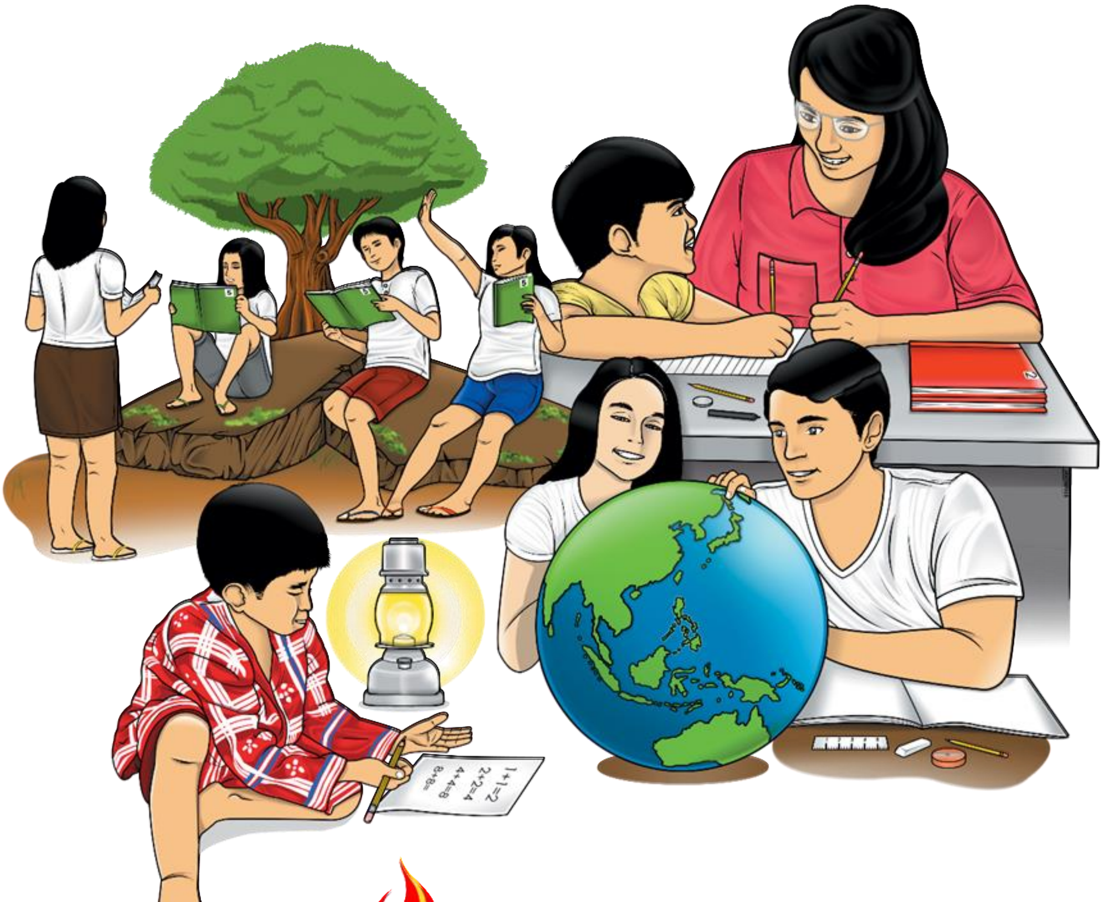
Senior High School

DepED
DEPARTMENT OF EDUCATION

Physical Science
Quarter 2 – Module 8:
Expanding Universe



ALTERNATIVE DELIVERY MODE
ADM

Physical Science
Alternative Delivery Mode
Quarter 2 – Module 8: Expanding Universe
First Edition, 2020

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Senior High School

Physical Science

Quarter 2 – Module 8:
Expanding Universe

Introductory Message

For the facilitator:

Welcome to the Physical Science 11/12 Alternative Delivery Mode (ADM) Module on Expanding Universe!

This module was collaboratively designed, developed, and reviewed by educators to assist you, the teacher or facilitator in helping the learners meet the standards set by the K to 12 Curriculum while overcoming their personal, social, and economic constraints in schooling.

This learning resource hopes to engage the learners in guided and independent learning activities at their own pace and time. Furthermore, this also aims to help learners acquire the needed 21st century skills while taking into consideration their needs and circumstances.

In addition to the material in the main text, you will also see this box in the body of the module:

Notes to the Teacher

This contains helpful tips or strategies that will help you in guiding the learners.

As a facilitator, you are expected to orient the learners on how to use this module. You also need to keep track of the learners' progress while allowing them to manage their learning. Furthermore, you are expected to encourage and assist the learners as they do the tasks included in the module.

For the learner:

Welcome to the Physical Science 11/12 Alternative Delivery Mode (ADM) Module on Expanding Universe!

Our hands are the most symbolized part of the human body. It is often used to depict skill, action, and purpose. Through our hands we may learn, create, and accomplish. Hence, the hand in this learning resource signifies that you as a learner is capable and empowered to successfully achieve the relevant competencies and skills at your own pace and time. Your academic success lies in your own hands!

This module was designed to provide you with fun and meaningful opportunities for guided and independent learning at your own pace and time. You will be able to process the contents of the learning resource while being an active learner.

This module has the following parts and corresponding icons:

What I Need to Know	This will give you an idea of the skills or competencies you are expected to learn in the module.
What I Know	This part includes an activity that aims to check what you already know about the lesson. If you get all the answers correct (100%), you may decide to skip this module.
What's In	This is a brief drill or review to help you link the current lesson with the previous one.
What's New	In this portion, the new lesson will be introduced to you in various ways such as a story, a song, a poem, a problem opener, an activity or a situation.
What is It	This section provides a brief discussion of the lesson. This aims to help you discover and understand new concepts and skills.
What's More	This comprises activities for independent practice to solidify your understanding and skills of the topic. You may check the answers to the exercises using the Answer Key at the end of the module.
What I Have Learned	This includes questions or blank sentences/paragraphs to be filled in to process what you learned from the lesson.
What I Can Do	This section provides an activity that will help you transfer your new knowledge or skill into real - life situations or concerns.

Assessment

This is a task which aims to evaluate your level of mastery in achieving the learning competency.

Additional Activities

In this portion, another activity will be given to you to enrich your knowledge or skill of the lesson learned. This also tends retention of learned concepts.

Answer Key

This contains answers to all activities in the module.

At the end of this module you will also find:

References

This is a list of all sources used in developing this module.

The following are some reminders in using this module:

1. Use the module with care. Do not put unnecessary mark/s on any part of the module. Use a separate sheet of paper in answering the exercises.
2. Do not forget to answer *What I Know* before moving on to the other activities included in the module.
3. Read the instruction carefully before doing each task.
4. Observe honesty and integrity in doing the tasks and in checking your answers.
5. Finish the task at hand before proceeding to the next.
6. Return this module to your teacher/facilitator once you are through with it.

If you encounter any difficulty in answering the tasks in this module, do not hesitate to consult your teacher or facilitator. Always bear in mind that you are not alone.

We hope that through this material, you will experience meaningful learning and gain a deep understanding of the relevant competencies. You can do it!

What I Need to Know

This module will help you understand the evolution and expansion of the universe through approximation of distance and movement of stars and galaxies. This module will provide you with discussions and learning activities designed to be easily understood.

CONTENT STANDARD: The learners demonstrate an understanding of Relativity and the Big Bang.

PERFORMANCE STANDARD: The learners should be able to create a video presentation that details the impact of the Theory of Relativity to human.

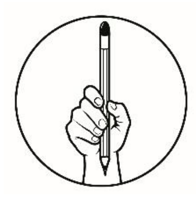
LEARNING COMPETENCIES: The learners must explain how the speeds and distances of far-off objects are estimated (e.g., Doppler Effect and Cosmic Distance Ladder) and explain how we know that we live in an expanding universe which used to be hot and is approximately 14 billion years old.

CODE: **S11/12PS-IVj-72-73**

- Lesson 1 – Astrometry and Cosmology

After going through this module, you are expected to:

1. Explain the different ways in which the speed and distance of celestial objects are estimated; and
2. Explain the various pieces of evidence for the theory of an expanding universe.



What I Know

DIRECTIONS: Read each question carefully. Choose the letter of the best answer. Write your answer on a separate sheet of paper.

1. What is a light-year?
   A. The distance travelled by light in one year (365 ¼ days)
   B. The distance travelled by light in a leap year (366 years)
   C. The time required for light to cover 1 AU of distance travelled
   D. The time required for light to make a round trip from a nearby star

2. What is the approximate age of the universe?
   A. 14 million years
   B. 14 billion years
   C. 4.5 million years
   D. 4.5 billion years

3. What is an Astronomical Unit (AU)?
   A. It is the average spacing of the planets.
   B. It is the average distance of the earth from the Sun.
   C. It is the average distance of the earth from the moon.
   D. It is the average distance of the Sun from the nearest Star.

4. What is a parallax?
   A. An imaginary parallel line of reference when viewing distant stars.
   B. A unit of measurement of the displacement of celestial objects due to atmospheric factors.
   C. An apparent displacement of the observed position of objects viewed from different lines of sight.
   D. A pulsing of light emitted by stars that are at least 1200 Light-years away from the Solar System.

5. Which part of the spectrum does the Starlight show a shift in wavelength?
   A. Infrared ends of the EM Spectrum
   B. Red light ends of the visible spectrum
   C. Blue light ends of the visible spectrum
   D. Ultraviolet-ray ends of the EM spectrum

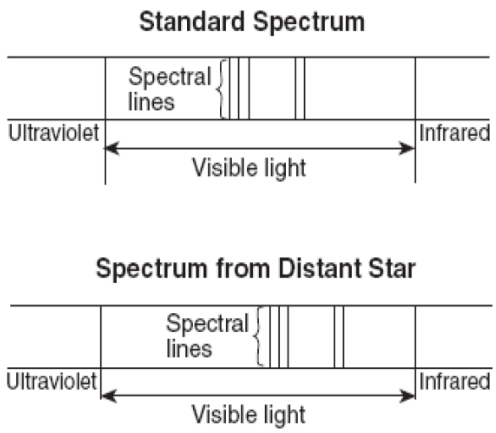
6. Which is **TRUE** about the movement of galaxies observed from earth?
   A. Far galaxies tend to move faster towards observers on earth.
   B. Far galaxies tend to move slower towards observers on earth.
   C. Far galaxies tend to move faster away from observers on earth.
   D. Far galaxies tend to move slower away from observers on earth.

7. What do red-shifted lights mean?
   A. The source is slowing down.

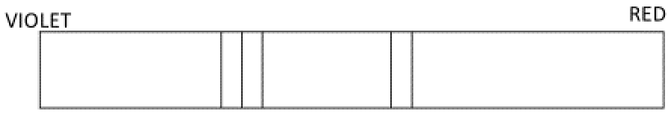
B. The source is moving towards the observer.
C. The source is moving away from the observer.
D. The source is moving perpendicular to the observer.

8. What does the redshifted light from a distant galaxy tell about the universe?
A. It indicates that the universe is shrinking.
B. It indicates that the universe is expanding.
C. It indicates that the universe is not shrinking nor expanding.
D. It indicates that the universe is shrinking and expanding in cycles.

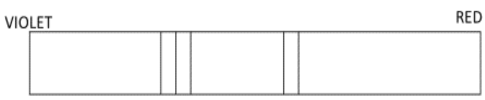
9. The diagram on the right shows the comparison between the standard spectrum of an element and a spectrum produced by a distant star. What conclusion can be drawn from this?
A. The distant star collapsed.
B. The distant star is approaching the earth.
C. The distant star is moving away from the earth.
D. The distant star is following an elliptical movement.

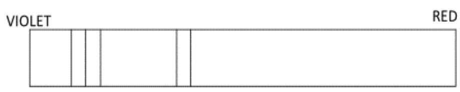


10. The figure below shows the spectral lines from an element in a laboratory.



Which diagram best illustrates the spectral lines when the light is observed from a distant star moving away from the earth?

A.


C.


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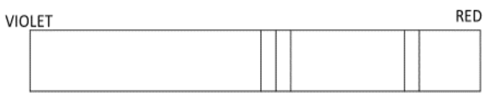

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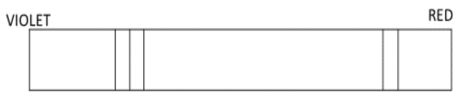


Lesson 1

Astrometry and Cosmology


Photo Credits: Alexis Gapal

On a trip to Lobo, Batangas in 2017, a photography enthusiast tried to take a shot of the Milky Way Galaxy, where our Solar System is located. After several tries, his efforts paid off and the result is this magnificent unedited photo of the galactic core of the Milky Way.

When we look at the night sky, especially during star gazing activities, we would normally wonder how far are the stars from earth.

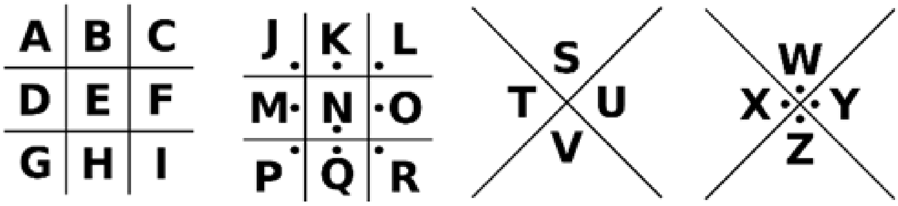
Our universe is not static. It has been evolving for billions of years from the time of the Big Bang. As time progresses, the matter was produced from the very small quarks, atoms, and elements to very large such as planets, stars, and galaxies. These galaxies move relative to each other and hence, change their position as observed here on earth. But how do scientists know that these stars and galaxies are moving?

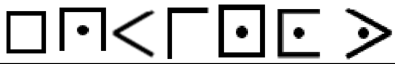
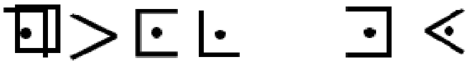
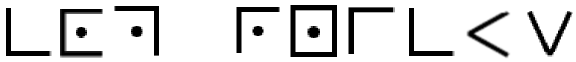
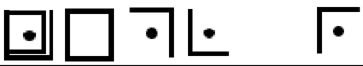
Cosmology is the branch of astronomy that deals with the origin and evolution of the universe. Astrometry on the other hand is the branch of astronomy involved in the measurement of distances and motion of celestial bodies. These two branches are related.

This module will help you understand how scientists were able to approximate the distances and movement of stars and galaxies in our universe. This material will also help you recognize the different pieces of evidence to prove that our universe is expanding since it was hypothesized to have existed 13.8 billion years ago.

What's In

In the previous modules, you were introduced to the contributions of various scientists in the development of early astronomical concepts. As a review, use the Pigpen cipher below to decode the words listed in the table. Choose from the options below the corresponding description of the decoded words. Write your answer in alphabetical order.



Words for Decoding	Decoded Words	Description
		
		
		
		
		

Description Options:

A. He is credited for formulating the laws of Planetary Motion.
B. It happens during March and September when the length of daylight and nighttime are approximately equal.
C. He published a revolutionary paper contradicting the widely accepted Earth-centered model of the Solar System.
D. The two days in a year in which the Sun is at the farthest declination (north or south) from the celestial equator.
E. He is an advocate of the Geocentric or Earth-Centered model of the Solar System.

What's New

First few steps of the Cosmic Distance Ladder

Even without the aid of sophisticated tools, early scientists were able to make many meaningful approximate measurements in astronomy. By observing the circular arc-shaped shadow casted by the earth on the moon during lunar eclipse, and the shape of the phases of the moon, **Aristotle** (384-322 BCE), was able to tell that *the earth and the moon is spherical.* **Eratosthenes** (276-194 BCE) used geometry with a lot of observation to calculate the radius of the earth which is accurate within 8% of the actual radius of the earth. **Aristarchus** (310 – 230 BCE) was also responsible for making the first documented measurement of the distance of the Moon from the Earth, as well as , the approximate radius of the moon. Aristarchus was also credited for his approximation of the size of the sun which also lead him to propose that the earth revolves around the sun, rather than the sun revolving around the earth (which was the long standing belief). Among these discoveries, it is important to note that the succeeding measurements and approximations were done by using data obtained from previous observations. Such that measurements for the moon were obtained by using measurements made for the earth, and measurements for the sun were obtained using measurements from the moon and the earth.

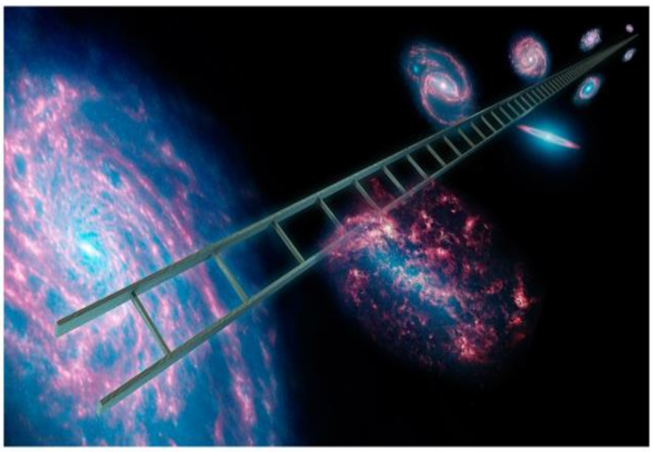


Figure 1. Artists conception of Cosmic Distance Ladder
From: https://images.app.goo.gl/NsDdEr4AQXKKEVgM7

The **Cosmic Distance Ladder** is a series of successive methods used by astronomers to determine the distances of distant celestial bodies such as stars and galaxies. In this method, one rung or step of the ladder correspond to a process done to measure certain ranges of distances, to which information gathered in this step can be use to obtain approximate measurements of the next higher rung.

The measurements done on earth during the time of the early Greeks served as the first foundations of the cosmic distance ladder. With the development of modern astronomy, more sophisticated devices and methods yielded more accurate measurements on the earth's size. Scientists used the term **Astronomical Unit (AU)** – the average distance of the Earth from the Sun which is now measured to be $\mathbf{1.498\,x\,10^{8}\,km}$. Originally, this value was obtained by careful observations of the transit of Venus across the sun as its backdraft. Now, more accurate measurements are made using *telemetry* - the process of recording and transmitting readings of a network of instruments.

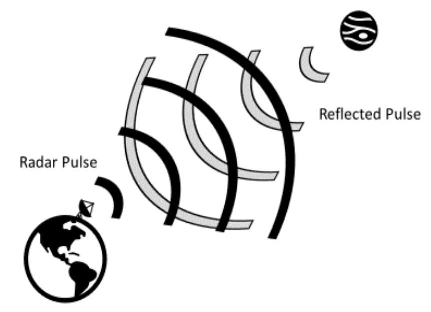


Figure 2: Radar Ranging
Artwork: A.G. Cabic

In considering measurements of distances within the solar system, **Radar Ranging** is used. As depicted in figure 2, Radar pulses in the form of EM waves will be sent from earth towards the target celestial object. This pulse will be reflected from the target celestial object to the earth. The time of the reflected pulse to be detected back on earth will be recorded to calculate the approximate distance of the target celestial object. Radar ranging serves as the *first rung or step* in our cosmic distance ladder. This is used to determine the distance of objects in the Solar System.

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What is It

Going Beyond the Solar System

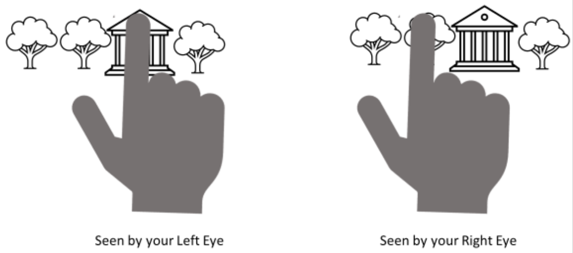

Figure 3: Demonstrating Parallax
Artwork: A.G. Cabic

The next rung in the Cosmic Distance Ladder is the use of **Parallax** – the apparent displacement or difference in the apparent position of an object viewed along two different lines of sight. This can be demonstrated in Figure 3. Extend your arm and look at your finger with a distant background, with one of your eyes closed. You will notice that when you focus at your finger (closer object of interest) while having a distant object as background, the image of your finger appears to shift positions relative to the background when you use only one eye alternately. This apparent "shift" in the position of the object of interest is due to the change in the position of the observer (your right and left eye respectively).

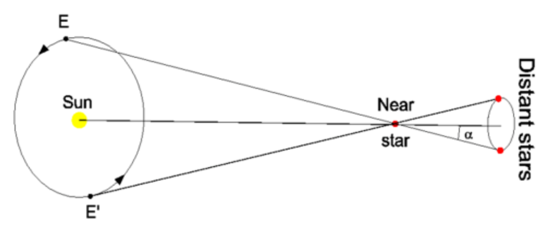

Figure 4: Using Parallax to Measure distance
Image from:
https://images.app.goo.gl/D677gK84BSiwgeV26

As applied to astrometry, astronomers use *trigonometric parallax* to calculate the distance of a relatively nearby celestial object such as a nearby star (other than the sun). This is done by comparing observations of a nearby star that are taken six months apart. The nearby star appears to be displaced against the background of farther stars because the observations were taken from two opposite points of Earth's orbit around the sun. Figure 4 shows how this is done. Upon careful analysis, you will notice that nearby objects tend to have greater "shifting" or parallax, while more distant objects tend to have smaller "displacements".

When using parallax, the units of measurement commonly used is **light-year,** the distance travelled by light in one Julian Year (365 ¼ days) and **parsec**, the distance of which the mean radius of the earth's orbit subtends an angle of one second of arc. One light-year is $9.46\ x\ 10^{12} km$ while 1 parsec is equivalent to 3.26 light-years. Trigonometric parallax can only be accurate for distances less than 100 parsecs. There are also other kinds of parallaxes, however, these are not as accurate as the trigonometric parallax. For distances greater than 100 parsecs to 10,000 parsecs (halfway across the Milky Way), it requires combination of such parallaxes to make more accurate measurements.

Standard Candles and Cepheid Variable Stars

Fig. 5: Street lamp lights in Puerto Princesa, Palawan
Image source: https://web.archive.org/web/20161024200642/http://www.panoramio.com/photo/87990544

With the development of techniques in measuring stellar brightness, approximating distances of stars in the Milky Way Galaxy relied on **Standard Candles –** objects with known luminosity. In using standard candle methods, it is important to group stars according to their distinct properties such as absolute and apparent magnitude (which in turn is related to the luminosity). The inverse square law can be use to determine the distance of the star from the earth. A good analogy to this is by observing the light emitted by streetlamps at night. Assuming that each lamp is of the same power rating, if one lamp appears ¼ as bright as another, then we can say that the dimmer one is twice as far as the brighter lamp; if the lamp is three times farther, it's expected to be 1/9 as bright as the closer lamp (See Figure 5). The challenge of measuring astronomical distances using standard candles is to find objects that makes the best standard candle such that we can accurately identify its magnitude or luminosity.

Among the standard candles available, the most useful for nearby galaxies are special classes called **Cepheid variable stars or Cepheids.** These stars vary in luminosity alternately appearing to be dim and bright with intervals from a few days to a few months. **Henrietta Leavitt** in 1912 discovered that when Cepheids have longer periods of alternating brightness, the more luminous it become. Combining it with parallax measurements on Cepheids, and data on their apparent brightness, it became possible to calculate its true luminosity and identify the distance from such data. It was also observed that this period of alternating brightness of Cepheids is also related to its size. Larger Cepheids takes longer intervals of alternating brightness. Cepheids can be used to approximate the distance of stars and Galaxies up to 100 million light-years away. Like Cepheids, **White dwarf supernovae** can also be used to measure distances of very far galaxies. This is due to the idea that they all have the same peak luminosity because they originated from the same sizes of main sequence stars.

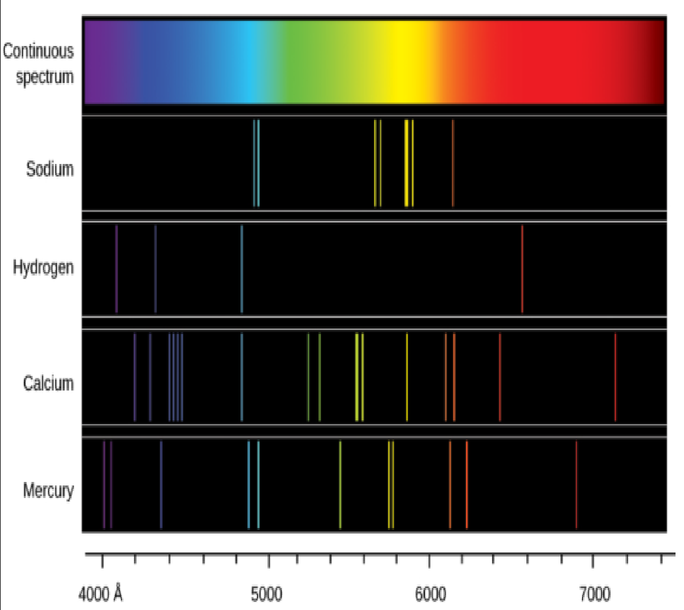

Fig. 6: Continuous Spectrum and Emission lines of various elements
Image source: OpenStax Astronomy 2018 page 164

Through studies done on elements, scientists were able to determine that elements and molecules emit specific kind of absorption and emission lines. Each type of atom and molecule possesses a specific and unique set of energy levels, causing the production of emission and absorption lines appearing in certain wavelengths of the spectra. In a way, these emission and absorption line patterns serve as a form of fingerprint to identify the elemental composition of a material – including stars!

Doppler Effect

You might have experienced hearing the sound of siren from an approaching ambulance or train. You noticed that as the source of sound approaches your location, the sound emitted by the source become louder.. As the source moves away from your location, the sound gradually fades. This is a manifestation of

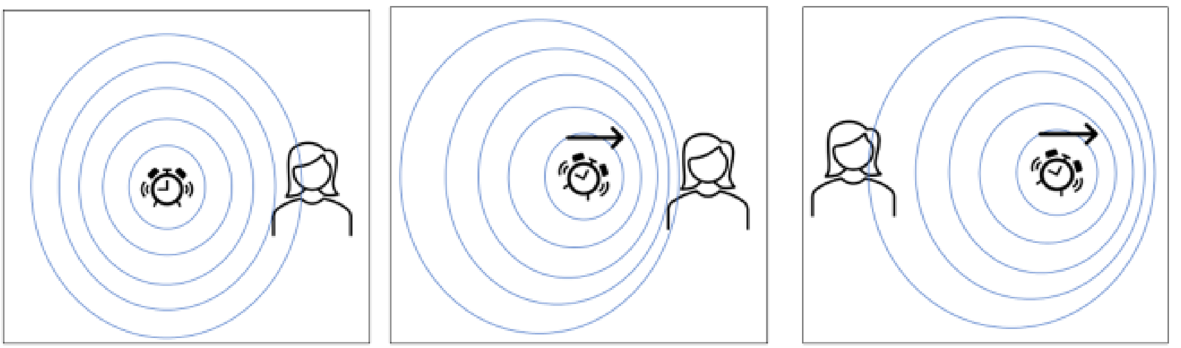
Figure 7. Doppler Effect for Sound.
Artwork: A.G. Cabic

Doppler Effect.

Figure 7 which shows the Doppler effect for sound. (Left) When the source is stationary, the observer would not notice any change in wavelength of the sound waves, thus, no change in frequency and no change in pitch. (Middle) Once the source of sound moves, the region being approached by the source will have more compressed wavelengths of sound, hence, greater frequency and an increase in pitch is observed.(Right) When the source is moving away from the observer, there will be a region where the sound waves are not compressed; hence, longer wavelengths of sound corresponding to a decrease in pitch.

Doppler Effect is also observed in light and when this happens, the wavelength of light from sources such as flashlights, light bulbs or even stars will be affected. Once the wavelength of light is affected, there will be changes in the observed colors of light. When the source of light is moving towards the observer, the observed light turns **Blue shifted** or shifted towards the short wavelength portion of the spectrum. When the source of light is moving away from the observer, the observed light becomes **Red Shifted** or shifted towards the long wavelength portion of the spectrum. As an analogy, the *headlights of cars appear bluish* when the car is approaching you. The *taillight of cars appears reddish* when the car is moving away from you.

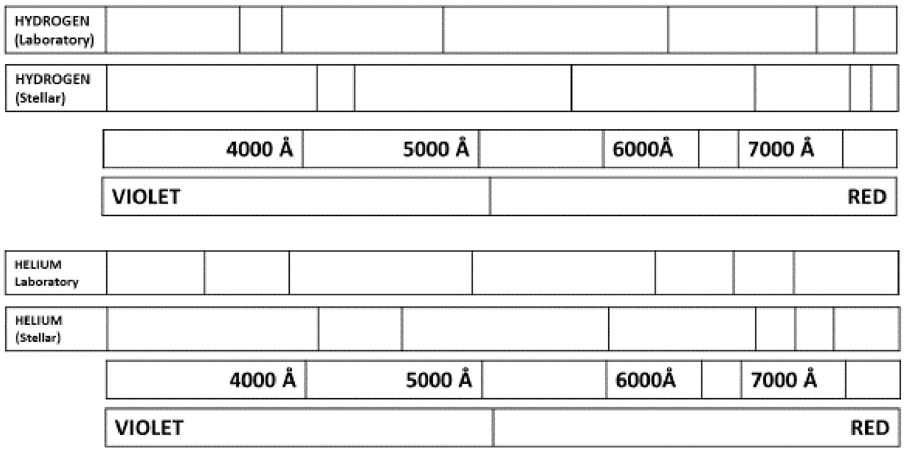

Fig. 8: Shifting of spectral patterns from spectral lines from stars. Notice that it is shifted towards the Long wavelength (Red) end, and thus the term red shift.
Artwork: A. G Cabic

Figure 8 shows a simplified spectral line comparison between a normal spectral line pattern observed in a laboratory and a spectral line pattern from a star. The patterns from stars appears to be shifted to the Red end, and thus Red-Shifted. This indicates that the star being observed is moving away from the observer on earth.

The methods that were discussed enabled scientists to determine two things. First, the continuously expanding measurements of distances from the closest neighbors in the solar system to the most distant stars in the outskirts of the Milky way galaxy, as well as other galaxies and galaxy clusters in the universe. Second, the stars, and galaxies are moving as indicated in the Red Shift of light coming from these stars and galaxies. All of these were approximately measured by using the previous rungs or steps in the cosmic distance ladder to arrive at more advanced steps.

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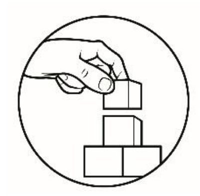


What's More

Hubble's Law and the Expanding Universe

Edwin Hubble's discovery of the Andromeda Galaxy enabled him to study for the Milky Way Galaxy. This made scientists believe that the Milky Way is only a small portion of a larger universe. What is more interesting in Hubble's findings is the fact that as galaxies and stars get farther and farther, it tends to move faster away from the observer. This relationship between the distance of the star or galaxy is observed to its recession speed (speed at which it is moving away) is called **Hubble's Law**. Sometimes, this relationship is also used in reverse. By knowing the recession speed of the galaxy (through redshift calculations), one can approximately determine the distance of a star or a galaxy from the earth. Having observed that galaxies are moving farther, and faster, this led to the well-accepted idea of an **Expanding Universe**. But how do we visualize an expanding universe?

Activity:

1. Put 3 or more dots on a deflated balloon.

2. From the markings, select one reference dot and mark it as 1. Mark the rest of the dots as 2, 3, etc.

3. Use a tape measure to measure the distances between the reference mark and the other markings. Record your measurements.

3. Inflate the balloon and tie its end to maintain its size. Using the reference mark, re-measure the distances of the other markings from the reference. Record your observation and compare it with the measurements when the balloon is deflated.

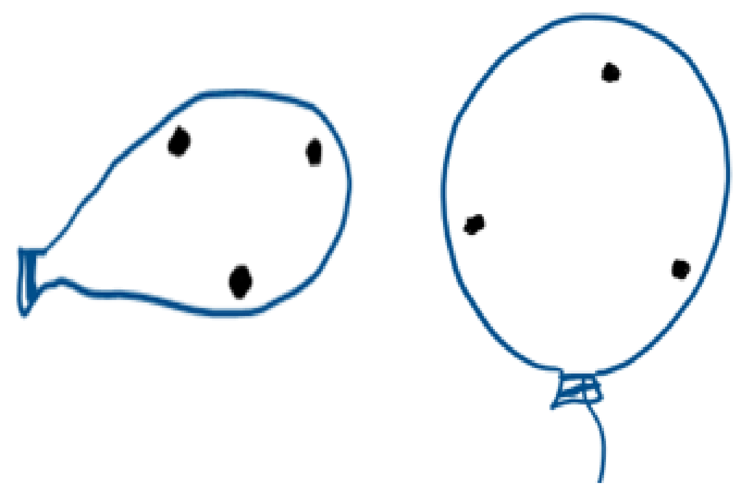


Figure 9. Markings on a deflated balloon (Left) and inflated balloon (Right)
Artwork: A.G. Cabic

Markings	Distance from 1 Deflated Balloon	Distance from 1 (Inflated Balloon)
2		
3		
4		
5		

Guide Questions:

1. What have you observed on the distances of the dots/markings between a deflated balloon and an inflated balloon?
2. What caused the difference in the distances of the markings between a deflated and an inflated balloon?
3. If you will compare the balloon to our universe, with the dots / markings as galaxies or galaxy clusters, what can you say about the distances of the galaxies as continuously expands?

The previous activity simulates how scientists model our expanding universe. This is like a raisin-bread loaf model, shown in Figure 10. Notice that when the bread is still small, the raisins are close to each other. As the bread expands due to more yeast added, the distances between the raisins also increase. The rate at which the raisins move away from each other is proportional to the distance of separation of the raisins. This is the same with the galaxies and galaxy clusters in our known universe. The farther they are from a point of observation, the faster they move away from the observer.

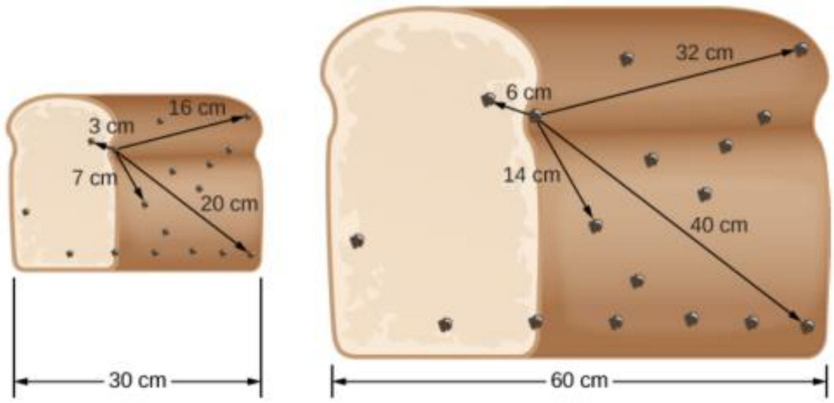


Figure 10. Raisin Loaf bread analogy for an expanding universe
Image source: OpenStax Astronomy 2018 page 958

The concepts discussed in the first part of this module are some of the main arguments that the universe is expanding. But since there are pieces of evidence of its expansion, then it also follows that there should be a description of the state of the universe on its early stages from the beginning. The theory which explains how the universe expanded from a highly dense and hot state is what we call the **Big Bang Theory**. Aside from the observations made by Hubble, the following are other observational evidence of the expansion of the universe:

1. *Cosmic Background Radiation* – in 1964, Arno Penzias and Robert Wilson discovered strange "noises" in their Radio telescope observations. The noises turned out to be the remnants of the original radiation emitted by the expanding universe. Since the universe was initially very dense and very hot prior to its expansion, 14 billion years after, the universe should have cooled down. They measured this background radiation to be 2.75 K.

2. *Ratio of Primordial Elements* – during the early state of the universe, early elements such as hydrogen and helium, fuse to form new elements (Big Bang Nucleosynthesis), the same as how stars generate their energy through thermonuclear fusion. As time progresses, the ratio of elements should be proportional. Astronomers measure the ratios of hydrogen, helium, and other

trace elements. It turned out that the present ratio of elements is in accordance with the predictions made.

3. *Formation of Galaxies* – if the Big Bang is true, then there should be a great number of galaxies and galaxy clusters out there. Continuous discoveries of galaxy formation across the universe and differences in the structure of these galaxies also serve as strong evidence that the Big Bang really exists.

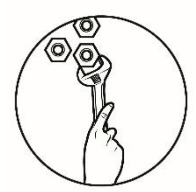
4. *Primordial Gas Clouds*- recently formed galaxies should contain a good mix of light and heavy elements. However, there were discoveries of Gas Clouds that only contain Hydrogen and Deuterium. These primordial gas clouds are said to be remnants of the early universe.

★★★

What I Have Learned

The important concepts discussed in this module are:

- There are ways to estimate the distance and motion of celestial bodies. One way is using the Cosmic Distance Ladder, wherein a series of methods were used in succession to measuring distances of celestial objects.
- Doppler Effect (Red Shifting) in light allows scientists to determine that stars and galaxies are moving away from an observer. Doppler Effect together with Hubble's discoveries was used to introduce the concept of an expanding universe.
- The existence of Cosmic Background Radiation, the proportion of Primordial Elements, the existence of primordial gas clouds, and observational evidence of the structure of recently formed galaxies served as evidence for the Expansion of the Universe from the extremely dense and hot state before the Big Bang. This proved that the universe expanded approximately 14 billion years ago.



What I Can Do

Time traveling is one of the most essential concepts in Science. One cannot travel back in the time given the present innovations and discoveries. According to this line, ***You can look back in time every time you look at the stars,*** do you agree with this? Explain your answer.

It is common knowledge that the universe is expanding. What do you think will be the future of our universe? Do you think there will come a time wherein we will have a more detailed understanding of the known universe?

★★★

Assessment

DIRECTIONS: Read each question carefully. Choose the letter of the best answer. Write your answer on a separate sheet of paper.

1. What is a light-year?
   A. The distance travelled by light in one year (365 ¼ days)
   B. The distance travelled by light in a leap year (366 years)
   C. The time required for light to cover 1 AU of distance travelled
   D. The time required for light to make a round trip from a nearby star

2. What is the approximate age of the universe?
   A. 14 million years
   B. 14 billion years
   C. 4.5 million years
   D. 4.5 billion years
3. What is an Astronomical Unit (AU)?
   A. It is the average spacing of the planets.
   B. It is the average distance of the earth from the Sun.
   C. It is the average distance of the earth from the moon.
   D. It is the average distance of the Sun from the nearest Star.

4. What is a parallax?
   A. An imaginary parallel line of reference when viewing distant stars.
   B. A unit of measurement of the displacement of celestial objects due to atmospheric factors.
   C. An apparent displacement of the observed position of objects viewed from different lines of sight.
   D. A pulsing of light emitted by stars that are at least 1200 Light-years away from the Solar System.

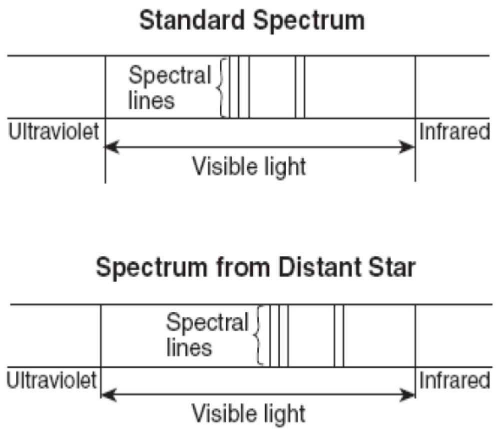
5. Which part of the spectrum does the Starlight show a shift in wavelength?
   A. Infrared end of the EM Spectrum
   B. Red light end of the visible spectrum
   C. Blue light end of the visible spectrum
   D. Ultraviolet-ray end of the EM spectrum

6. Which is **TRUE** about the movement of galaxies observed from earth?
   A. Far galaxies tend to move faster towards observers on earth.
   B. Far galaxies tend to move slower towards observers on earth.
   C. Far galaxies tend to move faster away from observers on earth.
   D. Far galaxies tend to move slower away from observers on earth.

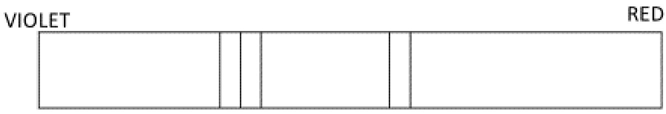
7. What do red shifted lights mean?
   E. The source is slowing down.
   F. The source is moving towards the observer.
   G. The source is moving away from the observer.
   H. The source is moving perpendicular to the observer.

8. What does the redshifted light from a distant galaxy tell about the universe?
   E. It indicates that the universe is shrinking.
   F. It indicates that the universe is expanding.
   G. It indicates that the universe is not shrinking nor expanding.
   H. It indicates that the universe is shrinking and expanding in cycles.

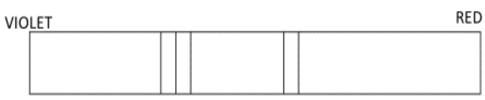
9. The diagram on the right shows the comparison between the standard spectrum of an element and a spectrum produced by a distant star. What conclusion can be drawn from this?
   A. The distant star collapsed.
   B. The distant star is approaching the earth.
   C. The distant star is moving away from the earth.
   D. The distant star is following an elliptical movement.



10. The figure below shows the spectral lines from an element in a laboratory.



Which diagram best illustrates the spectral lines of this element when its light is observed from a distant star moving away from the earth?

A.


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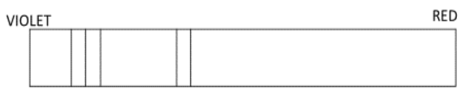
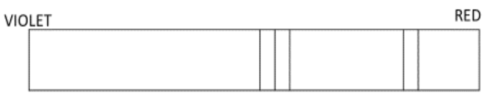
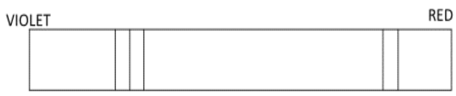


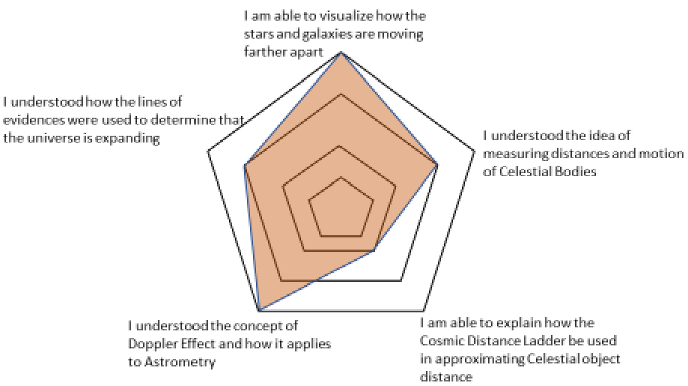
B.


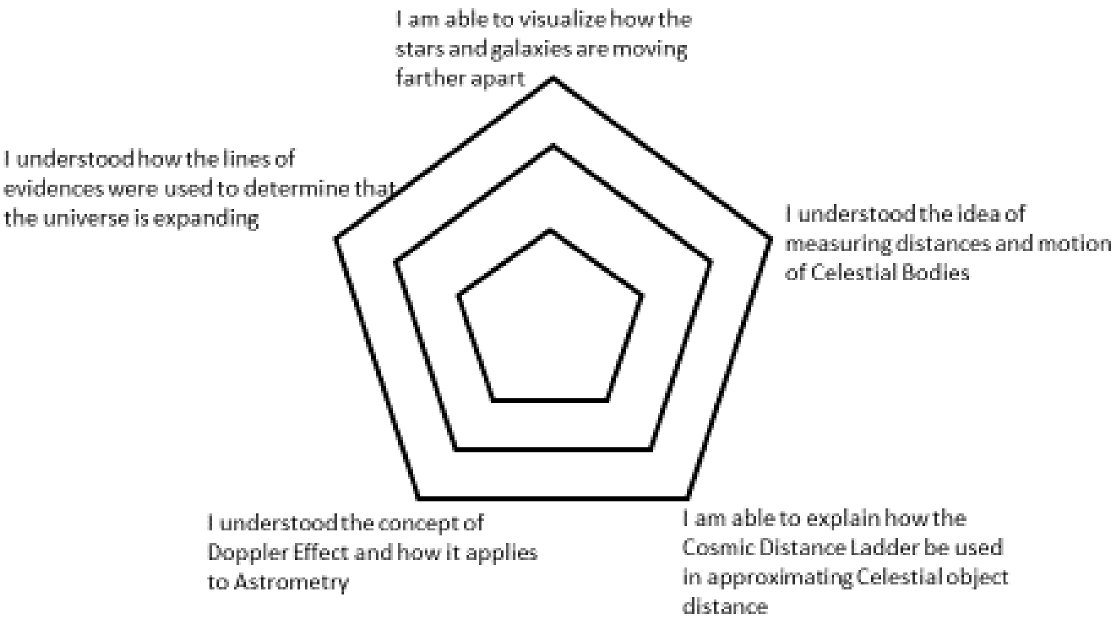
D.


Additional Activities

Directions: Make a personal radar chart based on your evaluation of this module.

SAMPLE





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Answer Key

What I Know

1. A
2. B
3. B
4. C
5. B
6. A
7. C
8. B
9. C
10. B

What's In

1. Equinox
2. Solstice
3. Ptolemy
4. Copernicus
5. Kepler

Assessment

1. A
2. B
3. B
4. C
5. B
6. A
7. C
8. B
9. C
10. B

References:

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Image Sources:

- https://images.app.goo.gl/NsDdEr4AQXKKEVgM7
- https://web.archive.org/web/20161024200642/http://www.panoramio.com/photo/87990544

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