within it.

• There will be three tests and an *optional* extra credit report (only 1). Extra credit projects will be described in a BlackBoard file. There's no guarantee but if done well (up to +4 points) it *might* move your final grade up by a half-letter, like C-→C, C+→B-, B → B+. But just going to an event or

planetarium show is not enough. A report is required, as described in the instructions. Write the report promptly after a visit or show for full credit.

• DON'T BE ABSENT. DON'T BE LATE. Attendance will be taken. Absences will not subtract from your average but will determine how much of a curve (0 to 9 points) will be added to your test average. More than 9 absences will result in no curve being given to you so *you'll sink or swim on just your raw test average.*

• Absent from a test? Notify me immediately by email as to why. Be ready for a make-up test during the next class. Bring a note. Otherwise, a 0 will be given.

• A photo ID will be required during tests.

• Review sheets for tests will be put in BlackBoard. You may use your answers during the tests. HOWEVER, all your answers and other notes must be compressed onto one sheet of paper and must handwritten. You cannot use photocopies from the textbook, nor of PowerPoint lecture slides, nor of someone else's work. Only notes you wrote by hand from the review sheet and readings can be used, and just one sheet (both sides OK.)

• Readings from the text will be assigned on separate BlackBoard announcements or on the last slide of each PowerPoint presentation. Read the pages assigned and try some questions at the chapter's end to cement your understanding. Homework will not be collected. The wise student will do it!

• The Final is not comprehensive. It only covers topics taught or assigned after Test 2.

General Education Information

As part of the College's General Education Curriculum, this course is designed to enhance your understanding of artistic issues and how they are studied. Students successfully completing this course will develop the following proficiencies:

Oral and written communication skills - Students will produce well-reasoned written or oral arguments using evidence to support conclusions.
Critical thinking skills - Students will evaluate evidence and arguments critically or analytically.
Information literacy - Students will gather, interpret, and assess information from a variety of sources and points of view.
Scientific World proficiency – Students will identify and apply the fundamental concepts and methods of a discipline or interdisciplinary field exploring the scientific world.

Detailed Astronomy Topics for Entire Course, Prof. Kiefer

Some topics and their Power Point presentations may assigned as independent study.

Celestial Observations with Modern Explanations: 1
Course introduction
Hierarchy of objects beyond Earth
Powers of Ten- relative sizes of all things
Rotation- day/night, 15°/h
Polaris and latitude
Constellations- 88 official, asterisms
Revolution- changing constellations defines the year
Precession- cycle of North stars and equinox point
Planets- 5 ancient "wanderers", an orrery
Major and minor planets, "demotion" of Pluto
Retrograde motion- major problem for ancients
The ecliptic, Zodiac constellations, nebular hypothesis

Celestial Observations with Modern Explanations: 2
Moon, moon phases
Eclipses
Tides- daily and weekly variations explained
Changing size of sun's disk, elliptical orbits
Why one side of moon always faces Earth, tidal locking, 1 rotation = 1 revolution, other examples
Earthshine

Celestial Observations with Modern Explanations: 3
Key measurements for astronomical distances:
miles, km, m, AU, ly, pc
Reason for the seasons
"Equation" for summer
Inventory of the Solar System
Asteroids
Meteoroids, meteors, meteorites
Comets, elliptical/hyperbolic orbits
Relative sizes of Solar System objects

Celestial Observations with Modern Explanations: 4
The milky way and The Milky Way Galaxy
Proper motion of stars
Nebulae: •gaseous (emission/reflection)
•star clusters (open/globular)
•planetary nebulae around exploded stars
•other galaxies

Brief History of Western Astronomy
Mystical, magical, and mechanical views
Geocentric model (Ptolemaic)
Heliocentric model (Copernican)
Brahe
Kepler, three laws of planetary motion,
math problems involving
Galileo's five central discoveries: moon features,
sunspots, milky way, moons of Jupiter,
phases of Venus and Mercury

Newton's Laws (physics in astronomy)
Three laws of force and motion
Mathematics of 2nd Law, F = ma
Universal gravitation, F_G equation
Inverse square relationship
G and g, mass and weight
Circular motion, centripetal force F_C
Understanding revolving in orbits

Planets
Key facts and unique features
Temperature; absolute zero; °C, °F, K scales

Telescopes
Refractors/reflectors
Curved mirrors and lenses, focal length (f)
Three functions: gather light, resolve, magnify
Importance of front diameter and eyepiece f length
Key aspects in buying an amateur telescope

Light
Four representations: waves, ripples, rays, particles
Standard aspects of all waves: medium, A, λ, f, T, v
Problems using wave equation and relationship
between λ, f, and v
Light as an E/M wave. Color. Speed
Dispersion of white light into colors with exact λs by
prisms and diffraction gratings
E/M waves: gamma X, UV, visible, IR, micro, radio
Inverse square law for light and stars
Three measurements for star brightness: m, M, L
Magnitude scale of star brightness
Linking m, M, and d (distance)
Linking M and L

Spectra
Spectroscopy, color "fingerprint" for each element
Continuous, emission ("bright line"), and
absorption ("dark line')
Doppler effect in sound and in spectral lines
Star spectra for composition, % composition, velocity,
surface temperature, spin, pressure, magnetic field
Detection of exoplanets by star oscillations

The sun
Stats about, special features, place among all stars
Source of energy, nuclear fusion, review of atoms
Hydrostatic equilibrium
Major zones within and around it, solar wind

Star Classification and the H-R diagram
Classifications: A → P, now by O-B-A-F-G-K-M
Classification, surface temperature, and visible color
Parallax for near-by star distances, pc = 1/p"
The H-R diagram, various axes possible
Four star types: MS, RG, BG, WD
Information compressed within an H-R graph

Star birth and death
Formation of stars, mass is critical

Why stars die. Subsequent fusions after H → He
Upsets to hydrostatic equilibrium
Mechanisms for star death: peter out to BD; explode to PN & WD, or SN & NS, or SN & BH
Comparative lifetimes

Ladder rungs for distance measurement
Radar/Transits of Venus
Parallax
Spectroscopic parallax- spectrum and H-R graph
Cepheid-type variable stars, period-L link
Tully-Fisher for galaxies, rotation-L link
Type 1A SN with constant L (standard candle)
Useful distance ranges for these methods

Galaxies and Hubble's Law
1930s: vast, new view of universe's size
Rooted in Cepheid and 1A SN stars
Edwin Hubble's impact
Galaxy types
Hubble's graph and equation, $v = H_0 \times d$
Significance of H_0 slope of 70 km/s/Mpc
Hubble's Law as final rung for distances
Big Bang

The Big Bang
Neither big nor bang
Cosmic inflation followed by cosmic expansion
Analogies for expansion of space itself carrying galaxies apart
$T_0 = 1/H_0 = 13.7$ Gy (billion years) ago
Contrast to Steady State view
Evidences:
- •Hubble expansion
- •Einstein's general theory of relativity
- •Uniform background radio waves, Penzias and Wilson, WMAP satellite
- •Nucleosynthesis of elements 1-3, 4-26, 27-92
- •Furthest galaxy distances to date

Major mysteries being explored today
Dark matter
Dark energy
Black holes
Exoplanets
Cosmology- past/future of universe, curvature of space, 4 fundamental forces
Structure of matter and antimatter, Standard Model, newest research on Higgs particle
Life in the universe- conditions, likely places, radio Communication
Future of space exploration
The moment of creation- sequences in Big Bang
The mystery of existence: Why should anything exist? How can the universe emerge from nothing?

Life in the Universe
Possibilities and probabilities
The Drake equation
Exoplanets- number to date, "hot Jupiters"
Radial velocity (spectrum) and transit methods
Viable stars
Habitable zone
Conditions for evolution
Urey-Miller experiment
Extremophiles
Broadcast technology
How long do advanced civilizations last?

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