



Conceptual Astronomy - Unit 1 - Interpreting Starlight

Unit Focus

In this unit, students will explore the idea of how the universe may have formed. Students will learn about light and its composition as well as how it can be used to identify, explain, and predict movements of celestial objects in our galaxy and beyond. Additionally, students will learn how the tools in astronomy and advances in technology are used to acquire information about distant celestial objects and their movements. Working both independently and with their peers, students will utilize essential skills such as mathematics, reading for information, critical thinking, and problem-solving to enhance their understanding.

Stage 1: Desired Results - Key Understandings

Standard(s)	Transfer	
<p>Next Generation Science Standards Performance Expectations: High School Physical Sciences</p> <ul style="list-style-type: none"> Use mathematical representations to support a claim regarding relationships among the frequency, wavelength, and speed of waves traveling in various media. (HS-PS4-1) <p>Performance Expectations: High School Earth and Space Sciences</p> <ul style="list-style-type: none"> Develop a model based on evidence to illustrate the life span of the sun and the role of nuclear fusion in the sun's core to release energy that eventually reaches Earth in the form of radiation. (HS-ESS1-1) Communicate scientific ideas about the way stars, over their life cycle, produce elements. (HS-ESS1-3) <p>Disciplinary Core Ideas: High School</p> <ul style="list-style-type: none"> The study of stars' light spectra and brightness is used to identify compositional elements of stars, their movements, and their distances from Earth. (HSESS1-2),(HS-ESS1-3) (HS.ESS1.A.2) Other than the hydrogen and helium formed at the time of the Big Bang, nuclear fusion within stars produces all atomic nuclei lighter than and including iron, and the process releases electromagnetic energy. Heavier elements are produced when certain massive stars achieve a supernova stage and explode. (HS-ESS1-2), (HS-ESS1-3) (HS.ESS1.A.4) Nuclear Fusion processes in the center of the sun release the energy that ultimately reaches Earth as radiation. (secondary to HS-ESS1-1) (HS.PS3.D.1) 	<p><i>Students will be able to independently use their learning to...</i></p> <p>T1 Use the scientific process to generate evidence that addresses the original questions.</p> <p>T2 Analyze qualitative and quantitative data to interpret patterns, draw conclusions, and/or make predictions.</p>	
	Meaning	
	Understanding(s)	Essential Question(s)
<p><i>Students will understand that...</i></p> <p>U1 The distance of a celestial object from the earth can be determined by its movements.</p> <p>U2 Some forms of energy, including light are carried from one place to another by waves.</p> <p>U3 The luminosity of celestial objects are influenced by various factors.</p> <p>U4 The composition, temperature, and movement of celestial objects can be inferred from the light they emit.</p> <p>U5 All stars are the result of a balance of forces: the force of gravity compresses atoms in interstellar gas until the fusion reactions begin.</p> <p>U6 Different forces dominate at different scales: gravity shapes orbits and largescale structure; electromagnetism governs light, spectra, and plasma behavior; nuclear forces drive fusion and element formation.</p> <p>U7 Stars are celestial objects that are born, change over time, and eventually die.</p> <p>U8 The origin of the universe is supported by the composition of stars.</p>	<p><i>Students will keep considering...</i></p> <p>Q1 What can scientists learn from the movements of celestial objects?</p> <p>Q2 What can scientists learn from light emitted by celestial objects?</p> <p>Q3 How do the fundamental forces of the universe explain the behavior of celestial objects?</p> <p>Q4 How do stars evolve and contribute to the formation of elements in the universe?</p>	

Stage 1: Desired Results - Key Understandings

Cross Cutting Concepts: High School

- In nuclear processes, atoms are not conserved, but the total number of protons plus neutrons is conserved. (HS-ESS1-3) (HS.SS.CC.2.2)

Next Generation Science Standards (DCI)

Science: 9

- The study of stars' light spectra and brightness is used to identify compositional elements of stars, their movements, and their distances from Earth. (ESS1.9.A2)
- The Big Bang theory is supported by observations of distant galaxies receding from our own, of the measured composition of stars and non-stellar gases, and of the maps of spectra of the primordial radiation (cosmic microwave background) that still fills the universe. (ESS1.9.A3)
- Other than the hydrogen and helium formed at the time of the Big Bang, nuclear fusion within stars produces all atomic nuclei lighter than and including iron, and the process releases electromagnetic energy. Heavier elements are produced when certain massive stars achieve a supernova stage and explode. (ESS1.9.A4)
- Nuclear processes, including fusion, fission, and radioactive decays of unstable nuclei, involve release or absorption of energy. The total number of neutrons plus protons does not change in any nuclear process. (PS1.9.C1)
- Forces at a distance are explained by fields (gravitational, electric, and magnetic) permeating space that can transfer energy through space. Magnets or electric currents cause magnetic fields; electric charges or changing magnetic fields cause electric fields. (PS2.9.B3)
- Nuclear Fusion processes in the center of the sun release the energy that ultimately reaches Earth as radiation. (PS3.9.D4)
- Electromagnetic radiation (e.g., radio, microwaves, light) can be modeled as a wave of changing electric and magnetic fields or as particles called photons. The wave model is useful for explaining many features of electromagnetic radiation, and the particle model explains other features. (PS4.9.B1)
- Atoms of each element emit and absorb characteristic frequencies of light. These characteristics allow identification of the presence of an element, even in microscopic quantities. (PS4.9.B2)

Acquisition of Knowledge and Skill

Knowledge

Students will know...

- K1** The luminosity of an object depends on its temperature, size, and distance from the observer.
- K2** Indirect evidence is observed when something affects something we can observe.
- K3** The distance of celestial objects can be determined by measuring its parallax.
- K4** The electromagnetic spectrum is the entire distribution of electromagnetic radiation according to frequency or wavelength.
- K5** Visible light is made of various colors, each with a different wavelength along the electromagnetic spectrum
- K6** By examining light emitted by celestial objects with a spectroscope, astronomers can identify their composition based upon their spectra.
- K7** Astronomers analyze changes in a celestial object's spectrum over time, called the Doppler Effect, to learn about their movement.
- K8** A star is type of celestial object consisting of a plasma held together by the force of gravity.
- K9** A star is born when atoms are squeezed under enough pressure for their nuclei to undergo thermonuclear fusion.
- K10** Stars are born from giant clouds of gas and dust, from which they mature, age, and eventually die.
- K11** Stars differ from one another in mass, size, composition, temperature, and distance from Earth.
- K12** Constellations are patterns of stars or other celestial bodies that emit light, whereas galaxies are natural groupings of stars held together by the force of gravity.
- K13** The origin of the universe is explained by the big bang model.
- K14** Vocabulary: Absolute magnitude, Apparent magnitude, Astronomical unit, Binary star, Black dwarf, Black hole, Blue shift, Cepheid variable, Constellations, Circumpolar, Continuous Spectrum, Distance modulus, Doppler effect, Electromagnetic radiation,

Skill(s)

Students will be skilled at...

- S1** Apply the concept of parallax, Doppler effect, and spectroscopy through modeling and laboratory investigations to infer the relative distance, movements, and composition of celestial objects from earth.
- S2** Use a model, such as the H-R diagram, to explain the relationship between a star's mass, temperature, and luminosity, and to communicate how these factors indicate the star's stage of evolution and nucleosynthesis processes.
- S3** Construct a model that can communicate scientific ideas about the way stars, over their life, produce elements through a process known as nucleosynthesis.
- S4** Explain the relationship between the earth and sun alignment, and the patterns of stars observed from Earth.

Stage 1: Desired Results - Key Understandings

Madison Public Schools Profile of a Graduate

- Analyzing: Examining information/data/ evidence from multiple sources to identify possible underlying assumptions, patterns, and relationships in order to make inferences. (POG.1.2)
- Product Creation: Effectively use a medium to communicate important information. (POG.3.2)

Electromagnetic spectrum, Emission Spectrum, Galaxy, HR diagram, Light year, Luminosity, Main sequence, Nebula, Neutron star, Nova, Parallax, Parsec, Protostar, Pulsar, Quasar, Red shift, Supernova, White dwarf