Astronomy 151

Course Objectives

The following is a list of topics that the student is expected to master. This list is grouped according to topics and not necessarily by chapter. The sub list for each chapter is fairly inclusive, but is not necessarily complete.

Astronomy and the Heavens

1. Be able to describe the scientific method.
2. Know the difference between a hypothesis and a theory.
3. Know what bodies the solar system comprises.
4. Understand the basic process that powers the Sun and other stars.
5. Understand how astronomers use angles to measure the size and position of objects in the sky.
6. Understand and be able to use powers-of-ten notation.
7. Know the units used to measure astronomical distances.
8. Know the basic units of the SI system.
9. Appreciate how the study of astronomy has led to practical applications here on Earth as well as expanding our knowledge of the universe and its origins.

Knowing the Heavens

1. Appreciate the role that astronomy played in ancient civilizations and the fact that some ancient astronomical concepts are still used in modern astronomy.
2. Know what constellations are, both the traditional and modern definitions.
3. Understand why the appearance of the sky changes over the course of a night.
4. Understand why the appearance of the sky changes from night to night.
5. Be able to describe the celestial sphere and its parts.
6. Understand how and why the sky looks different at different latitudes.
7. Understand what causes seasons and why they are opposite in the northern and southern hemispheres.
8. Be able to explain the precession of the Earth and how it causes changes in our view of the night sky.
9. Know Earth's tropics and circles and their significance.
10. Understand the different definitions for the day and which one is used.
11. Know the difference between sidereal and synodic months and years.
12. Be able to explain why there are leap years.
13.
Gravitation and the Waltz of the Planets

1. Be able to explain what is meant by retrograde motion.
2. Understand the difference between geocentric and heliocentric models of planetary motions.
3. Be able to explain the Ptolemaic system and what it attempted to describe.
4. Understand how the Copernican heliocentric system better explains our observations of the planets.
5. Know how Tycho Brahe revolutionized the practice of astronomy.
6. Know Kepler's three laws and be able to explain them.
7. Understand how Galileo's telescopic observations supported a heliocentric model.
8. Know Newton's three laws of motion and be able to give examples of each.
10. Be able to explain how Newton's laws of motion and gravity explain the motions of the planets.
11. Understand tidal forces and the origin of the tides.

Eclipses and the Motion of the Moon

1. Understand why the Moon goes through phases.
2. Understand the Moon's rotation and why we always see the same face of the Moon.
3. Be able to explain the difference between a sidereal month and a synodic (or lunar) month.
4. Know why solar and lunar eclipses do not happen every month.
5. Be able to describe what happens during total, partial, and penumbral lunar eclipses.
6. Be able to describe what happens during total, partial, and annular solar eclipses.
7. Understand the methods Greek astronomers used to calculate the size of the Earth and distances to the Sun and Moon.
8. Be able to explain the long term relationship between the Moon and the Earth.

The Nature of Light

1. Know the speed of light and how it was determined.
2. Understand the dual nature of light (as particles and as waves).
3. Be able to describe the types of radiation that make up the electromagnetic spectrum.
4. Understand why a dense object emits electromagnetic radiation according to its temperature.
5. Know the three temperature scales in common use and the relationships among them.
6. Be able to define blackbody and blackbody curve.
7. Know Wien's law and the Stefan-Boltzmann law and how they are used.
8. Understand what spectral lines are and how they are used to identify chemical substances.
10. Be able to explain Rutherford's model of the atom.
11. Know what the periodic table is and be able to explain what isotopes are.
12. Be able to describe the Balmer series, Lyman series, and Paschen series of the spectral lines of hydrogen.
13. Know what an energy-level diagram is.
14. Be able to explain the Doppler effect.
Optics and Telescopes

1. Be able to describe how a refracting telescope works.
2. Understand the advantages and disadvantages of refracting telescopes.
3. Know the difference between magnification and light-gathering power.
4. Know what chromatic aberration is and how it is corrected.
5. Be able to describe how a reflecting telescope works.
6. Understand the advantages and disadvantages of reflecting telescopes.
7. Know what spherical aberration is and how it is corrected.
8. Be able to describe the difference between reflecting and refracting telescopes.
9. Know what light pollution is and be able to describe the methods used to overcome it.
10. Be able to explain what a charge-coupled device (CCD) is and why it's superior to photographic film.
11. Understand how a spectrograph works.
12. Know what a radio telescope is and the kind of information it provides.
13. Understand why we place telescopes in orbit.
14. Understand what is meant by resolving power.

Comparative Planetology 1: Our Solar System

1. Be able to describe the differences between the inner terrestrial planets and the outer Jovian planets.
2. Know the seven large satellites in our solar system and which planets they orbit.
3. Understand how spectroscopy is used to reveal the chemical composition of the planets' atmospheres and solid surfaces.
4. Know the differences in composition between the terrestrial and Jovian planets.
5. Understand how temperature affects the atmospheres and surfaces of the planets.
6. Know what asteroids, comets, and Kuiper belt objects are and where they are found in the solar system.
7. Understand what astronomers learn from the number of craters on a terrestrial world's surface.
8. Be able to explain what a planet's magnetic field tells us about its internal structure.
Comparative Planetology II: The Origin of Our Solar System

1. Know which elements are most abundant in the solar system (and in the universe as a whole) and why.
2. Know what the solar nebula is and how it formed.
3. Understand the role of gravity and heat in transforming the solar nebula into the protosun and protoplanetary disk.
4. Understand the principle of conservation of angular momentum.
5. Be able to explain the role of condensation temperature in formation of the planets.
6. Understand how collisions of dust grains and pebbles accreted into planetesimals, planetesimals into protoplanets, and protoplanets into planets.
7. Be able to describe two competing models for the origin of the Jovian planets.
8. Be able to explain the process of chemical differentiation.
9. Know what the solar wind is.
10. Be able to describe the astrometric method and the radial velocity method for detecting planets orbiting other stars.
11. Know the general characteristics of the extrasolar planets discovered so far.
12. Know what a brown dwarf is.

The Living Earth

1. Appreciate the many factors that make Earth unique in the solar system.
2. Know the three basic types of rocks and how they form.
3. Be able to describe the various types of waves that are produced by earthquakes.
4. Understand how the study of earthquakes has revealed Earth's interior structure and be able to describe that structure.
5. Know the major points of the theory of plate tectonics.
6. Be able to describe the various types of interactions occurring between plates.
7. Understand the role of plate tectonics in shaping Earth's surface.
8. Be able to describe the chemical composition, structure, and behavior of Earth's atmosphere.
9. Be able to describe Earth's magnetic field and magnetosphere.
10. Understand some of the effects of human population on the Earth's biosphere and atmosphere.

Our Barren Moon

1. Be able to describe the surface of the Moon.
2. Know what libration is and how it relates to the Moon's orbit around the Earth.
3. Be able to explain how craters, maria, and highlands formed on the Moon.
4. Know the major manned missions to the Moon and what they accomplished.
5. Be able to describe what we know about the Moon's chemical composition and internal structure.
6. Understand the Moon's role in producing tides on Earth.
7. Know the major kinds of rocks found on the Moon.
8. Be able to describe how scientists determine the ages of lunar rocks.
9. Understand the collisional ejection theory of the Moon's creation.
10. Know the general outlines of the Moon's geological history.

**Sun-Scorched Mercury**

1. Understand why Earth-based optical observations of Mercury are difficult.
2. Know the times when Mercury can best be seen from Earth.
3. Be able to describe the history of how Mercury's rotation and orbit came to be known accurately.
4. Understand why there is such a tremendous difference between daytime and nighttime temperatures on Mercury.
5. Be able to describe Mercury's surface.
6. Understand the similarities and differences between Mercury's surface and that of the Moon.
7. Be able to describe Mercury's internal structure.
8. Know the theories that have been advanced to explain Mercury's high iron content.
9. Be able to describe Mercury's magnetosphere.

**Cloud-Covered Venus**

1. Understand why Venus appears featureless through Earth-based telescopes.
2. Know the configurations in which Venus can be seen as a morning star and as an evening star.
3. Be able to describe Venus's rotation, how astronomers determined it, and why it is important.
4. Understand how the greenhouse effect works on Venus.
5. Know the composition of Venus's atmosphere.
6. Be able to describe the circulation patterns of Venus's atmosphere.
7. Be able to describe Venus's ionosphere.
8. Understand why sulfur and sulfur compounds are found in abundance in the atmosphere of Venus.
9. Be able to describe volcanism and volcanic structures found on Venus.
10. Understand how and why Venus's atmosphere evolved differently from Earth's.
11. Know the major features of the surface of Venus.
12. Be able to explain why Venus lacks plate tectonics.
13. Be able to describe a theory to account for the uniform density of craters over the entire surface of Venus.
Red Planet Mars

1. Understand the configurations under which Mars is best observed from Earth.
2. Be able to describe the history of observations of Mars and speculations about it.
3. Know what kinds of surface features unmanned spacecraft found on Mars.
4. Understand the differences between craters found on Mars and those found on the Moon.
5. Be able to explain the similarities and differences among volcanoes found on Mars, Earth, and Venus.
6. Be able to describe the evidence that water once flowed on Mars.
7. Know the composition of Mars's atmosphere.
8. Be able to explain how the atmospheres of Mars and the Earth evolved differently.
9. Be able to describe the key scientific findings from recent missions to Mars.
10. Understand seasonal variations on Mars.
11. Be able to describe the Martian moons.

Jupiter and Saturn: Lords of the Planets

1. Know the best configurations for observing Jupiter and Saturn from the Earth.
2. Be able to describe how the rotation of Jupiter and Saturn is different from that of the Earth.
3. Understand the similarities and differences in the atmospheric compositions of Jupiter and Saturn.
4. Know what causes the circulation patterns of the atmospheres of Jupiter and Saturn.
5. Understand why Jupiter and Saturn emit more energy than they receive from the Sun.
6. Be able to explain the nature of belts and zones in Jupiter and Saturn's atmospheres.
7. Know what the Galileo Probe discovered about Jupiter's atmosphere.
8. Understand the evidence that Jupiter and Saturn have rocky cores.
9. Know what produces the magnetic fields of Jupiter and Saturn.
10. Be able to describe Jupiter and Saturn's magnetospheres.
11. Know when Saturn's rings are best seen from Earth.
12. Be able to describe the composition, structure, and origin of the Saturnian ring system.
13. Know the differences between the rings of Jupiter and of Saturn.
14. Understand how Saturn's satellites affect the structure of the planet's rings.
Jupiter and Saturn’s Satellites of Fire and Ice

1. Understand the special relationship among the orbits of the Galilean satellites around Jupiter.
2. Be able to explain how data returned by spacecraft have allowed us to determine the sizes, masses, and densities of the Galilean satellites very accurately.
3. Understand how the Galilean satellites probably formed.
4. Be able to describe the surface of Io.
5. Understand how volcanism on Io differs from that on Earth.
6. Be able to explain the effects of Jupiter's magnetic field on Io.
7. Be able to describe the surface of Europa and the evidence for liquid water below the surface.
8. Be able to describe the surfaces of Ganymede and Callisto and the evidence for geologic activity on these satellites.
9. Know the probable internal structures of the Galilean satellites.
10. Understand the nature of the atmosphere and surface of Saturn's satellite Titan.
11. Be able to describe the key properties of Jupiter's smaller satellites.
12. Understand the key attributes of Saturn's six moderate-sized satellites (Mimas, Enceladus, Tethys, Dione, Rhea, and Iapetus).

The Outer Worlds

1. Know how Uranus and Neptune came to be discovered.
2. Be able to explain what is unusual about Uranus's rotation.
3. Be able to describe the similarities and differences of the atmospheres of Uranus and Neptune.
4. Know the compositions of Uranus and Neptune and how they differ from those of Jupiter and Saturn.
5. Understand why planetary scientists find it challenging to explain how Uranus and Neptune formed.
6. Be able to describe the magnetic fields of Uranus and Neptune.
7. Be able to describe the ring systems of Uranus and Neptune and how they were discovered.
8. Be able to describe Uranus's system of satellites.
9. Understand what is unique about Miranda's surface and how scientists explain its unusual features.
10. Be able to describe Neptune's system of satellites.
11. Be able to describe Triton's surface and orbit.
12. Understand current thinking about Triton's history of tectonic activity.
13. Know how Pluto and Charon were discovered.
14. Be able to describe what is known about the surfaces, compositions, and orbits of Pluto and Charon.
15. Understand why scientists think there are many Pluto-like objects in the Kuiper belt.
Vagabonds of the Solar System

1. Know how the asteroids were discovered.
2. Understand why the asteroids, rather than a planet, formed between Mars and Jupiter.
3. Know what happens when an asteroid collides with another asteroid or the Earth.
4. Understand the possible role of an asteroid collision with Earth in the extinction of the dinosaurs and other species 65 million years ago.
5. Know the differences among a meteor, a meteoroid, and a meteorite.
6. Know how meteorites are classified.
7. Understand the evidence from meteorites that a nearby supernova may have triggered the formation of the solar system 4.56 billion years ago.
8. Be able to describe a comet, its structure, and its orbit.
9. Know where short-period and long-period comets are thought to originate.
10. Understand the relationship between comets and meteor showers.

The Search for Extraterrestrial Life

1. Know the evidence that organic molecules—the chemical building blocks of life—exist throughout space.
2. Be able to describe the classic Miller-Urey experiment and what it suggests about the origin of life.
3. Understand why scientists think that life could possibly have evolved on Mars or on Europa.
4. Be able to discuss the meteoric evidence for ancient microbial life on Mars.
5. Understand what the Drake equation is and how scientists use it.
6. Understand how astronomers are attempting to detect signals from extraterrestrial civilizations.
7. Know about proposed projects to search for Earthlike planets around other stars.