ASTRONOMY 100
SPRING 2024

Dr. Edward Rhodes
MWF 2:00 p.m. – 3:20 p.m.

REGISTRATION AND QUESTIONNAIRE

PLEASE, COMPLETE AND TURN IN THE FOLLOWING:

NAME (PRINT) _____
LAST FIRST MIDDLE

SIGNATURE _____

EMAIL _____

STUDENT ID _____

SCHOOL ADDRESS _____

LOCAL PHONE NO. _____

What are your goals for this course?

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ASTRONOMY 100Lxg: The Universe

Spring Semester 2019:	**January 8, 2024 – April 26, 2024**
Course Meetings:	**MWF 2:00 p.m. – 3:20 p.m. (in SLH 100)**
Instructor:	**Dr. Edward J. Rhodes, Jr.**
Office:	**SHS 374**
Office Hours:	**M 3:25 – 4:15 p.m., WF 3:25 – 4:55 p.m. or by appointment**
Telephone:	**(818) 923-9243 (cell)**
E-Mail:	**erhodes@usc.edu**
Laboratory Room:	SGM 313
Laboratory Director:	Joseph (Joe) Vandiver
Office:	SGM 309
E-Mail:	vandiver@usc.edu
Student Services Assistant:	Giovanni Diaz
Email:	giovannd@usc.edu
Dept. Main Office:	ACB 439
Dept. Telephone:	(213) 740-7728

Textbooks, Course Readers, and Lab Manuals

Required Materials

- Theo Koupelis, ***In Quest of the Universe***, 7th Edition (packaged with student CD-ROM)
- Lecture slide set for Astronomy 100 (available on Blackboard under the "Lecture Slide Sets" tab in the left-hand column, to be printed individually and brought to class or accessed via laptop during class)
- Laboratory manual (distributed during first lab session)

Optional Supplementary Textbook

- Roger Freedman, Robert Geller, & William J. Kaufmann, ***Universe***, 10th Edition

Exams, Lab Assignments, and Grading

Exams

There will be three 80-minute midterm examinations and one two-hour final exam. The score of the lowest of the three mid-terms will be dropped and only the scores of the two highest exams will be counted in the Overall Point Total. Students who do not take all three of the mid-term exams will have only the scores recorded for the one or two exams that they do take. In addition to the examinations, you must complete the laboratory portion of the course. The lab assignments will be described later. Your Raw Lab Scores will be scaled so that they will count up to 48 points, or 20 %, of the Overall Point Total. Your Raw Final Exam Scores will be scaled so that they will count up to 72 points, or 30 % of the Overall Point Total of 240 points. The Overall Point Total will be computed as follows:

Component	Maximum Points	Percentages
Two highest mid-term exam scores	2 * 60 = 120	2 * 25% = 50%
Scaled Laboratory Scores	48	20%
Scaled Final Exam Scores	72	30%
Overall Point Total	240	100%

The Overall Point Total will be curved to determine the final grades in the course. Historically, there have been about 22-24% As and A-s, 30% B+s, Bs, and B-s, 40% C+s, Cs and C-s, and 6-8% D+s, Ds and D-s. During the semester, I will prepare and announce approximate grading curves based upon each of the three mid-term exams. In computing these curves, I will rank the raw scores from highest to lowest and apply my historical percentages to the ranked scores to determine the cutoff points between the different grade brackets. No scaling will be applied to your raw mid-term exam scores. Also, I will not record the letter grades on these individual curves, rather I will record only your raw scores instead. After we have had all three of the mid-term exams, I will also prepare and announce another grading curve that will be based upon the sum of everyone's two highest mid-term exams in a similar manner. Once I have received the Scaled Lab Scores, I will prepare and announce a Pre-Final Grade Curve that will be based upon the sum of the two highest mid-terms plus the Scaled Lab Scores. I will announce each of these five different grading curves via Blackboard.

After the Final Exam has been administered and scored, I will prepare the Final Grade Curve. The Final Grade Curve will be based upon then sum of the Pre-Final Point Totals plus the Scaled Final Exam Scores. Since there will be 126 questions on the Final Exam, the Scaled Final Exam Scores will be computed by multiplying the Raw Final Exam Scores by the quotient of 72/126 so that a perfect score on the Final Exam will count 72 points as a Scaled Final Score. The course grades will be assigned using the Final Grade Curve.

If you are taking this class on a Pass/No Pass basis, you must receive at least the equivalent of a C- to on the Final Grade Curve to receive a pass. Attendance will be taken during each Zoom lecture and recorded. This attendance information will be used in deciding upon the divisions of the Final Grade Curve that will be computed using your Overall Point Totals.

I will teach all of the lectures in SLH 100, but you will also be expected to come in to SLH 100 to take all of your mid-term exams and the final exam. You will also be expected to participate in all of your lab session in person in SGM 313. I will make recordings available after each of the lectures so that you will be able to view them whenever you are unable to come to SLH 100 or to participate in the Zoom meetings while the lectures are in progress.

Please note that the third mid-term exam will serve as a make-up exam for either of the first two exams. **There will not be any other make-up exams**. Any student missing two of the three mid-terms will only have recorded the points scored on the one exam taken unless he or she also completes the required minimum number of laboratory assignments.

The questions on the exams will cover the lectures, and the assigned readings. The questions on the exams will mainly be objective (multiple choice or matching); however, there may be a few short answer questions as well. The final exam will cover material from the whole course, although it will emphasize the material in the latter portion of the course. Each exam will be an individual effort, closed book, closed notes exam.

Examples of past examinations will be available on the course website on Blackboard under the "Exam Materials" tab in the left-hand column.

Course Structure

During most weeks there will be three lectures. All three meetings will be held in the lecture hall. During some weeks, I will schedule an afternoon review session before each of the exams. I will also post study guides before each of the review sessions which we will go over during those sessions.

Course Outline

The detailed course outline and reading assignment list are attached. Please note that the dates of the midterm exams listed on the course outline are subject to change during the course. Any changes in the mid-term schedule will be announced during the week preceding the scheduled time. All such announcements will be made during lecture only.

Lecture Slide Sets

Sets of PowerPoint slides are available for all 40 of the lectures under the "Lecture Slides Sets" tab on Blackboard. You may print out each set of slides prior to the lecture and bring the printouts with you or you may bring a laptop to class and view the slides on the laptop. Please note that the animations that will be shown in the lectures are available with the Student CD-ROM that accompanies the required textbook.

Lecture Attendance Policy

Attendance will be taken during all lectures using the participation reports that Zoom will generate after each of the lectures. As mentioned earlier, the overall lecture attendance will be taken into consideration when I am determining the different cutoff points of the grade brackets on the Final Grade Curve at the end of this semester.

Laboratory Sections

The laboratory meetings will be held during alternating weeks beginning on the Mondays or Tuesdays listed on the lab schedule that is given later. Attendance during the first week is mandatory. Failure to attend the lab session for which you are registered may result in the cancellation of your lab registration. Each laboratory meeting will last approximately 110 minutes.

In addition to the assignments to be done in the laboratory, there will also be one mandatory on-campus evening observing session will be scheduled to view the sky. More details of these sessions will be announced later. Sign-ups for each of the campus observing sessions will be handled by the TA's during the lab meetings. Additional evening observing sessions will be scheduled in case any of the planned sessions have to be canceled due to inclement weather. If bad weather interferes with all of the scheduled observing sessions, a required alternative assignment will be announced late in the term.

In order to get the maximum possible lab score, you will need to do all seven assignments and attend the evening observing session. Each of the seven assignments will count for a maximum of 20 points for a total of 140 possible

points. The observing session will count for an additional 40 points, so that the maximum possible score you can have for the lab portion of the course will be 180 points. To convert this Raw Lab Score into a Scaled Lab Score, your Raw Lab Score will be multiplied by the ratio of 48/180 so that a perfect Raw Lab Score of 180 points will become a Scaled Lab Score of 48 points. If you skip any of the assignments, you will receive a zero score for those assignments. While 20 percent of the final course grade may not sound like it will affect your course grade by much, please keep in mind that failure to complete the laboratory component of the course, can result in a dramatic lowering of your final grade. Even failure to complete all seven of the assignments and to participate in the On-Campus Observing Session can lower your final course grade substantially.

Labs will take place in SGM 313. All lab policies are outlined in the Laboratory Manual, including your attendance at one evening On-Campus Observing Session.

Course Goals

My goals for each of you this semester include the following:

1) That you will learn to understand how science is done, what questions science can answer, and what questions science cannot answer.
2) That you will gain an appreciation for the historical development of astronomy, including the importance of past discoveries in the development of new knowledge.
3) That you will gain a better appreciation for the wonders of the universe.
4) That you will cultivate an interest in learning more about astronomy throughout your lives, such that you will want to read articles about astronomy in the future after this class has ended.
5) That you will have an opportunity to observe the heavens using USC's refurbished Campus Observatory.

Course Content Distribution and Synchronous Session Recordings Policies

USC has policies that prohibit recording and distribution of any synchronous and asynchronous course content outside of the learning environment.

Recording a university class without the express permission of the instructor and announcement to the class, or unless conducted pursuant to an Office of Student Accessibility Services (OSAS) accommodation. Recording can inhibit free discussion in the future, and thus infringe on the academic freedom of other students as well as the instructor. (Living our Unifying Values: The USC Student Handbook, page 13).

Distribution or use of notes, recordings, exams, or other intellectual property, based on university classes or lectures without the express permission of the instructor for purposes other than individual or group study. This includes but is not limited to providing materials for distribution by services publishing course materials. This restriction on unauthorized use also applies to all information, which had been distributed to students or in any way had been displayed for use in relationship to the class, whether obtained in class, via email, on the internet, or via any other media. (Living our Unifying Values: The USC Student Handbook, page 13).

Since creating, analytical, and critical thinking skills are part of the learning outcomes of this course, all assignments should be prepared by the student working individually or in groups. Students may not have another person or entity complete any substantive portion of the assignment. Developing strong competencies in these areas will prepare you for a competitive workplace. Therefore, using AI-generated tools is prohibited in this course, will be identified as plagiarism, and will be reported to the Office of Academic Integrity.

Statement on Academic Conduct and Support Systems

Academic Integrity:

The University of Southern California is a learning community committed to developing successful scholars and researchers dedicated to the pursuit of knowledge and the dissemination of ideas. Academic misconduct, which includes any act of dishonesty in the production or submission of academic work, compromises the integrity of the person who commits the act and can impugn the perceived integrity of the entire university community. It stands in opposition to the university's mission to research, educate, and contribute productively to our community and the world.

All students are expected to submit assignments that represent their own original work, and that have been prepared specifically for the course or section for which they have been submitted. You may not submit work written by others or "recycle" work prepared for other courses without obtaining written permission from the instructor(s).

Other violations of academic integrity include, but are not limited to, cheating, plagiarism, fabrication (e.g., falsifying data), collusion, knowingly assisting others in acts of academic dishonesty, and any act that gains or is intended to gain an unfair academic advantage.

The impact of academic dishonesty is far-reaching and is considered a serious offense against the university. All incidences of academic misconduct will be reported to the Office of Academic Integrity and could result in outcomes such as failure on the assignment, failure in the course, suspension, or even expulsion from the university.

For more information about academic integrity see the student handbook or the Office of Academic Integrity's website, and university policies on Research and Scholarship Misconduct.

Please ask your instructor if you are unsure what constitutes unauthorized assistance on an exam or assignment, or what information requires citation and/or attribution.

Students and Disability Accommodations:

USC welcomes students with disabilities into all of the University's educational programs. The Office of Student Accessibility Services (OSAS) is responsible for the determination of appropriate accommodations for students who encounter disability-related barriers. Once a student has completed the OSAS process (registration, initial appointment, and submitted documentation) and accommodations are determined to be reasonable and appropriate, a Letter of Accommodation (LOA) will be available to generate for each course. The LOA must be given to each course instructor by the student and followed up with a discussion. This should be done as early in the semester as possible as accommodations are not retroactive. More information can be found at osas.usc.edu. You may contact OSAS at (213) 740-0776 or via email at osasfrontdesk@usc.edu.

Support Systems:

Counseling and Mental Health - (213) 740-9355 – 24/7 on call

Free and confidential mental health treatment for students, including short-term psychotherapy, group counseling, stress fitness workshops, and crisis intervention.

988 Suicide and Crisis Lifeline - 988 for both calls and text messages – 24/7 on call

The 988 Suicide and Crisis Lifeline (formerly known as the National Suicide Prevention Lifeline) provides free and confidential emotional support to people in suicidal crisis or emotional distress 24 hours a day, 7 days a week, across the United States. The Lifeline is comprised of a national network of over 200 local crisis centers, combining custom local care and resources with national standards and best practices. The new, shorter phone number makes it easier for people to remember and access mental health crisis services (though the previous 1 (800) 273-8255 number will continue to function indefinitely) and represents a continued commitment to those in crisis.

Relationship and Sexual Violence Prevention Services (RSVP) - (213) 740-9355(WELL) – 24/7 on call

Free and confidential therapy services, workshops, and training for situations related to gender- and power-based harm (including sexual assault, intimate partner violence, and stalking).

Office for Equity, Equal Opportunity, and Title IX (EEO-TIX) - (213) 740-5086

Information about how to get help or help someone affected by harassment or discrimination, rights of protected classes, reporting options, and additional resources for students, faculty, staff, visitors, and applicants.

Reporting Incidents of Bias or Harassment - (213) 740-5086 or (213) 821-8298

Avenue to report incidents of bias, hate crimes, and microaggressions to the Office for Equity, Equal Opportunity, and Title for appropriate investigation, supportive measures, and response.

The Office of Student Accessibility Services (OSAS) - (213) 740-0776

OSAS ensures equal access for students with disabilities through providing academic accommodations and auxiliary aids in accordance with federal laws and university policy.

USC Campus Support and Intervention - (213) 740-0411

Assists students and families in resolving complex personal, financial, and academic issues adversely affecting their success as a student.

Diversity, Equity and Inclusion - (213) 740-2101

Information on events, programs and training, the Provost's Diversity and Inclusion Council, Diversity Liaisons for each academic school, chronology, participation, and various resources for students.

USC Emergency - UPC: (213) 740-4321, HSC: (323) 442-1000 – 24/7 on call

Emergency assistance and avenue to report a crime. Latest updates regarding safety, including ways in which instruction will be continued if an officially declared emergency makes travel to campus infeasible.

USC Department of Public Safety - UPC: (213) 740-6000, HSC: (323) 442-1200 – 24/7 on call

Non-emergency assistance or information.

Office of the Ombuds - (213) 821-9556 (UPC) / (323-442-0382 (HSC)

A safe and confidential place to share your USC-related issues with a University Ombuds who will work with you to explore options or paths to manage your concern.

Occupational Therapy Faculty Practice - (323) 442-2850 or otfp@med.usc.edu

Confidential Lifestyle Redesign services for USC students to support health promoting habits and routines that enhance quality of life and academic performance.

Faculty Liaison

All courses in the Department of Physics & Astronomy have an assigned Faculty Liaison to serve students as a confidential, neutral, informal, and independent resource when they wish to discuss issues concerning their course without directly confronting their instructor. The Faculty Liaison for this course is Prof. Jack Feinberg, feinberg@usc.edu, 213-740-1134, SSC 327.

Spring 2024 Lab Schedule (in SGM 313)

Week of Semester	Dr. Rhodes Sections
Jan. 8th	Basic Aspects of Astronomy
Jan. 15th	No Labs
Jan. 22nd	Starry Night
Jan. 29th	No Labs
Feb. 5th	Optics
Feb. 12th	No Labs
Feb. 19th	Telescopes
Feb. 26th	No Labs
Mar. 4th	Kepler's Laws
Mar. 11th	Spring Break
Mar. 18th	No Labs
Mar. 25th	The Sun
Apr. 1st	No Labs
Apr. 8t th	Digital Astrophotography
Apr. 15th	No Labs
Apr. 22nd	No Labs

ASTRONOMY 100
REQUIRED READING ASSIGNMENTS
COURSE OUTLINE AND EXAM SCHEDULE
(All required reading assignments are in parenthesis after the topics)

Wk.	Lec.	Date	Topics
WEEK 1	1	January 8	Introduction; Early Astronomy (pp.1-5; middle of page 28 to bottom of page 31)
	2	January 10	Celestial sphere; geographic coordinates; celestial coordinates; Earth's motions and orientation in space (pp.6 – middle of p.12)
	3	January 12	The equinoxes and solstices; the seasons; the zodiac; Early Greek Astronomy (The Geocentric view); Aristotle; Proofs for Rotation and Revolution of the Earth (middle of p.12 – middle of p.17; pp.38 – bottom of p.43; middle of p 46 – middle of p.48)
WEEK 2		January 15	**NO CLASS – Martin Luther King Jr. Birthday Holiday**
	4	January 17	Motions of the Planets; the Ptolemaic Model; Criteria for choosing among models; Pre-Renaissance Astronomy; Copernicus and the Heliocentric Model (bottom of p. 43 – middle of p. 46; section 1-7; sections 2-5 and 2-6)
	5	January 19	Comparison of Ptolemaic and Copernican Models; Tycho Brahe; Johannes Kepler; Kepler's Laws of Planetary Motion; (Sections 2-7, 2-8, and 2-9 through top of p.63)
WEEK 3	6	January 22	Galileo Galilei; Newton and his laws of physics; circular motion; Newton's Law of Universal Gravitation; (p. 69 – through section 3-5)
	7	January 24	Angular momentum; Center of Mass; tides; Non-Spherical Shape of the Earth (Sections 3-6 and 3-7; middle of p.153 – through middle of p.156)
	8	January 26	Precession; Effects of Precession on the Seasons; Perturbation Theory; Discovery of Neptune; Spacecraft Orbits (middle of p.156 – p.157; Historical Notes on page 269 and on page 273)
WEEK 4	9	January 29	Electromagnetic Radiation or Light; Wave Nature of Light; The Speed of Light; Refraction; Dispersion; Interference Thermodynamics; Heat; Temperature; Heat Transfer; Black body Radiators; (p.95-end of p.103)
	10	January 31	Radiation Laws; The Quantum Idea; The Photoelectric Effect; The Beginnings of Astrophysics; Kirchhoff's Rules of Spectral Analysis; Early 20th Century Models of the Atom; (top of p.104 – bottom of p.105)
	11	February 2	The Bohr Model of the Atom; Energy Levels in Atoms; Excitation, de-excitation, ionization, and recombination of electrons; Absorption and emission of light by atoms; the Particle Nature of Light; Quantum Modifications of the Bohr Model of the Atom; The Heisenberg Uncertainty Principle; (section 4-6)
WEEK 5	12	February 5	The Doppler Effect; Radial Velocity; The Inverse-Square Law of Light; Size of the Moon; Distance of the Moon; Lunar Phases; Blue Moons; (middle of p.113-middle of p. 118; pp. 149– middle of p.153; middle of p.17 – to middle of p.20)
	E1	**February 7**	**Midterm Exam 1 (Wed.) in SLH 100**
	13	February 9	Lunar and Solar Eclipses; The Structure of the Earth; the Geomagnetic Field; (middle of p. 20 –middle of p. 26; p.158 – bottom of p.161) The Earth's Magnetosphere; Plate Tectonics;
WEEK 6	14	February 12	The Ice Ages; Earth's Atmosphere; Ozone Layer Depletion; Global Warming Controversy; (bottom of p.161 – to end of section 6-3) The Surface, Interior, and History of the Moon;
	15	February 14	the Origin of the Moon; Measuring Distances and Masses in the Solar system; classifying the Planets: The Terrestrial and Giant Planets; (sections 6-4, 6-5, and 6-6; p.177 – middle of p.187)
	16	February 16	Planetary Atmospheres and Escape Velocities; Formation of the Solar System; Discovery of Planets orbiting other stars; Interplanetary Spacecraft; Julia Childs and the Building Blocks of Life; (p. 187 – p. 203; sections 19-4 through 19-6)
WEEK 7		February 19	NO CLASS Presidents' Day Holiday

	17	February 21	Mercury and its Motions; Venus (pp.207 – bottom of p. 221)
	18	February 23	Mars: Its Motions and Topography; Volcanoes on Mars; Search for Life on Mars; Martian Polar Caps; Martian Atmosphere; Possible Past Martian Water, (bottom of p. 221 – middle of p. 238)
WEEK 8	19	February 26	Martian Moons; Properties of Giant Planets; Jupiter: Its Size, Mass, and Density; Jupiter's Rapid Rotation and Oblate Shape; Spacecraft visits to Jupiter; Jupiter's Atmosphere and Clouds; Jupiter's Interior and Magnetic Field; Jupiter's Magnetosphere; (Middle of p.238 – 240; p. 244 – bottom of p.251)
	20	February 28	Jupiter's Moons; Jupiter's Ring System; Saturn and Its Ring System; Saturn's Motions; Saturn's Rotation and oblateness; Saturn's Atmosphere; Saturn's Moons; (bottom of p.251 – bottom of p.263)
	21	March 1	Roche Limit; Formation of Saturn's Rings; Uranus and its Ring System; Unique Orientation of Uranus; Its Moons; Its Magnetic Field; Neptune; Neptune's Ring System; Neptune's Moons; (bottom of p.263 – bottom of p.273) Accidental Discovery of Pluto; Discovery of Pluto's Moon, Charon; Pluto's Mass; Pluto's Atmosphere; What is Pluto? The Asteroids; Discovery of Ceres; Asteroid Orbits and
WEEK 9	22	March 4	Kirkwood's Gaps; The Trojan Asteroids; Origin of the Asteroids; (p. 277 – end of section 10-3)
	23	March 6	Halley's Comet; Comets: their Parts and their Orbits; The Oort Cloud and the Kuiper Belt; Meteoroids; Meteors; Meteor Showers and Comets; Meteorites; Asteroid Impacts on Earth; did an Asteroid Impact Kill the Dinosaurs? (section 10-4 to end of chapter 10 on p. 303)
	24	March 8	Basic Solar Data; the "Solar Constant" and Why It Is Not Constant; The Solar Photosphere and Its Motions; The Solar Atmosphere; Sunspots and the Solar Activity Cycle; George Ellery Hale and the Discovery of Solar Magnetic Fields; The Zeeman Effect; The Maunder Minimum; (p.308 - end of section 11-1; section 11-5 through bottom of p.329)
WEEK 10		March 11-15	**NO CLASS – SPRING RECESS**
WEEK 11	25	March 18	A Model for the Solar Cycle; Solar Flares; Solar Filaments and Prominences; The Energy Source of the Sun; The Equivalence of Mass and Energy; Sub-atomic particles; quarks, hadrons, and leptons; Anti-Particles; (bottom of p. 329 – p. 335; and section 11-2 through top of p.312)
	E2	**March 20**	**Midterm Exam II (Wed.) in SLH 100**
	26	March 22	Thermonuclear fusion Reactions; The Proton-Proton Chain; The Solar Interior; The Solar Neutrino Problem; Solar Oscillations and Helioseismology; (top of p.312 through end of section 11-4)
WEEK 12	27	March 25	Observed Properties of Stars: Apparent magnitudes; absolute magnitudes; parallaxes and distances; Stellar luminosities; Stellar Motions; Spectral Classifications; Reasons for Different Appearance of Stellar Spectra; Revision of Spectral Sequence (p.339 – to the top of p.348)
	28	March 27	The Hertzsprung-Russell Diagram; The Main Sequence Stars; The Red Giant Stars; The Supergiant Stars; White Dwarfs; Luminosity Classes; Multiple Star Systems: Binaries and Stellar Mass Estimates; (top of p. 348 – bottom of p. 358)
	29	March 29	Cepheid Variable Stars; The Interstellar Medium: Gas and Dust Between the Stars; Emission Nebulae; Dark Nebulae; Reflection Nebulae (p.374; p.394-middle of p.403; p.394 – middle of p.403)
WEEK 13	30	April 1	Star Formation: Giant Molecular Clouds; Evaporating Gaseous Globules; Shockwave triggering; Protostars; Pre-Main Sequence Evolution; Star Clusters: Open and Globular Clusters; Brown Dwarfs; Life on the Main Sequence; (middle of p.374 – p.384; p.388 – middle of p.391)
	31	April 3	The Flyweight Stars; The Lightweight Stars; Post-Main Sequence Evolution of Lightweight Stars: Red Giants and the Helium Flash; There Goes the Earth; Planetary Nebulae; White Dwarfs (middle of p. 391 – bottom of p.404)
	32	April 5	Theory of White Dwarfs; Close Binary Stars, White Dwarfs, and Novae; The Chandrasekhar Mass Limit for White Dwarfs; Type I Supernovae; Middleweight and Heavyweight Stars and Type II Supernovae; Nucleogenesis; SN 1987a; (top of p.405 – top of p.411; p.415 – end of section 15-3)

WEEK 14	33	April 8	Neutron Stars and The Discovery of Pulsars: Indirect Evidence for the Existence of Neutron Stars; Deaths of Middleweight Stars: Formation of Neutron Stars; Einstein's Theory of Special Relativity; Einstein's Theory of General Relativity; (start of section 15-4 to end of section 15-6; sections 3-8 and 3-9; section 15-7)
	34	April 10	Experimental Tests of General Relativity; Binary Pulsars as Tests of General Relativity; Deaths of the Heavyweight Stars and the Formation of Black Holes; Do Black Holes Exist? Is the Universe a Black Hole? Do Black Holes Evaporate? Wormholes; The Laser Interferometric Gravitational Wave Observatory (LIGO) and the Recent Proof that Gravitational Waves Exist; Stellar Populations; Early Views of Our Galaxy; Modern Views of our Galaxy: The Milky Way Galaxy (sections 15-8 and 15-9; p.447 – middle of p.453)
	35	April 12	Components of the Milky Way Galaxy; The Galactic Nucleus; The Evolution of our Galaxy; The Controversy over the Nebulae; The Resolution of the Controversy by Edwin Hubble: Proof that Other Galaxies Do Exist (middle of p.453 – end of section 16-6)
WEEK 15	36	April 15	The Hubble Classification of Galaxy Types: Ellipticals, Spirals, Barred-Spirals, and Irregulars; Do Galaxies Evolve from one Shape to Another? Stellar contents of Different Galaxies; Distance Methods for other Galaxies; Evidence for the Expansion of the Universe: The Hubble Law; Mass Estimates of Galaxies; Clusters of Galaxies: The Local Group (pp. 473 – top of p.488)
	E3	**April 17**	**Midterm Exam III (Wed.) in SLH 100**
	37	April 19	Superclusters of Galaxies: The Local Supercluster; The Missing Mass; Abnormal Galaxies; Peculiar Galaxies, Radio Galaxies; Seyfert Galaxies; Active Galaxies: N Galaxies, Blazars, and Quasars; Gravitational Lenses; Cosmology: The Nature of the Universe (top of p.488 – end of chapter 17 on p.508)
WEEK 16	38	April 22	Key 20th Century Cosmological Ideas; Expanding, Relativistic Models of the Universe; Spacetime can be closed, flat, or open; Einstein's Static Model of the Universe; The Cosmological Constant: Einstein's Greatest Blunder or Not? The Steady-State Theory; What is Expanding? Spontaneous Pair Production; Grand Unification Theories; The Big Bang Model of the Universe (cont.); The Chronology of the Big Bang: The Planck Epoch; the Grand Unification Epoch; (p.512 – end of section 18-4)
	39	April 24	The Inflationary Epoch; The Quark Soup; the Big Freeze Out; The Opaque Era; The Recombination Era; The Evidence that a Big Bang Actually Occurred: the Cosmic Microwave Background Radiation; The Grand Structure of the Universe (sections 18-5 and 18-6)
	40	April 26	Cold Dark Matter Models; Top-Down vs. Bottom-Up Models; Hidden Dimensions of Spacetime; The Hubble Time and the Age of the Universe; What Model Universe De We Live In? What Will the Future of the Universe Be Like: Will We Expand Forever or Will We Fall into the Big Scrunch? (section 18-7 through end of chapter 18)
Final Exam			**Monday, May 6, 2024, 2:00-4:00 p.m.** (in SLH 100)