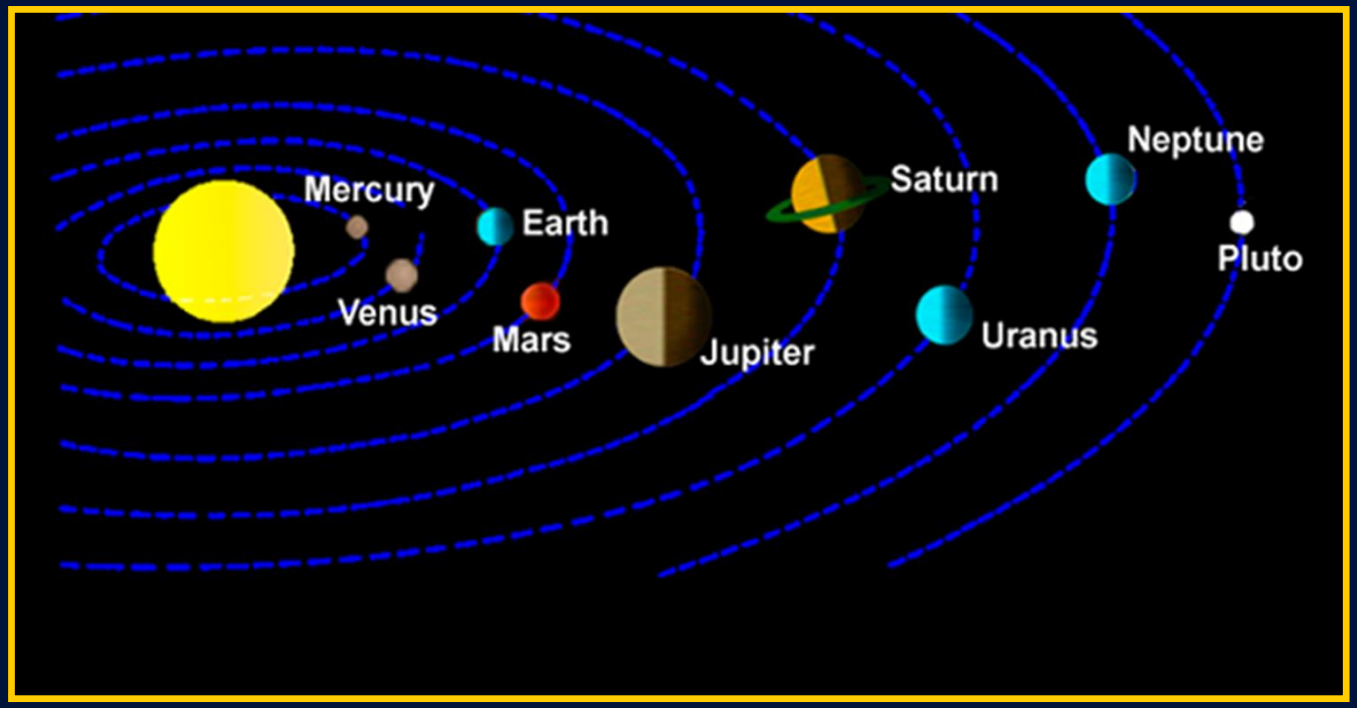
Module 4 – Nautical Science

Unit 4 Overview - Astronomy

(Slides 1-25)

Unit Overview

Astronomy is the study of the universe; in particular, of the stars and other heavenly bodies including their composition, motion, position and size.



Unit Overview

The study of astronomy has led to the discovery of the fundamental laws governing all modern technology that have significantly altered our lives.

Unit Overview

The size of the universe is beyond our comprehension.

Earth-based and space-based telescopes have found one million galaxies in the Big Dipper alone.

Unit Overview

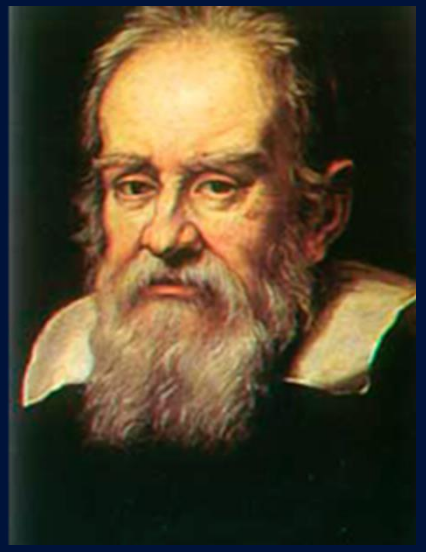
Since ancient people first began to study the world around them, scientists and philosophers have wondered how the Earth and universe came to be.

Tycho Brahe

Nicholas Copernicus

Francis Bacon

Galileo Galilei



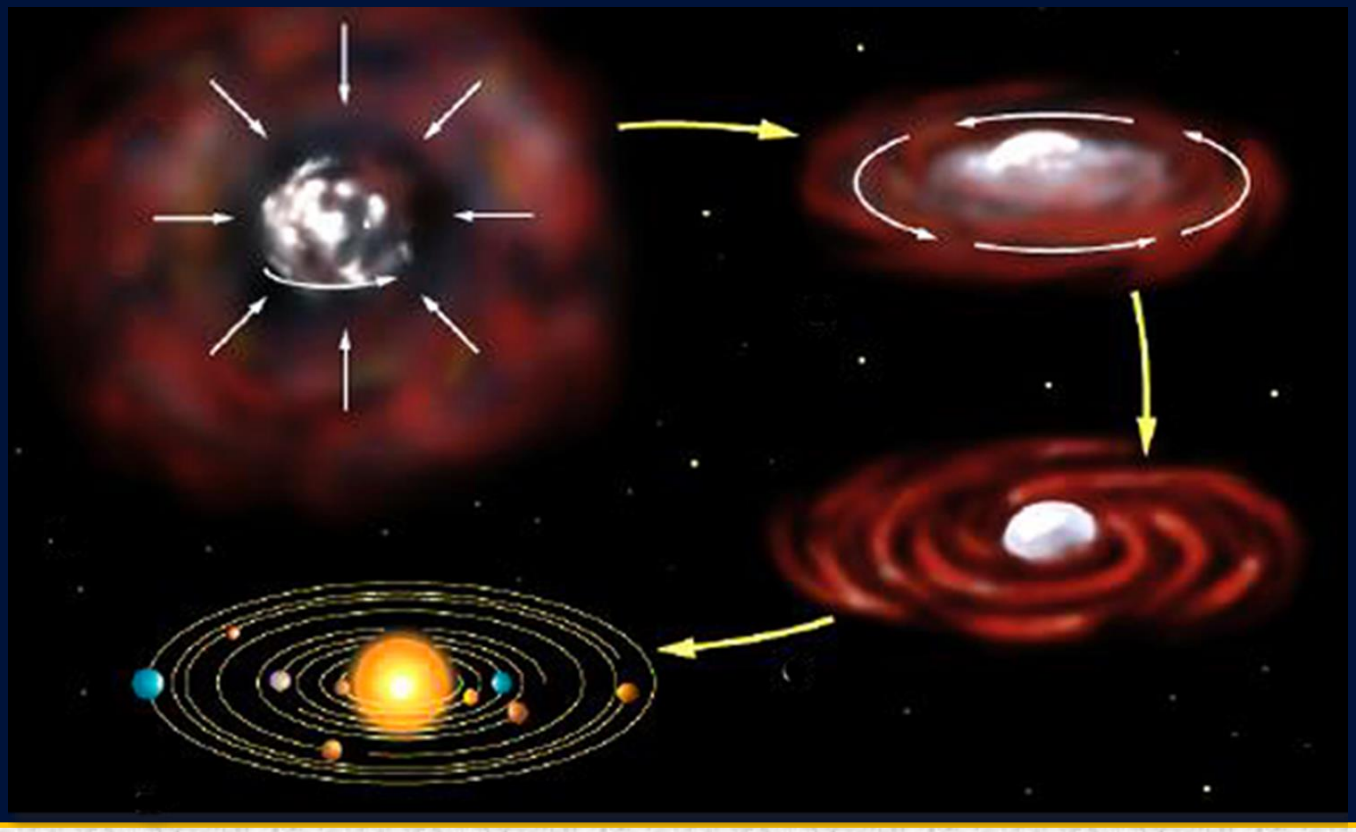
Unit Overview

Although we certainly know more than ancient thinkers did about the origin of things, many questions remain unanswered.

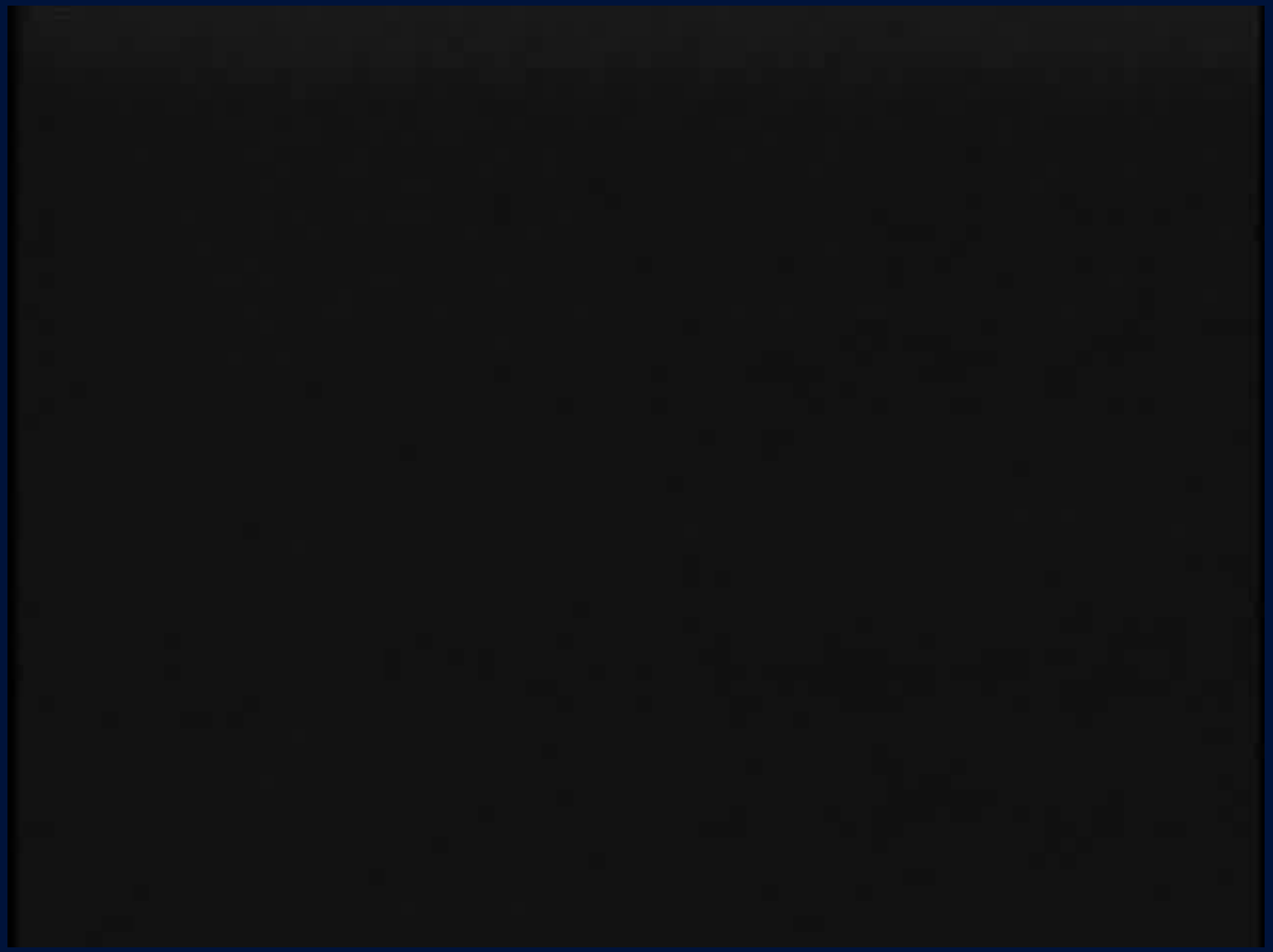
Astronomers and scientists that speculate on the nature of the universe and try to answer these questions are called cosmologists.

Unit Overview

The “Big Bang” or Expanding Universe Theory is explained in the video that follows…



Unit Overview



Unit Overview

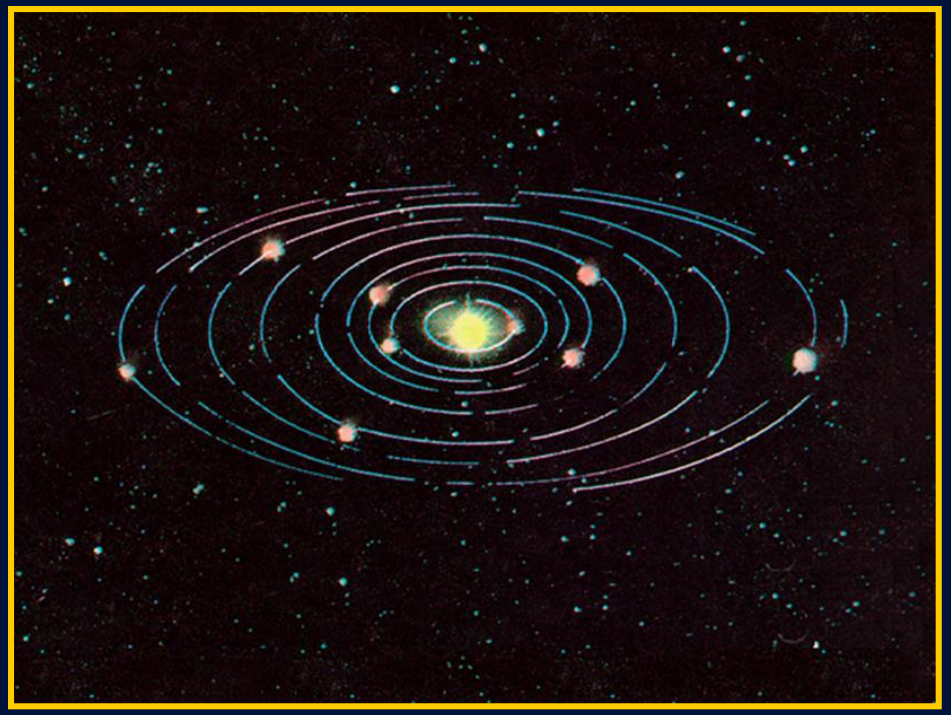
The Big Bang Theory was first proposed by Belgian astronomer Georges Lemaitre in 1927.

He postulated:

- All matter in the universe was originally concentrated in an incredibly dense mass
- Packed inside the mass was all the material of today's universe
- The mass temperature exceeded one hundred trillion degrees

Unit Overview

The Big Bang Theory



Cosmic Gas and Dust Cloud

Formation of Proto-Sun

Forming into a Disk

Formation of Proto-Planets

Today, scientists believe that this expanding motion will never cease, so our universe will continue to expand.

Unit Overview

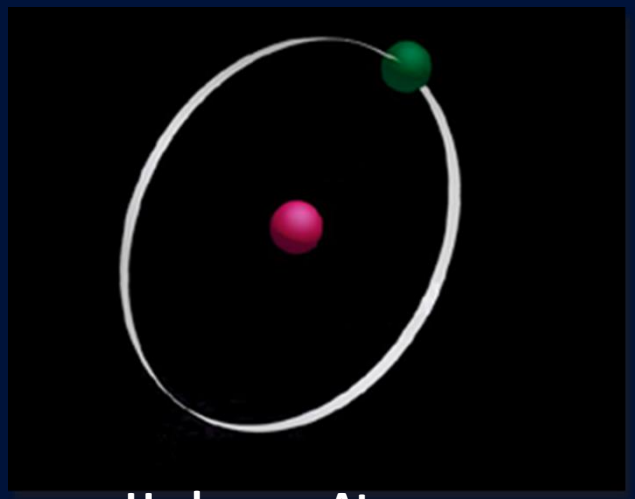
Due to extremely high temperatures, all the matter in this early central core was separated into…

- Protons (Positively charged elementary particles that are a fundamental constituent of all atomic nuclei)
- Neutrons (Particles found in the nucleus of an atom that are almost identical in mass to a proton, but carry no electrical charge)
- Electrons (The lightest stable subatomic particles known which carry a negative charge and are considered the basic charge of electricity)

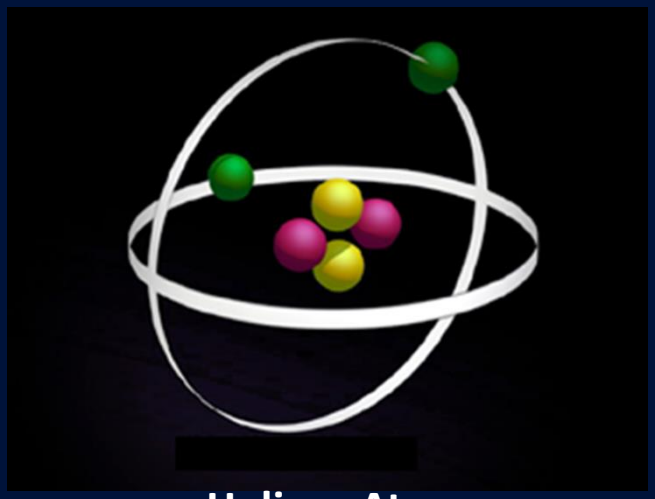
Unit Overview

Just after the explosion, temperatures dropped enough so that the particles could combine.

Slow neutron capture produced more stable elements with low atomic weight.



Hydrogen Atom



Helium Atom

Unit Overview

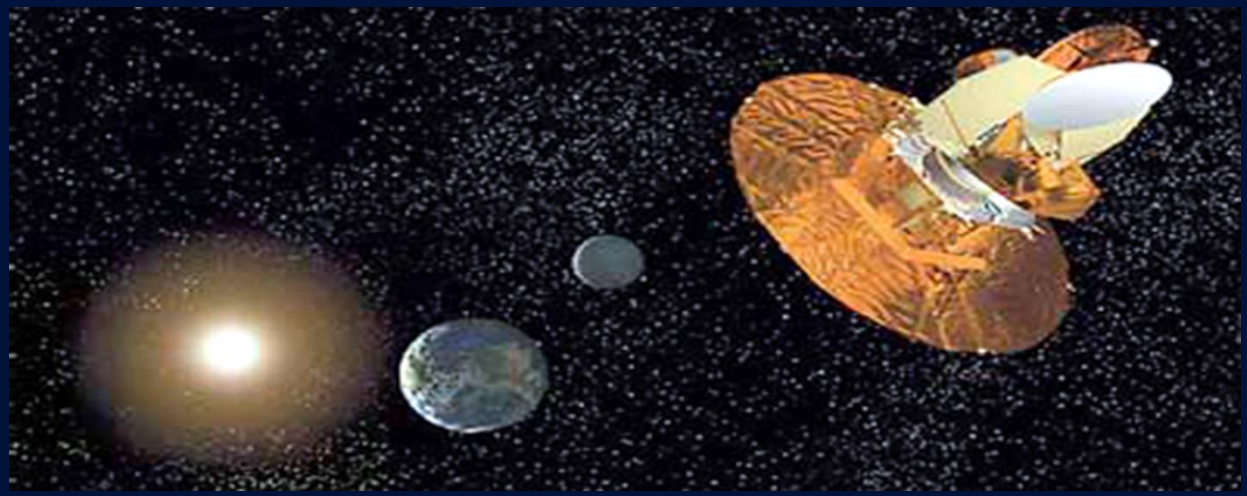
Atomic weight is the average weight of an atom of an element, formerly based on the weight of one hydrogen atom taken as a unit or on 1/16 the weight of an oxygen atom.

After 1961, it was based on 1/12 the weight of the carbon -12 atom.

Unit Overview

In May 1992, scientists verified the existence of slight temperature variations in space that would have resulted from the Big Bang.

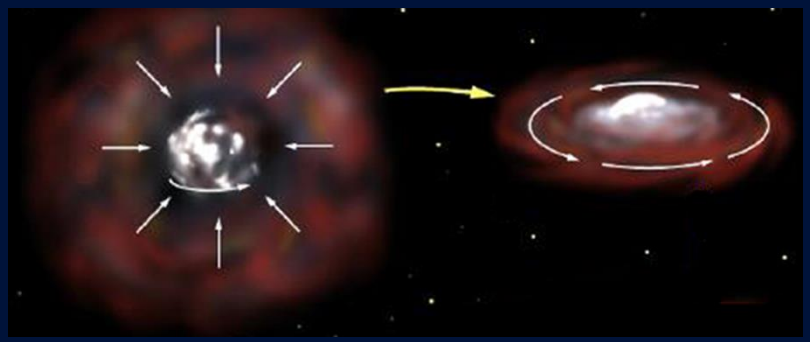
This discovery was based on microwave radiation data gathered by an orbiting Cosmic Background Explorer (COBE) satellite.



Unit Overview

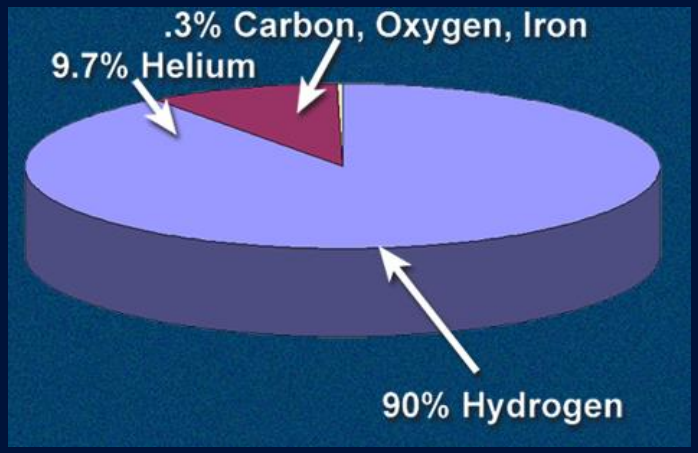
Cosmologists believe:

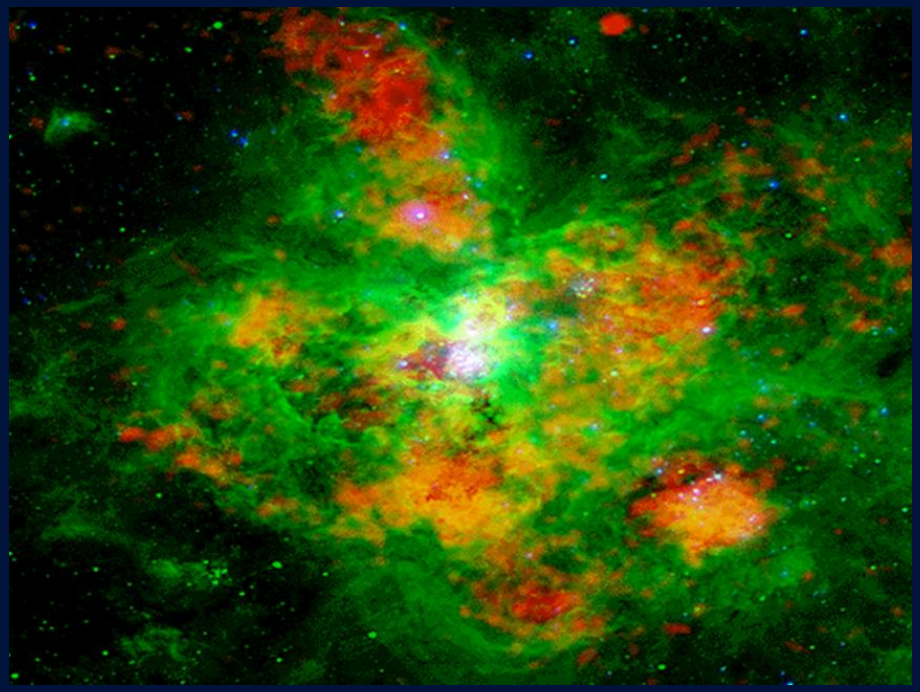
- That what is now our solar system began about 4.5 billion years ago as a large cloud of gas and dust from the Big Bang
- That this cloud contained the “cosmic mix” of molecules found everywhere in the universe



Unit Overview

The cosmic cloud was composed of 90% hydrogen, 9.7% helium and .3% heavier elements such as carbon, oxygen and iron.



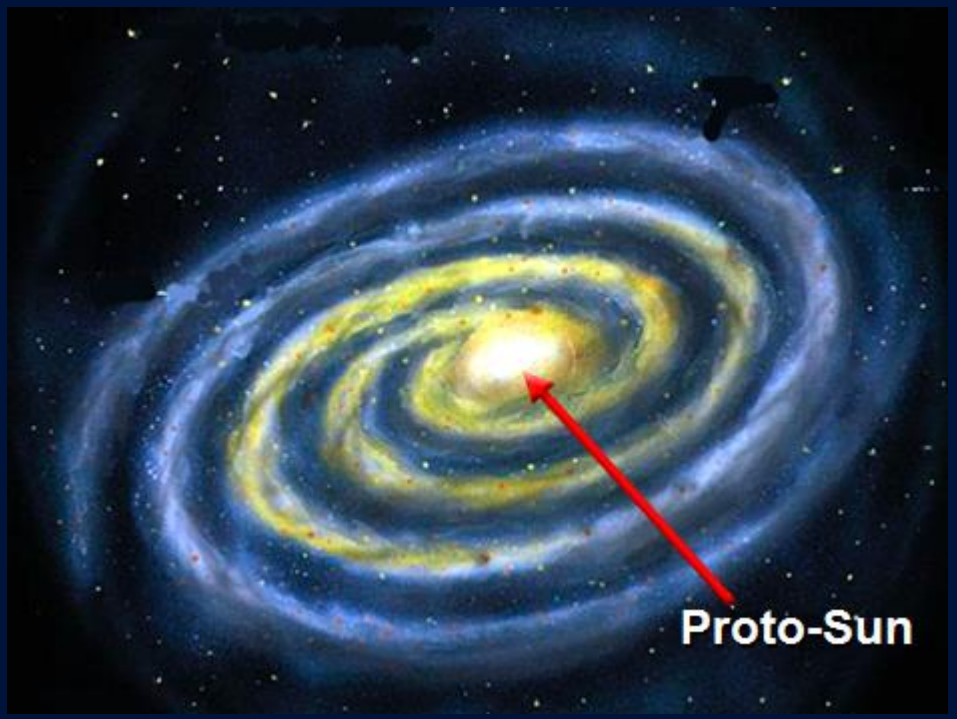


Unit Overview

They also believe that a large eddy at the center contracted more rapidly than the rest of the cloud and formed the "proto-Sun."

Gradually, forces in the spinning cloud flattened it into the shape of an enormous disk.

Unit Overview



Some eddies and swirls were torn apart by collisions, while others were broken up by the increasingly strong gravitational pull of the proto-Sun.

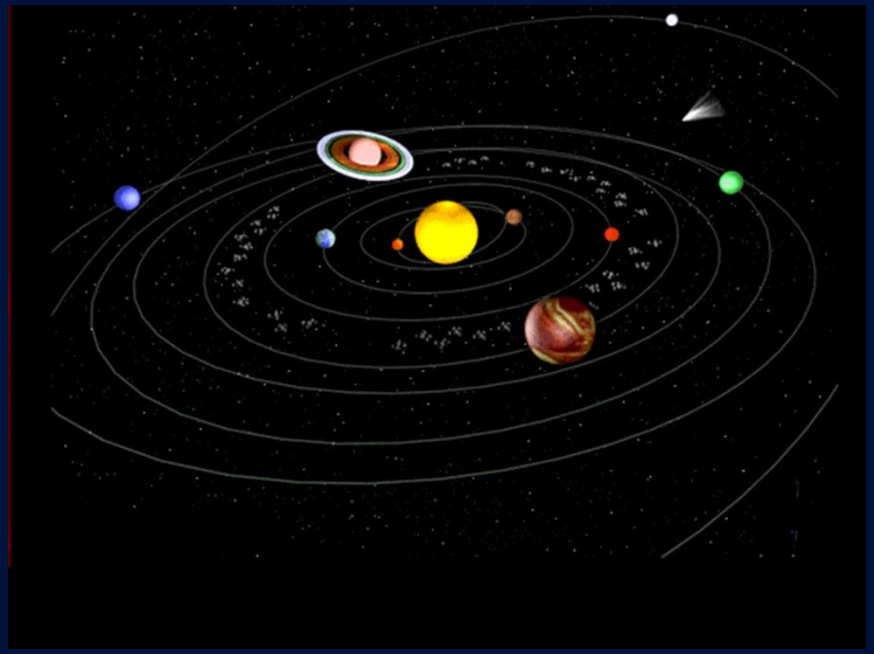
Unit Overview

A number of these swirls of gas became swirling disks large enough to hold together under the strength of their own gravitational fields, creating proto-planets.

Unit Overview

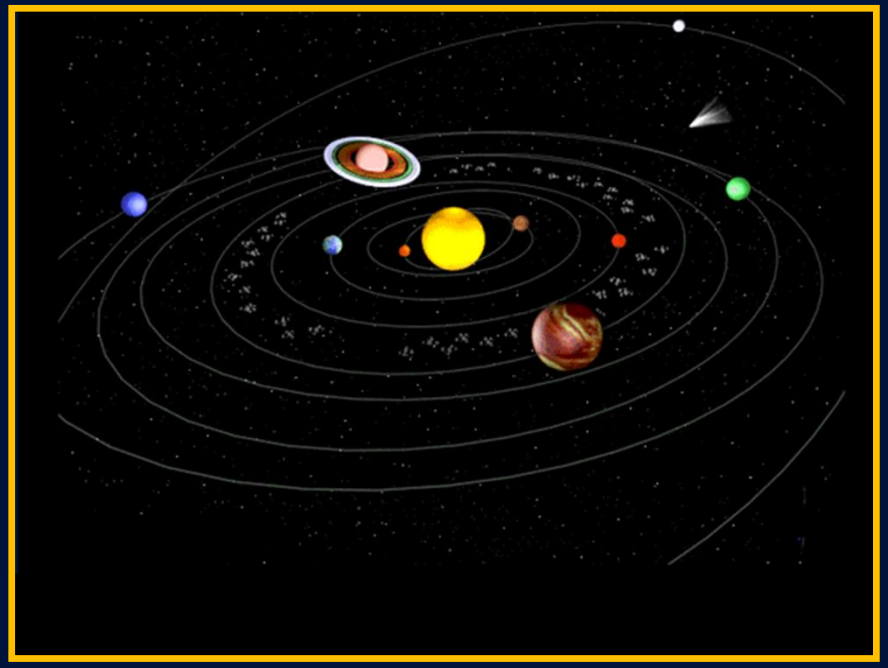
Thermonuclear fusion is the source of the energy that has kept the Sun ablaze ever since creation.

This fusion at the core released large amounts of energy and caused the proto-Sun to shine.



Unit Overview

Due to it being about one hundred times larger in diameter than the largest of the proto-planets, the proto-Sun became a star instead of a planet.



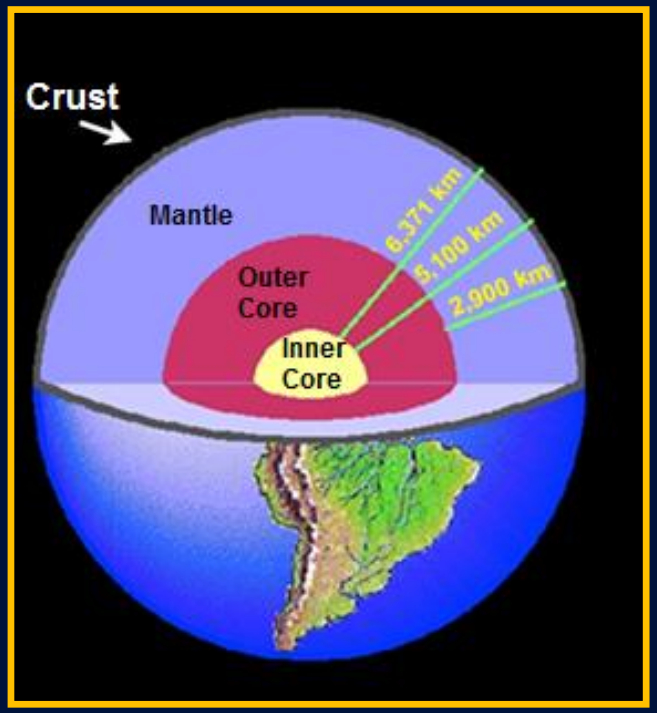
The proto-planets were born as whirling clouds of ice particles and solid fragments (each a cosmic dust storm).

Unit Overview

In time, the Earth began to give off heat.

After millions of years, the high temperatures began to melt materials at the Earth's center.

Iron, nickel, and other heavy metals began to sink, forming the molten core of the planet.



Molten rock outside the core (magma) broke through fissures to the surface.

Unit Overview

Molecules of hydrogen, water vapor and other gases escaped, creating an atmosphere above the planet's surface.

The oceans were formed when the water vapor released into the atmosphere began to condense and precipitate.

Unit Overview

Lighter gases, especially hydrogen, did not stay in the atmosphere long.

They left behind a high concentration of the heavier, rare elements of the universe…elements essential for the formation of rocks, plans and our own bodies.

Unit Overview

The undisputed theory of the creation of the universe and solar system has yet to be positively determined.

Module 3 – Nautical Science

Unit 4 – Astronomy

Chapter 12 - Astronomical Observations

Section 1 – Telescopes

What You Will Learn to Do

Demonstrate an understanding of astronomy and how it pertains to our solar system and its related bodies: Moon, Sun, stars and planets

Objectives

1. Explain the theories of the creation of the universe
2. List the methods for astronomical observation
3. Describe the methods for using the telescope
4. Identify the types of telescopes

Key Terms

CPS Key Term
Questions 1 - 4

Key Terms

Observatory -	A place equipped with powerful telescopes used for making observations of astronomical, meteorological or other phenomena
Refracting Telescope -	Consists of an objective lens set into one end of a tube and an adjustable eyepiece or combination of lenses set into the other end of a tube that slides into the first through which the enlarged object is viewed

Key Terms

CCD Camera -	A special electronic digital camera; charge-coupled device; capable of very high resolution of hundreds of megapixels
Reflecting Telescope -	Has a concave mirror that gathers light from the object and focuses it into an adjustable eyepiece or combination of lenses through which the reflection of the object is enlarged and viewed

Opening Question

What is an observatory, and describe what it is used for?

1.

2.

3.

(Use CPS “Pick a Student” for this question.)

Warm Up Questions

CPS Lesson
Questions 1 - 2

Introduction

Until the twentieth century, observations of the heavens were made visually from the Earth's surface, either with the naked eye or with a telescope.

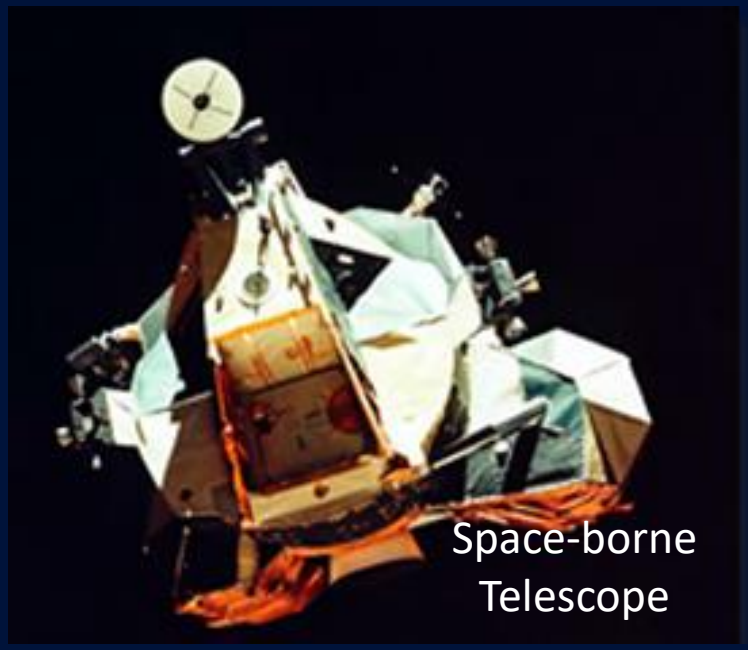
The Telescope

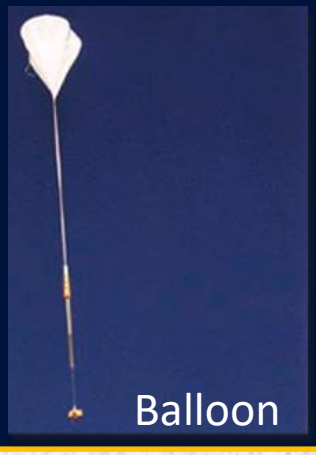
Telescope:
An optical instrument for making distant objects appear larger and therefore nearer.

The Telescope

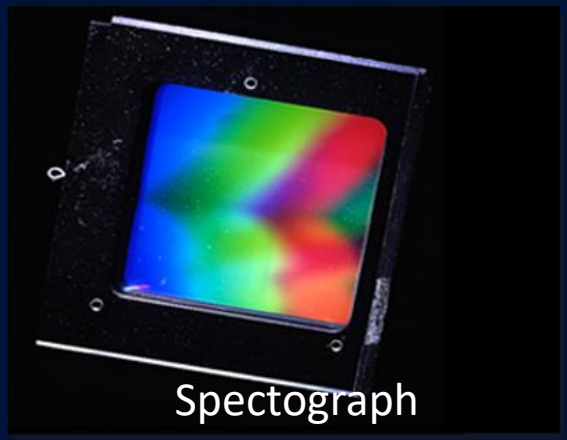
The Telescope

Twentieth-century technology has provided far better methods of observation of the heavens.


Space-borne Telescope


Balloon


Radiotelescope


Spectograph

Check On Learning Questions

CPS Lesson

Question

3 - 4

The Telescope

There are many types of optical telescopes, from those a few inches in diameter to computer-driven aiming machinery found in observatories.

The Telescope

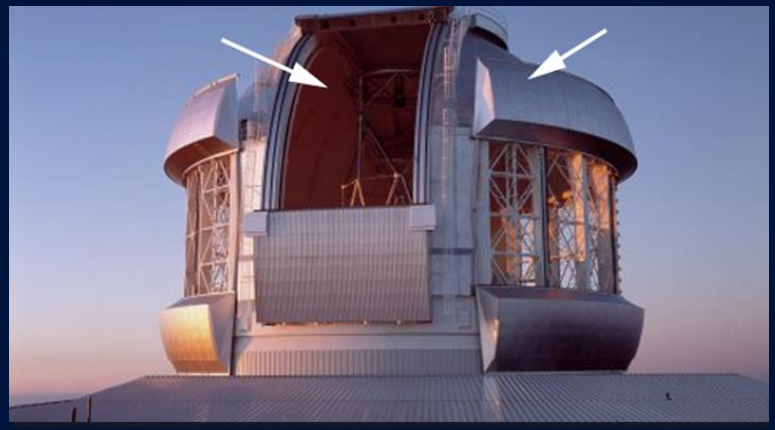
Professional astronomers use observatories to make most of their observations by means of time-exposure photography, rather than visual sighting.

Normal observatory working hours are at night. Observatories are ideally built on mountaintops where the weather affords a maximum number of clear nights with “steady atmosphere.”

The Telescope

The distinguishing feature of an observatory is its great revolving dome that turns to point the telescope at stars or planets anywhere in the sky.

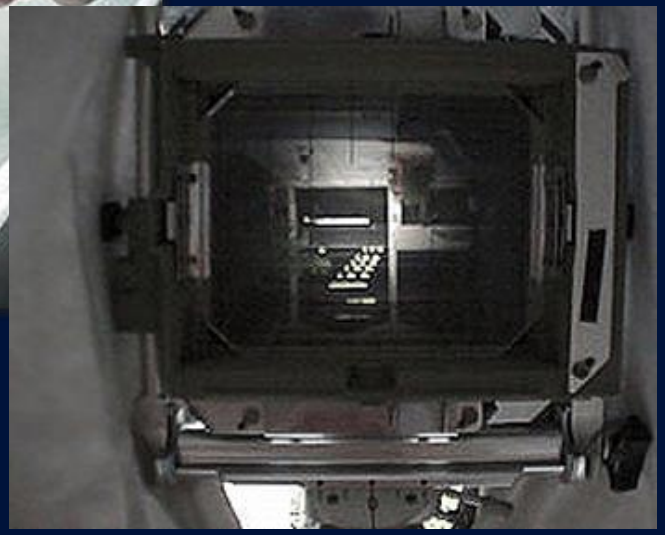
Telescope Dome



The environment inside the dome must be exactly as it is outside.

The Telescope

Astronomical photographs are taken on sensitive glass plates rather than film.



The Telescope

Time exposures are used because of the feeble light received from the stars and to reveal movement against a stationary background.

The Telescope

Today's astronomer wears many hats, including:

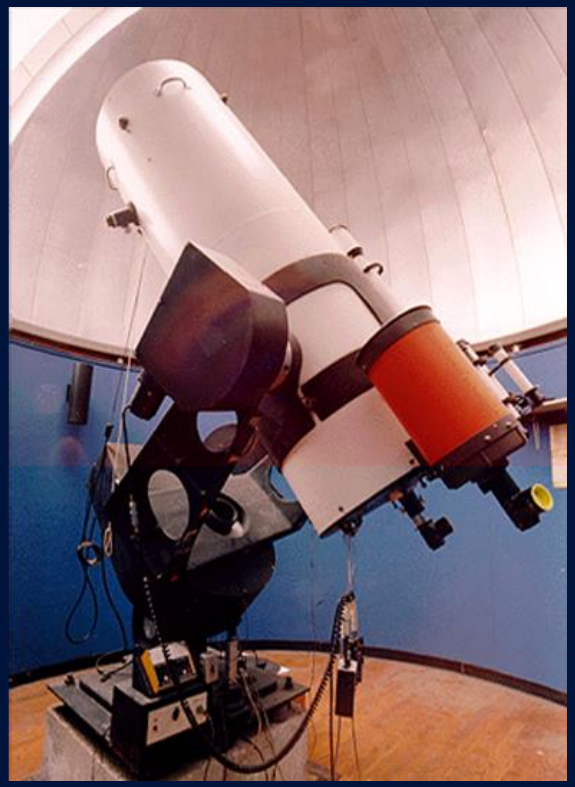
- Electronics technician
- Photographer
- Computer operator
- Mathematician
- Physicist
- Chemist
- Mechanic
- Research analyst
- Office manager

Types of Telescopes

There are two principal types of telescopes:

Refracting

Reflecting

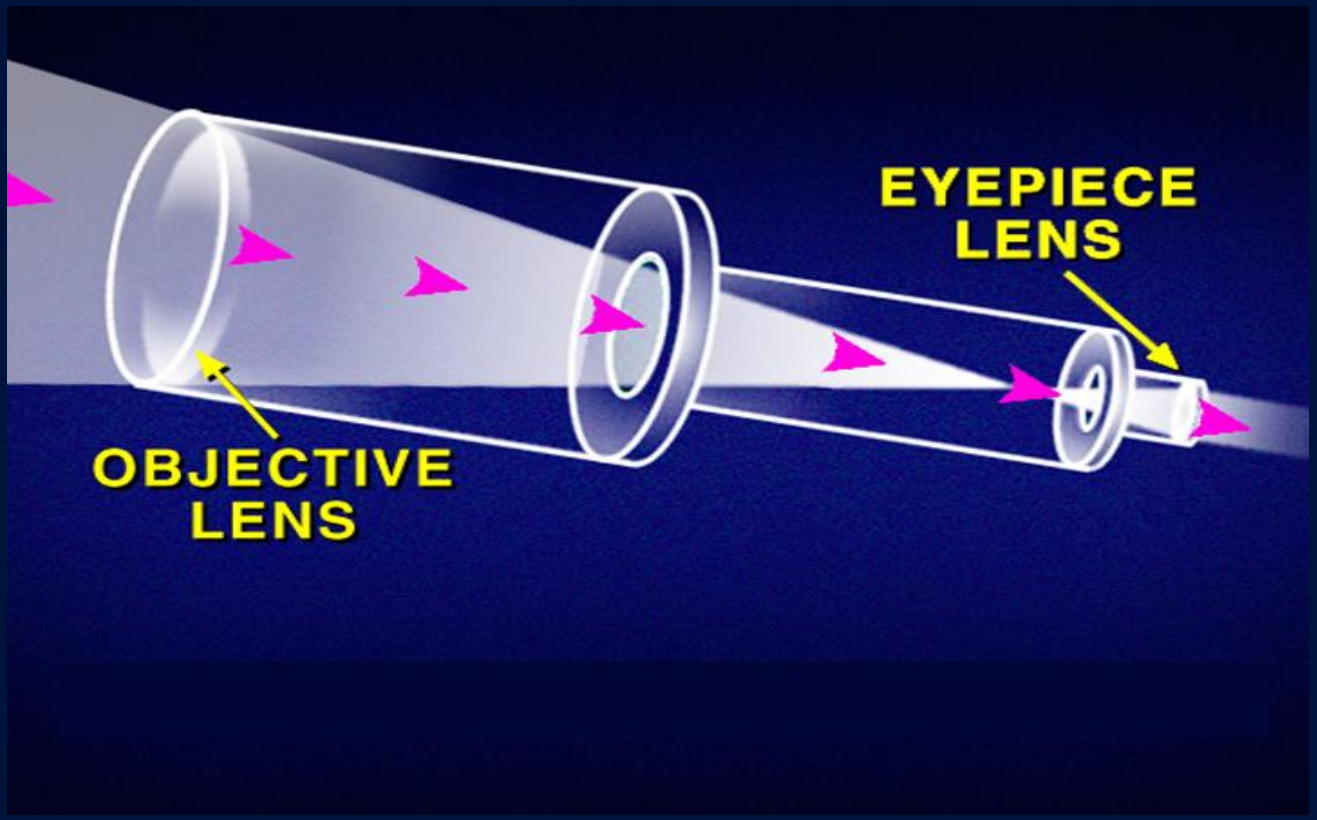


Types of Telescopes

The light-gathering power of the telescope is all-important.

The larger the lens or mirror, the brighter the star will appear.

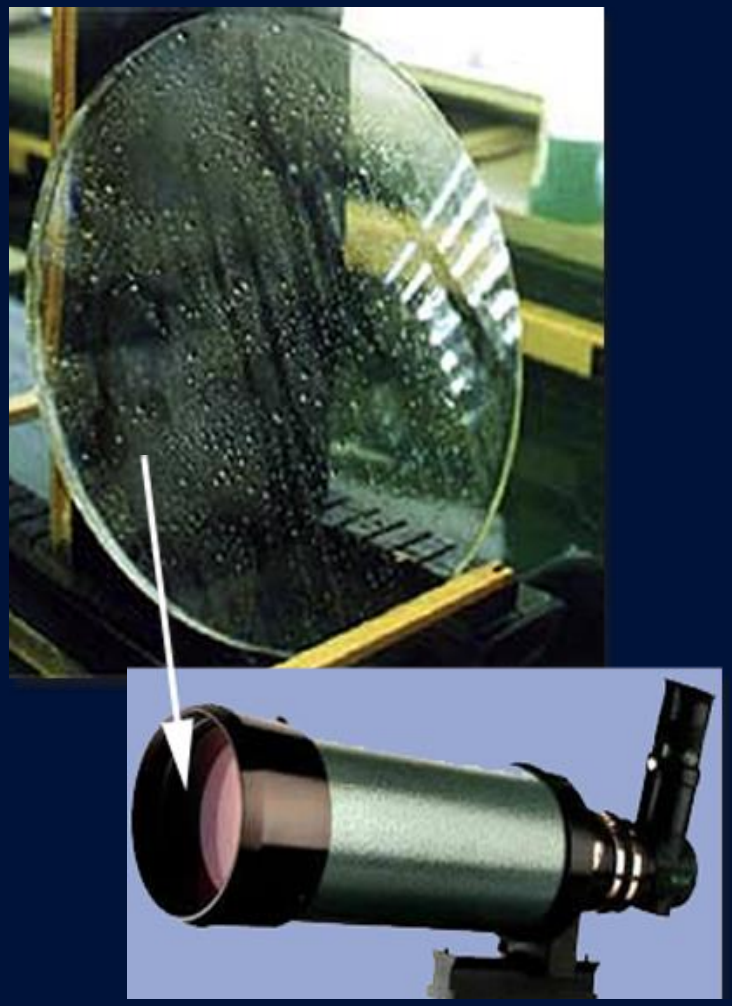
Types of Telescopes



The refracting telescope uses objective and eyepiece lenses.

Types of Telescopes

The objective lens is convex and located at the far end of the telescope. It forms a reduced, inverted image of the celestial body being viewed.

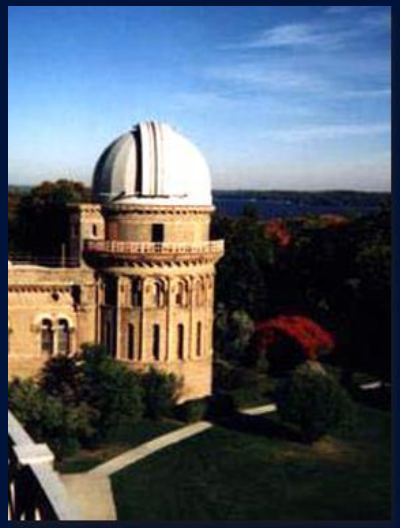


Types of Telescopes

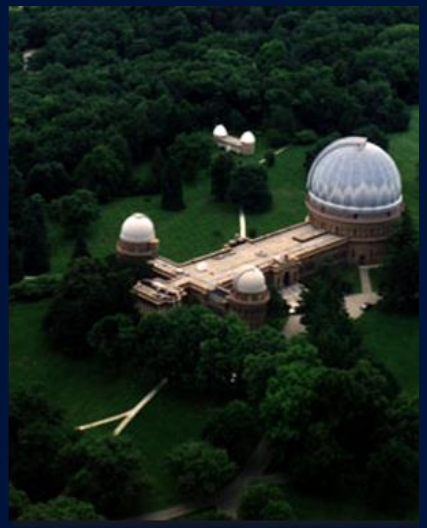
Eyepiece Lens

Magnifies the image formed by the objective lens, making the object appear closer.

Types of Telescopes



Refracting Telescope

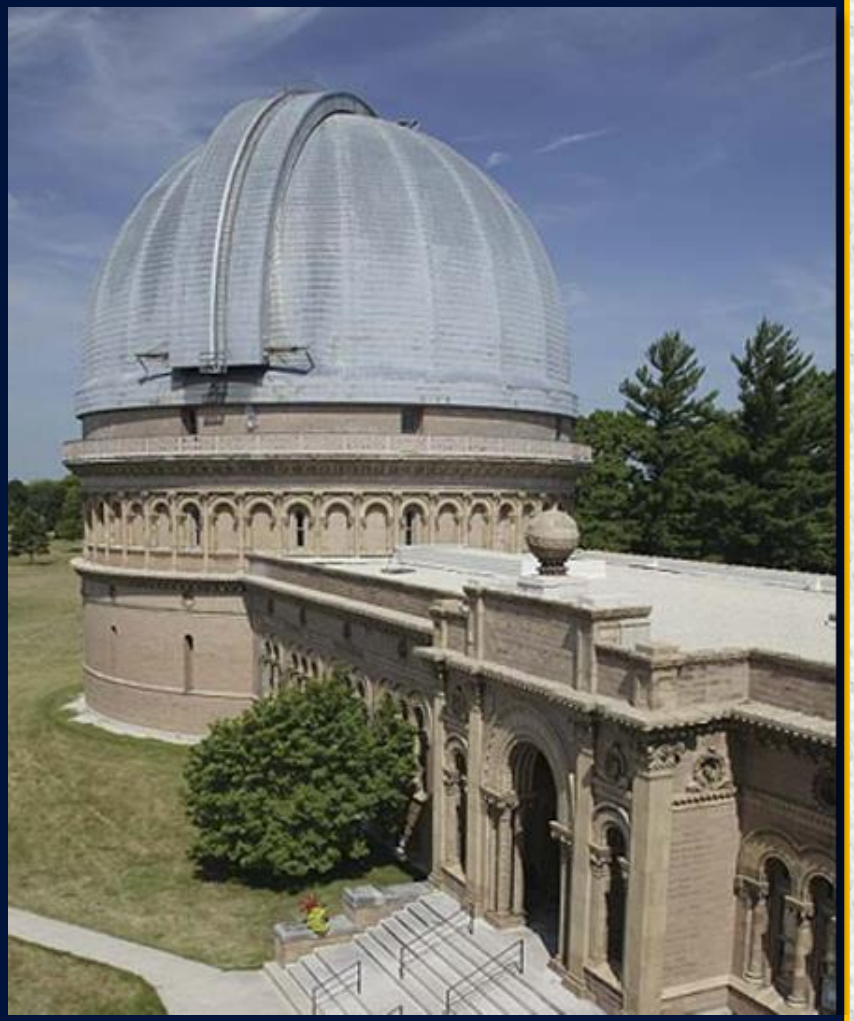


Yates Observatory

Operated by the University of Chicago at Williams Bay, Lake Geneva, Wisconsin, the world's largest refracting telescope has an objective lens with a 40-inch diameter.

Types of Telescopes

Yerkes Observatory at Williams Bay on Lake Geneva, Wisconsin



Check On Learning Questions

CPS Lesson

Question

5 - 6

Types of Telescopes

Sir Isaac Newton is credited with developing the first reflecting telescope in 1672.

Newton's Reflecting Telescope

Sir Isaac Newton

Types of Telescopes

This type telescope uses a slightly concave objective mirror in place of the objective lens.

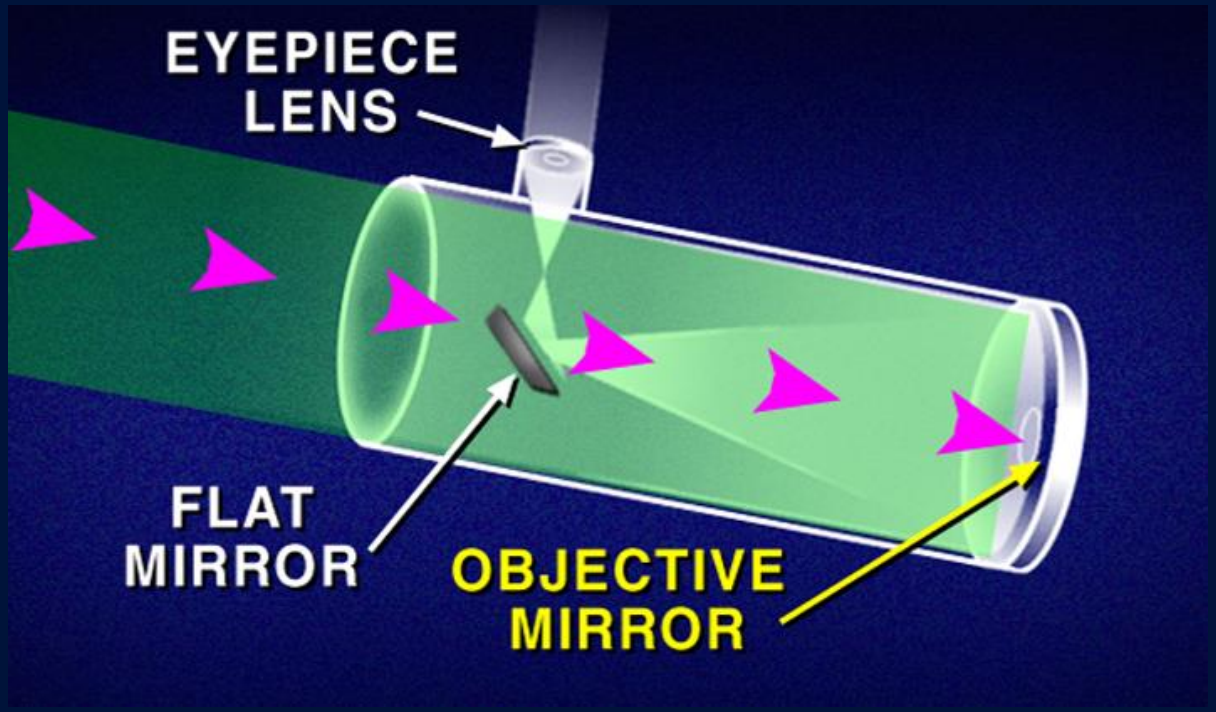
Types of Telescopes

There are two types of reflecting telescopes.

Newtonian Telescope

Cassegrain Telescope

Types of Telescopes

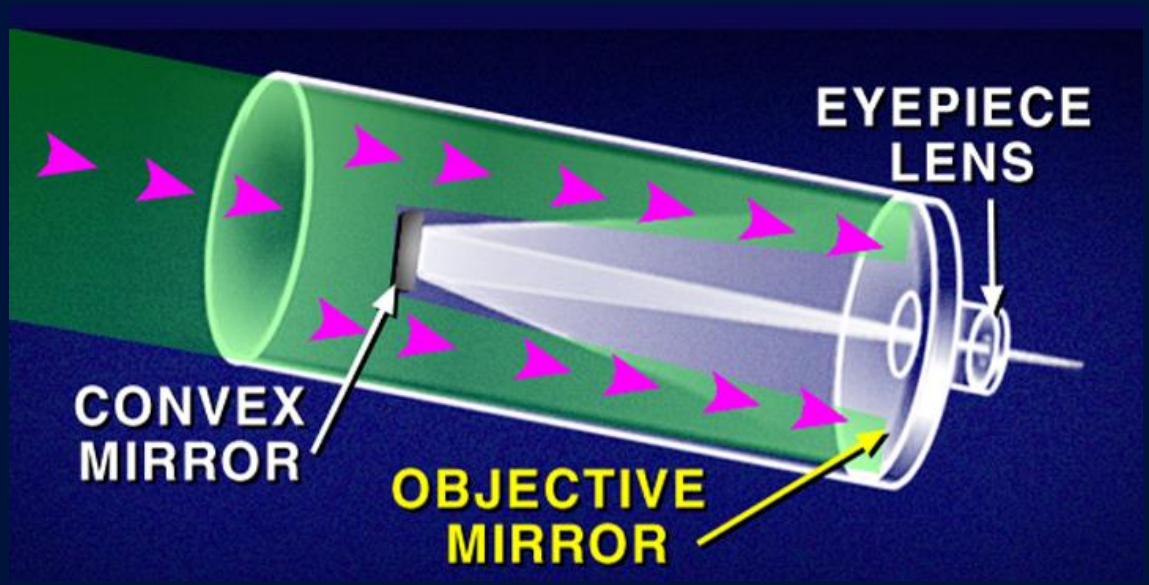


In the Newtonian telescope, a flat, secondary mirror reflects the light and brings it to a focus at the side of the telescope.

Types of Telescopes

Cassegrain Reflecting Telescope

In the Cassegrain telescope, the secondary mirror causes the light to focus behind the objective mirror.



The objective mirror must have a hole in the center to allow light to pass through.

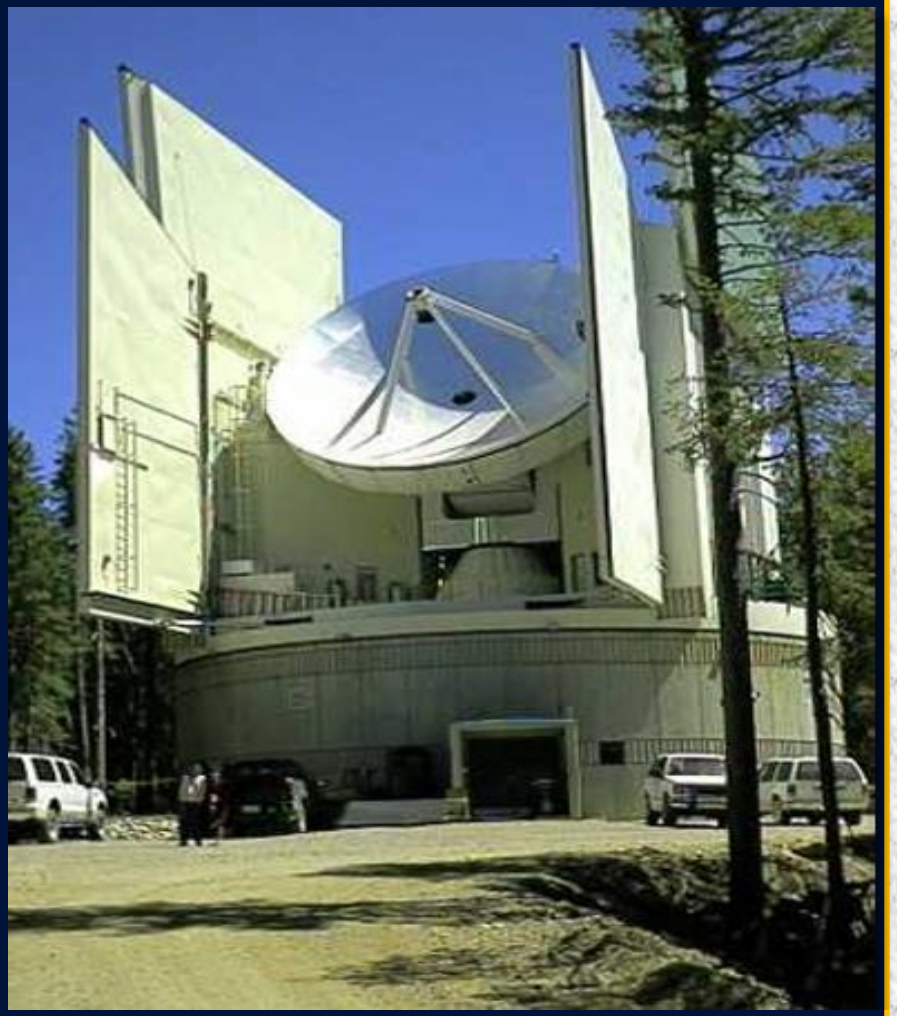
Types of Telescopes

The Mauna Kea Observatory in Hawaii has the world's largest reflecting telescope with a single one-piece primary mirror, 327 inches in diameter.

Types of Telescopes

Large Binocular Telescope

at the
Mount Graham
International
Observatory
Near Safford, AZ



Types of Telescopes

European Southern Observatory, Chile

An interferometer telescope is the equivalent of a 630-inch conventional telescope.

Types of Telescopes

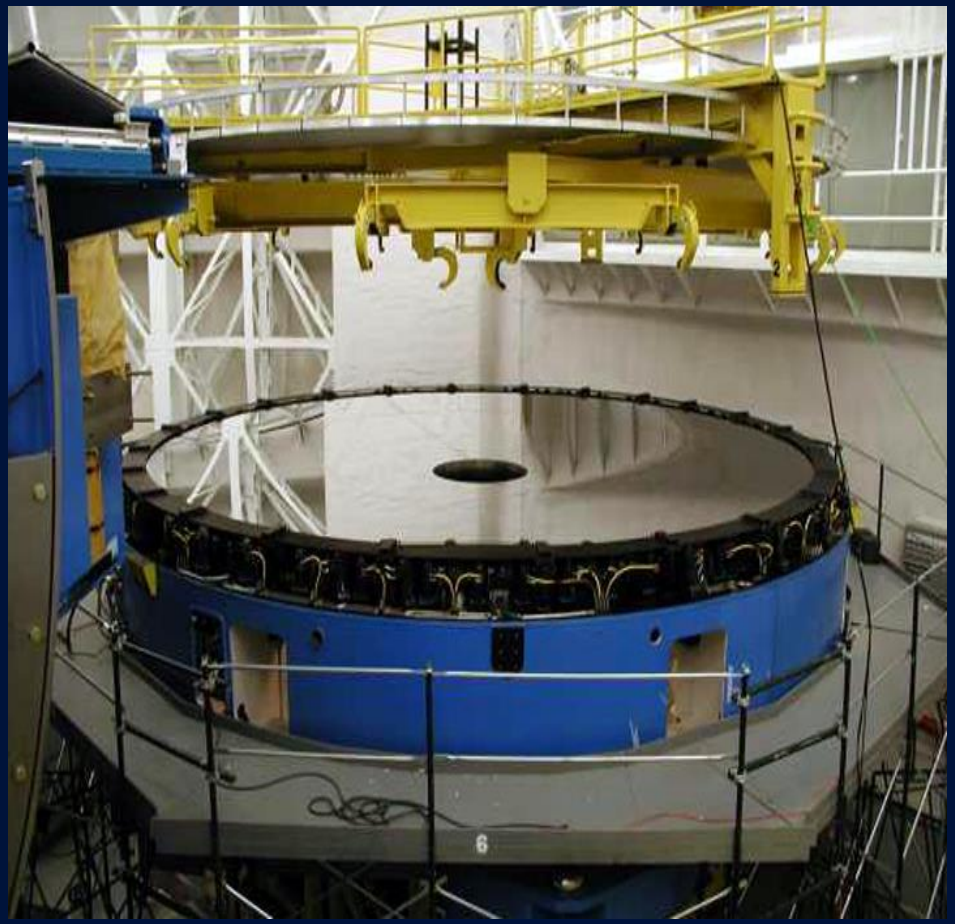
Very Large Telescope (VLT)

Can combine images of an array of four separate 8.2-meter telescopes using a technique called optical interferometry to achieve the same light-gathering ability as a 16-meter mirror.

Types of Telescopes

Technical problems with large mirrors led to innovative designs such as this 36-segment mirror.

Each segment is computer controlled to a tolerance of less than one millionth of an inch.



Types of Telescopes

Southern African Large Telescope (SALT)

Sutherland,
South Africa

Types of Telescopes

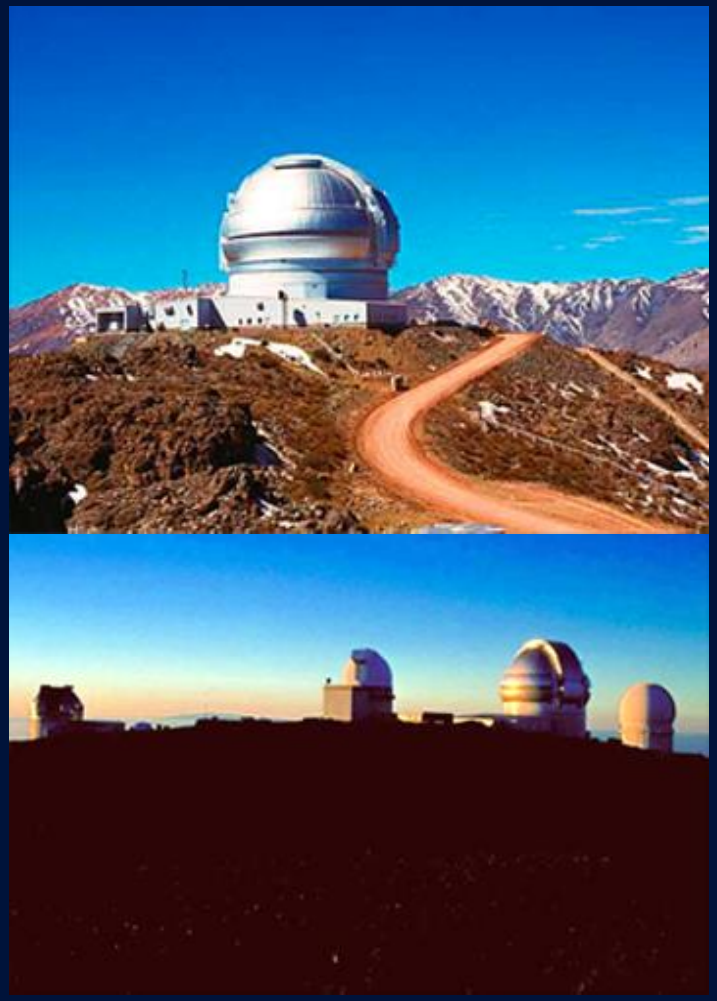
For the future, sponsors have proposed building an immense 100-meter reflecting telescope called the:

Overwhelmingly Large Telescope
(OWL)

Its location is yet to be determined.

Types of Telescopes

The OWL telescopes because of their huge size and great precision, not-withstanding some atmospheric distortion, will have more light-gathering capability and resolution of other space-based telescopes like the *Hubble*.



Types of Telescopes

Today, these telescopes are enabling Earth-bound astronomers to make observations of such things as planets orbiting distant stars and galaxies near the edges of the universe.

Review Question

Name and describe the two main types of telescopes.

1.

2.

3.

(Use CPS “Pick a Student” for this question.)

Closing Questions

CPS Lesson
Questions 7 - 8

Questions?