The Sun: Our Closest Star

Paula Messina

I. How are stars studied?

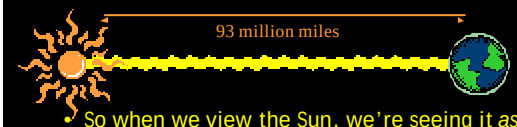
II. What is the physical nature of the Sun?

The *Speed of Light*

- All solar (and stellar) energy travels through the vacuum of space at *the speed of light*:
  - 186,000 miles per second
  - 300,000 kilometers per second
- 186,000 miles, or 300,000 km, is the distance it would take to travel 7.5 times around the surface of Earth

Astronomical Distances

- The distance between Earth and the Sun is approximately 93,000,000 miles
- This distance is called an "Astronomical Unit"
- It takes about 8 minutes for light from the Sun to reach Earth



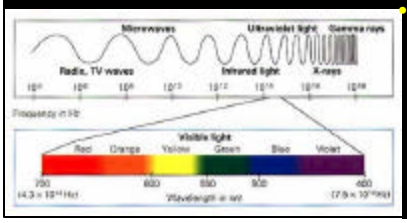
- So when we view the Sun, we're seeing it *as it was* 8 minutes ago.

Spectroscopy

- The study of properties of light
- Used in the detection and analysis of light from distant stars, as well as the Sun

Electromagnetic Spectrum

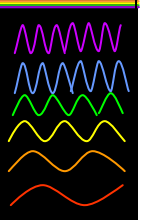
- Electromagnetic radiation is energy that can travel through empty space



- Different forms of electro-magnetic energy differ in their wavelengths

Visible Light Wavelengths

- Violet 380 - 440 nanometers
- Blue 440 – 500 nanometers
- Green 500 – 560 nanometers
- Yellow 560 – 590 nanometers
- Orange 590 – 640 nanometers
- Red 640 – 750 nanometers



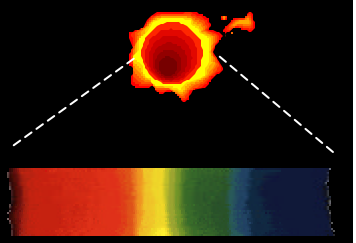
*One nanometer = 10^{-9} meter

Types of Spectra

- Continuous Spectrum
- Dark-line Spectrum (Absorption spectrum)
- Bright-line Spectrum (Emission spectrum)

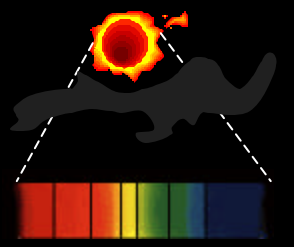
Continuous Spectrum

- An uninterrupted band of electromagnetic wavelengths
  - Continuous spectra are emitted by *incandescent* substances under pressure.



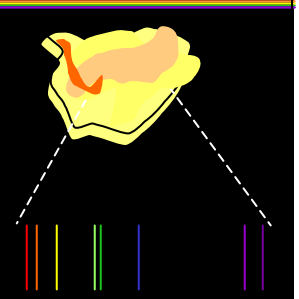
Dark-line Spectrum

- A discontinuous band, showing a few "missing" wavelengths
  - These wavelengths are absorbed by cool gases under low pressure

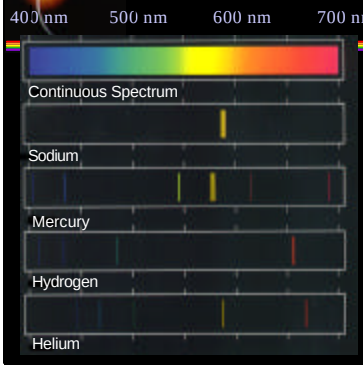


Bright-line Spectrum

- Bright lines of particular wavelengths, emitted by hot gases under low pressure
  - Every substance has its own spectral "fingerprint"



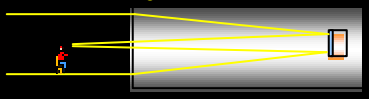
Bright Line Spectra



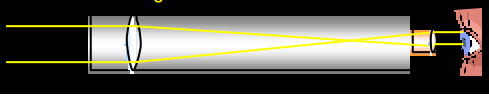
- Different gases emit different bright line spectra, when heated

Telescopes

- Visible light telescopes:
  - Reflecting



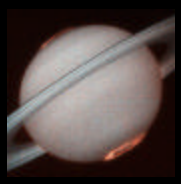
  - Refracting



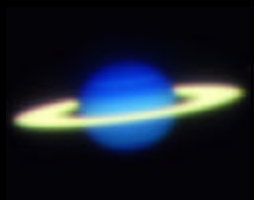
Hubble Space Telescope

- Capable of observations ten-times clearer than those from ground-based instruments

Comparison Views of Saturn

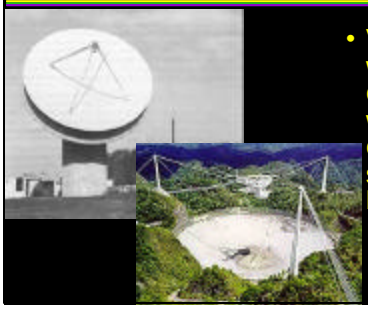


- Hubble Space Telescope, 1999 (notice the auroras!)



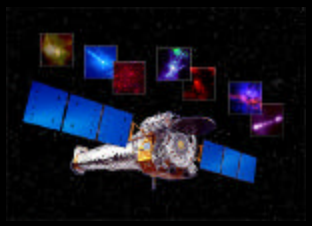
- Palomar Observatory, near-infrared bands.

Telescopes Can Observe Invisible Spectra



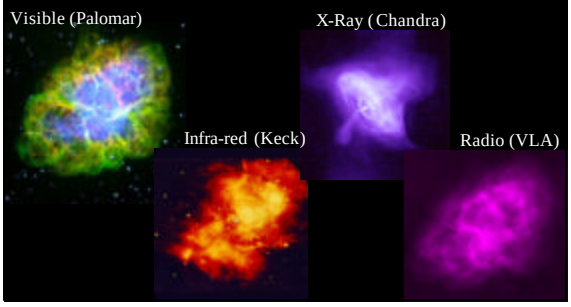
- Very long wavelength energy (radio waves) may be emitted by some stars, and may be detected by radio telescopes

Telescopes Can Observe Invisible Spectra



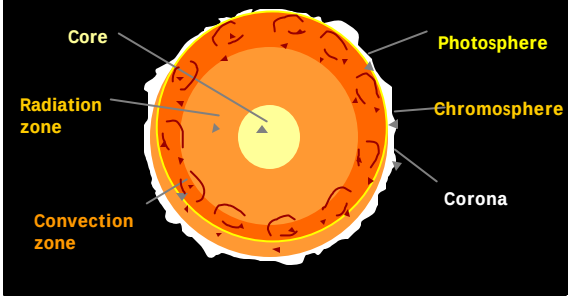
- Very short wavelength energy (X-Rays) may be emitted by stars as well.
- Such emissions may be detected by the Chandra X-Ray observatory, in orbit around Earth

Images of the Crab Nebula, at Different Wavelengths

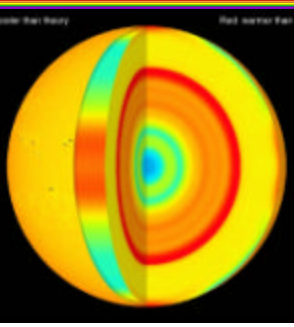


II. The Physical Structure of the Sun

Sun's Interior

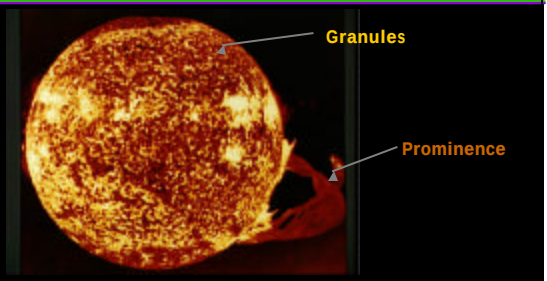


Solar Temperatures



- Data from SOHO heliospheric experiments

Sun's Surface



Sunspots

- Darker, cooler regions
- Magnetic storms (?)
- Occur with predicatble frequency

As of 11/27/01, there have been 122 sunspots observed on the sun this year.