


SECTION 28.1 Tools of Astronomy

Tools of Astronomy

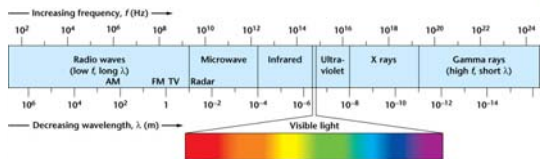

- The light that comes to Earth from distant objects is the best tool that astronomers can use to learn about the universe.
- In most cases, there is no other way to study the cosmos except to analyze the light that we receive from it.



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Radiation

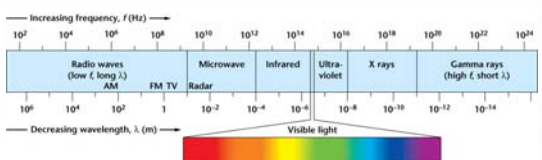

- Electromagnetic radiation consists of waves of electrical and magnetic disturbances.
- It includes visible light, infrared and ultraviolet radiation, radio waves, microwaves, X rays, and gamma rays.

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Radiation


- Electromagnetic radiation travels at the same speed and is classified by:
 - Wavelengths—the distance between peaks on a wave.
 - Frequency—the number of waves or oscillations occurring per second.

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Telescopes

- When exploring space, telescopes have many benefits:
 - Detectors can be attached to a telescope to observe all wavelengths, not just visible light.
 - A telescope brings much more light to a focus than the human eye can, allowing the observation of faint objects.
 - Specialized equipment, such as a photometer which measures the intensity of visible light, can be used with a telescope.
 - With the aid of imaging devices, telescopes can be used to make time exposures to detect objects that are too faint for the human eye to see.




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Telescopes

Refracting and Reflecting Telescopes

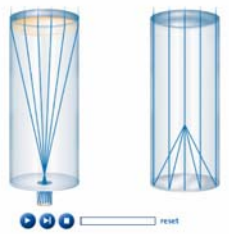

- Two different types of telescopes are used to focus visible light.
 - Refracting telescopes**, or refractors, are telescopes that use lenses to bring visible light to a focus.
 - Reflecting telescopes**, or reflectors, are telescopes that bring visible light to a focus with mirrors.
- Reflectors make up the majority of telescopes that are in use today.
- Most major observatories are located in remote, high elevation locations in order to minimize light and atmospheric interference.



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Telescopes

Refracting and Reflecting Telescopes

Telescopes

Telescopes at Other Wavelengths

- For all telescopes, the goal is to bring as much radiation as possible to a focus.
- – **Interferometry** is the process of linking separate telescopes together so that they act as one telescope.
- This process has been used with radio telescopes for a number of years and is now being applied to other telescopes as well.
- The detail in the images that they produce improves as the distance between the telescopes increases.



Satellites, Probes, and Space-Based Astronomy

- Instruments often must be sent into space to collect information because:
 - Earth's atmosphere blocks infrared radiation, ultraviolet radiation, X rays, and gamma rays.
 - When Earth's atmosphere does allow certain wavelengths to pass through, the images are blurred.
 - It is the only way to make close-up observations and even obtain samples from nearby objects in the solar system.



Satellites, Probes, and Space-Based Astronomy

- The *Hubble Space Telescope (HST)* makes observations in visible-light, infrared, and ultraviolet wavelengths.
- Other space-based telescopes, such as the *Far Ultraviolet Spectroscopic Explorer*, the *Chandra X-Ray Observatory*, and the *Spitzer Space Telescope*, observe other wavelengths that are blocked by Earth's atmosphere.



Satellites, Probes, and Space-Based Astronomy

Spacecraft

- Space-based exploration can be achieved by sending spacecraft directly to the bodies being observed.
- Robotic probes make close-up observations and sometimes land to collect information directly.
- More recently, the twin robots *Spirit* and *Opportunity* conducted scientific experiments on Mars in 2004.



Satellites, Probes, and Space-Based Astronomy

Human Spaceflight

- Exploring the short term effects of space has been accomplished with the space shuttle program, which began in 1981.
- Since habitation and research began in 2000, a multi-country space station called the *International Space Station* has been used to study the long-term effects of life in space.



Satellites, Probes, and Space-Based Astronomy

Spinoffs

- – **Spinoffs** are technologies that were originally developed for use in space programs that have been passed on to commercial industries for common use.
- More than 1400 different NASA technologies have been incorporated into products ranging from artificial hearts to cordless tools.

