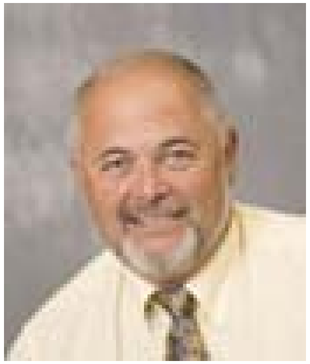
Week 8 Ch 16 PPT

EAPS 10000 Y01
Online Course
Planet Earth
Prof. Lawrence Braile

Welcome to the EAPS 10000 Y01 online course
Planet Earth *(also known as EAPS 100)!*



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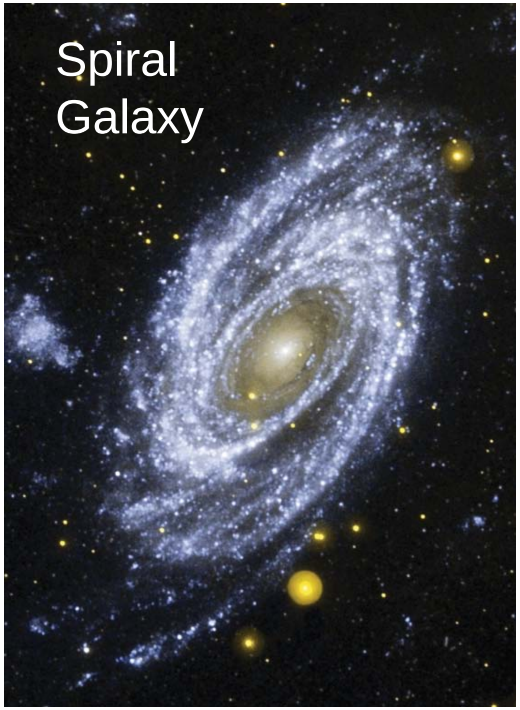
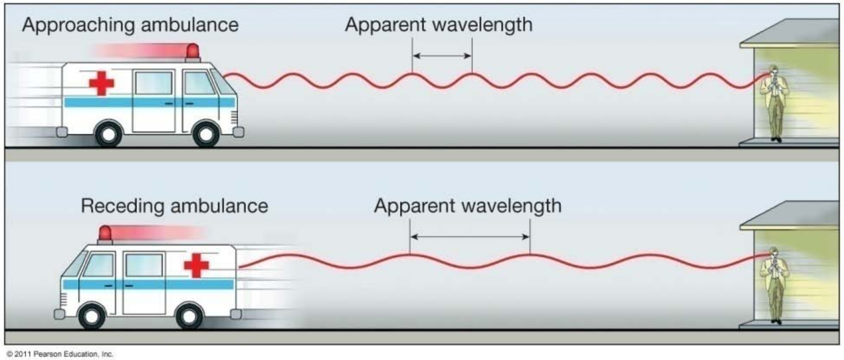
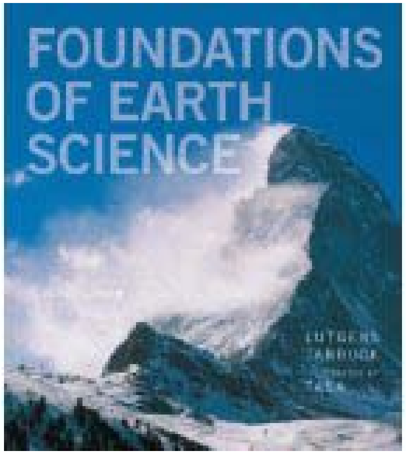
EAPS 10000 Y01 – Planet Earth (online course)
Week 8, Chapter 16 (see pages below)

Week	Chapter	Assigned Pages	Major Concepts	Important Terms
8	**16 – Beyond Our Solar System**	514-537, 543-545, Appendix D	Measuring astronomical distances, H-R diagram, stellar evolution, big bang theory	Stars, stellar parallax, magnitude, variable stars, galaxies, black holes, Doppler effect, Hubble red shift



The Doppler effect – change of pitch of siren sound from moving ambulance.





EAPS 10000 Y01 – **Planet Earth** (online course)
Week 8, Chapter 16 (pages 514-537, 543-545, Appendix D)

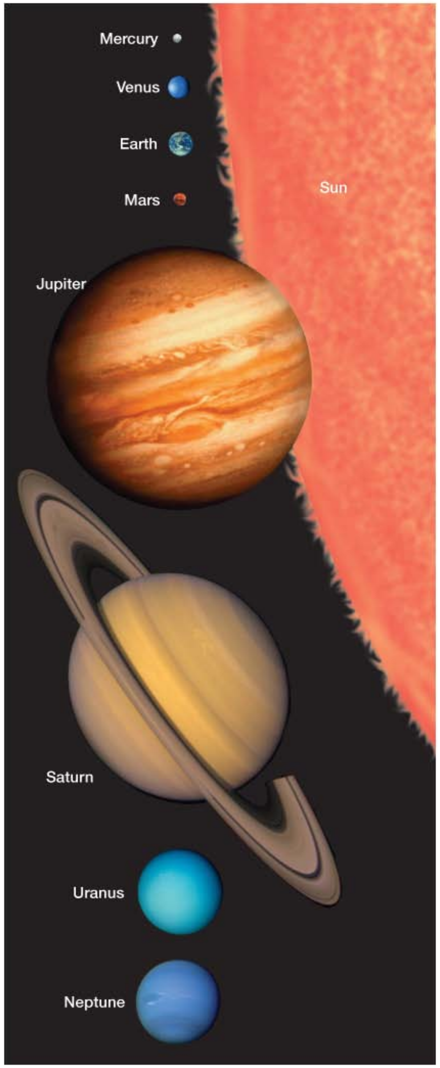
Read Chapter 16 and view the weekly PowerPoint file for Chapter 16, there is no quiz for Chapter 16.

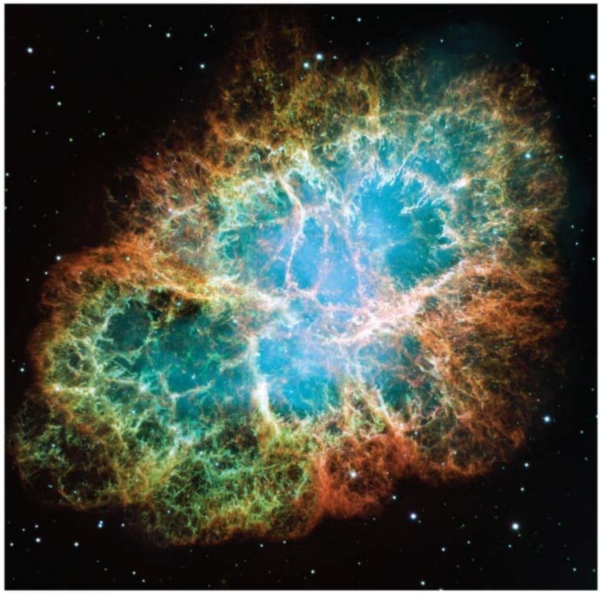
The PPT files (converted to PDF files) are best viewed with the Full Screen view in browsers.

The following slides illustrate some of the important concepts and topics of Chapter 16:

Astronomy

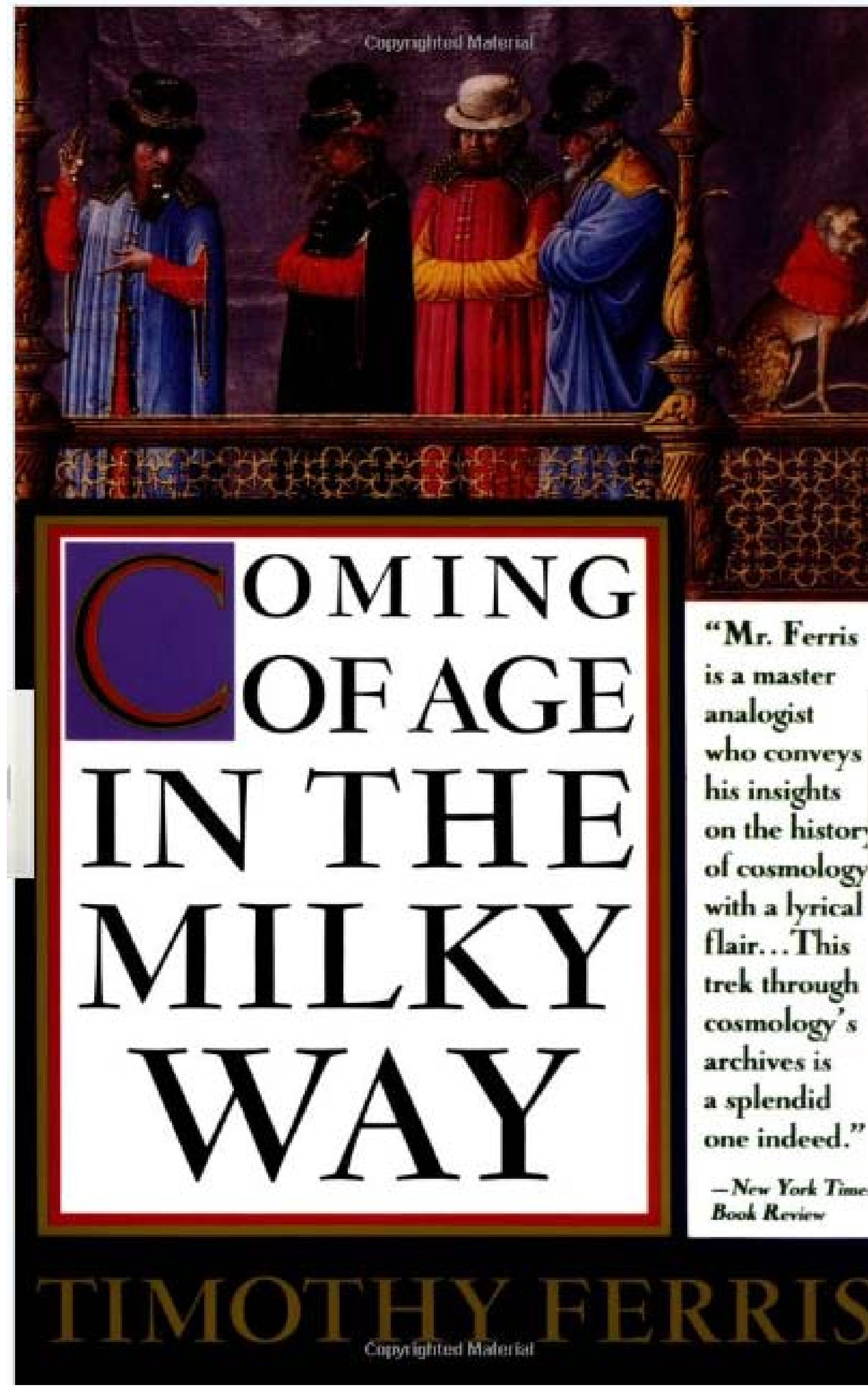
1. Introduction and Observations
2. Sun and Solar System
3. Stars (Stellar Evolution)
4. Galaxies
5. Universe (Deep Space, Expanding Universe, Hubble Red Shift, Cosmology)



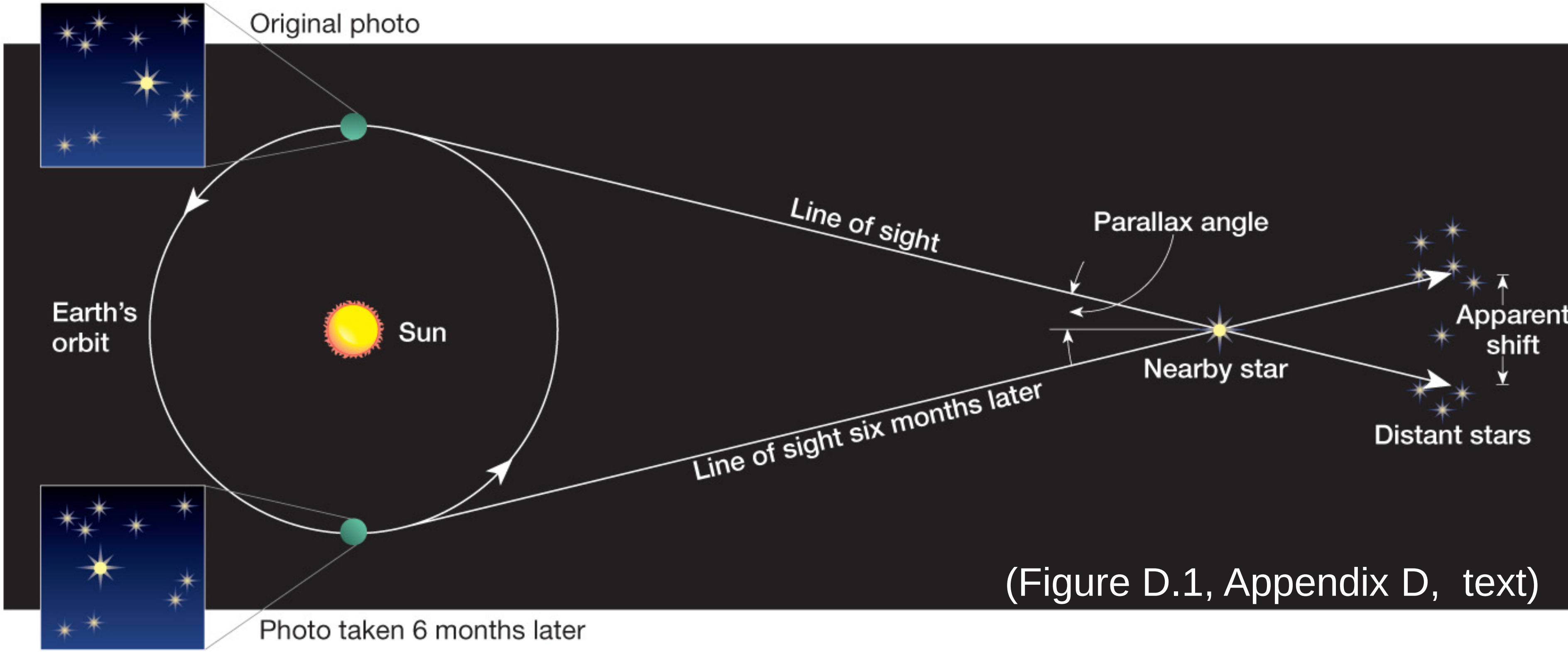


An excellent book on astronomy by Timothy Ferris
(1988, 2003)

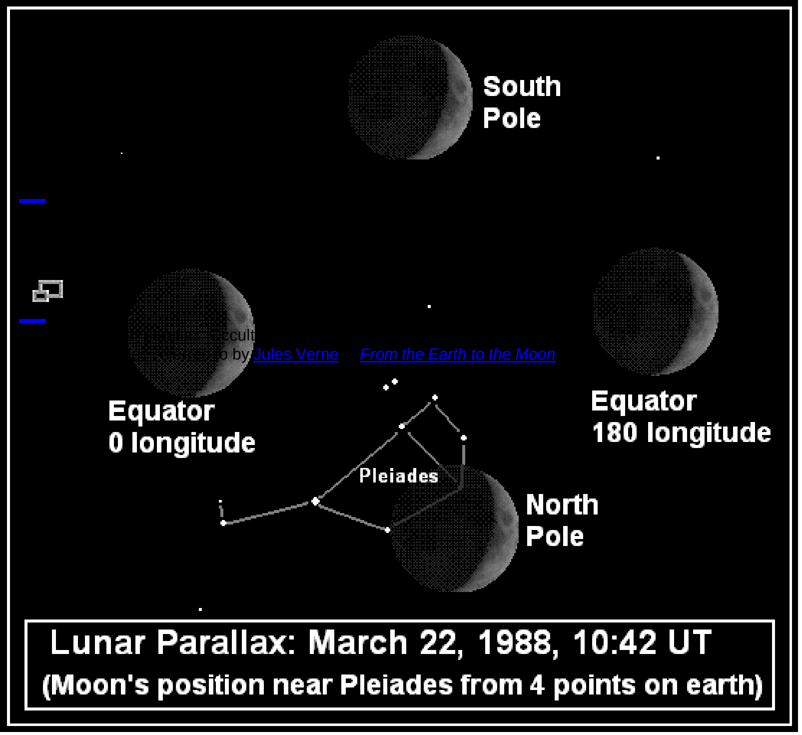
Also, there are two excellent periodicals related to astronomy – *Astronomy* and *Sky and Telescope*

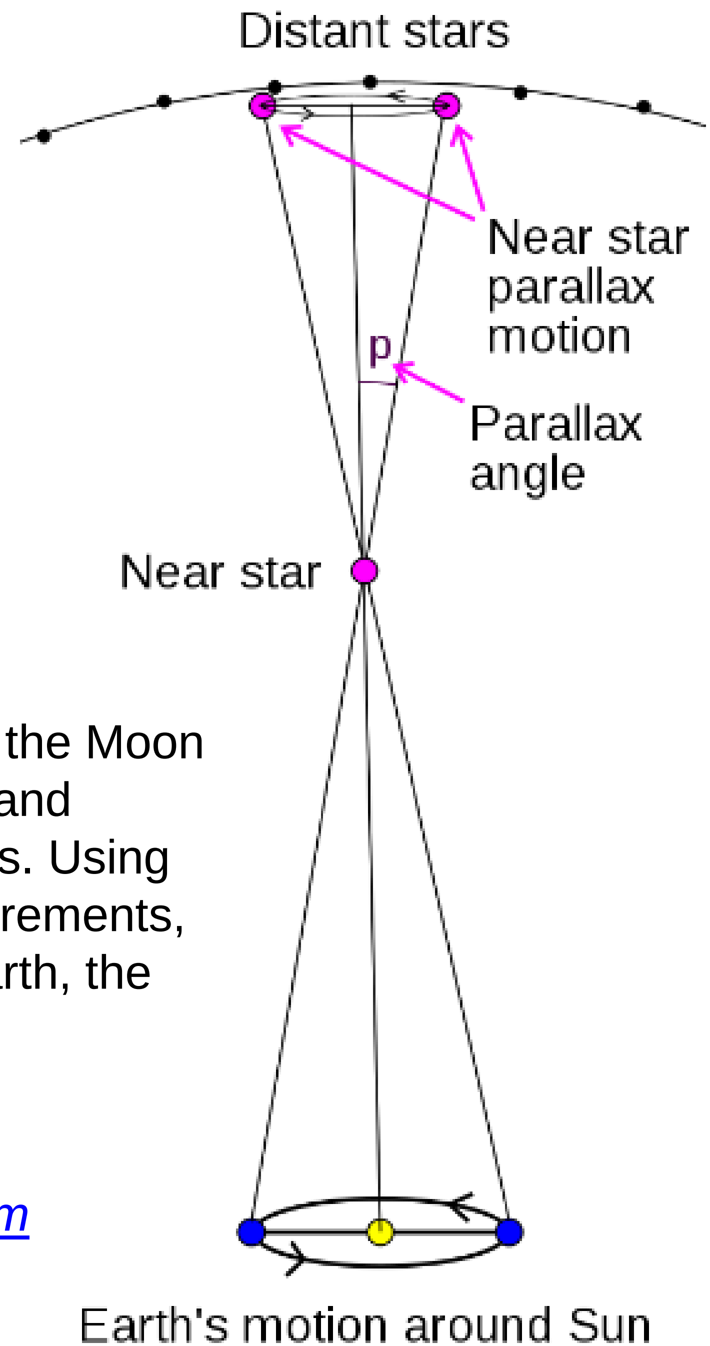


Measuring Distance to Stars: The Stellar Parallax method



Stellar Parallax – distance determined from parallax angle, the smaller the parallax angle the greater the distance to the star. A parallax angle of 1 second of arc (1/3600 degrees angle) corresponds to a distance of 3.09×10^{13} km and is called one Parsec. Distant stars are measured in MegaParsecs.





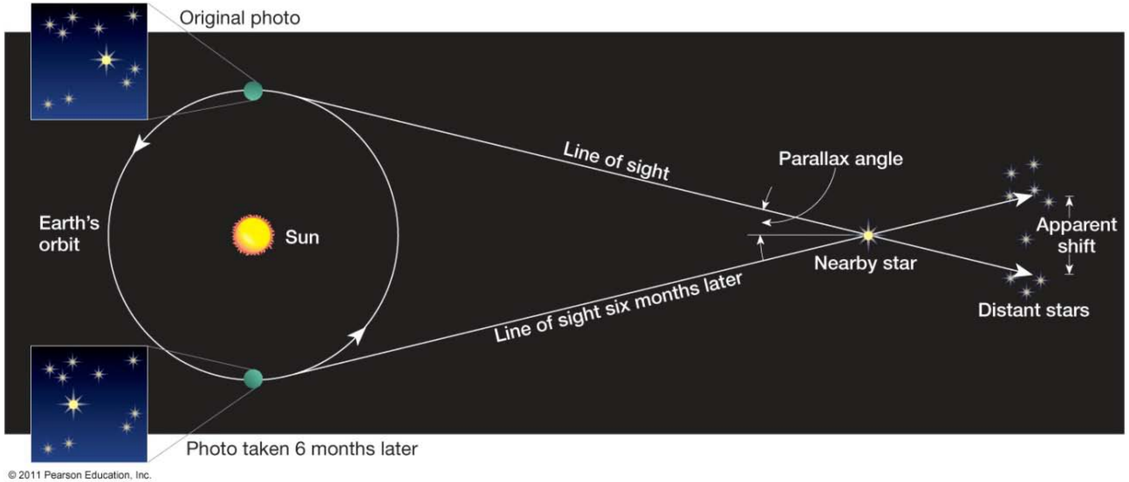
Another example of parallax is to take two pictures of the Moon at exactly the same time from two locations on Earth and compare the positions of the Moon relative to the stars. Using the orientation of the Earth, those two position measurements, and the distance between the two locations on the Earth, the distance to the Moon can be triangulated:

$$\text{distance}_{\text{moon}} = \frac{\text{distance}_{\text{observerbase}}}{\tan(\text{angle})}$$

This is the method referred to by Jules Verne in *From the Earth to the Moon*.

http://en.wikipedia.org/wiki/File:Stellarparallax2.svg

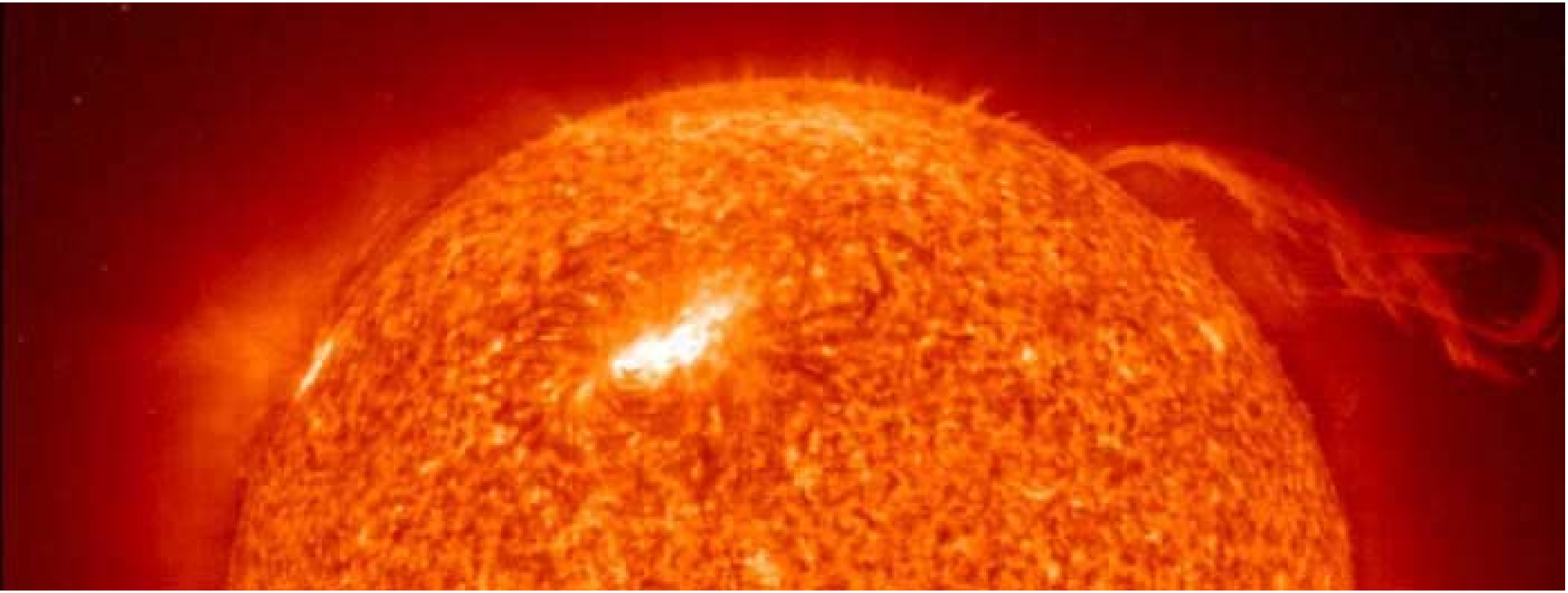
Measuring Distance to Stars: **The Stellar Parallax method**



We use a process related to parallax with our two eyes to focus on objects at different distances. You can see the parallax effect with a simple demonstration. Point your index finger up and position your hand at arms length in front of you. Now use your other hand to cover your left eye. Note the position of your finger relative to the wall in the distance. Now, without moving your finger, cover your right eye. Note that the position of you finger relative to the wall in the background has changed. That's the same parallax effect as see above for stars.

Stellar Parallax – Animation available at:
http://www.astro.ubc.ca/~scharein/a311/Sim.html

The Sun – A Typical Star

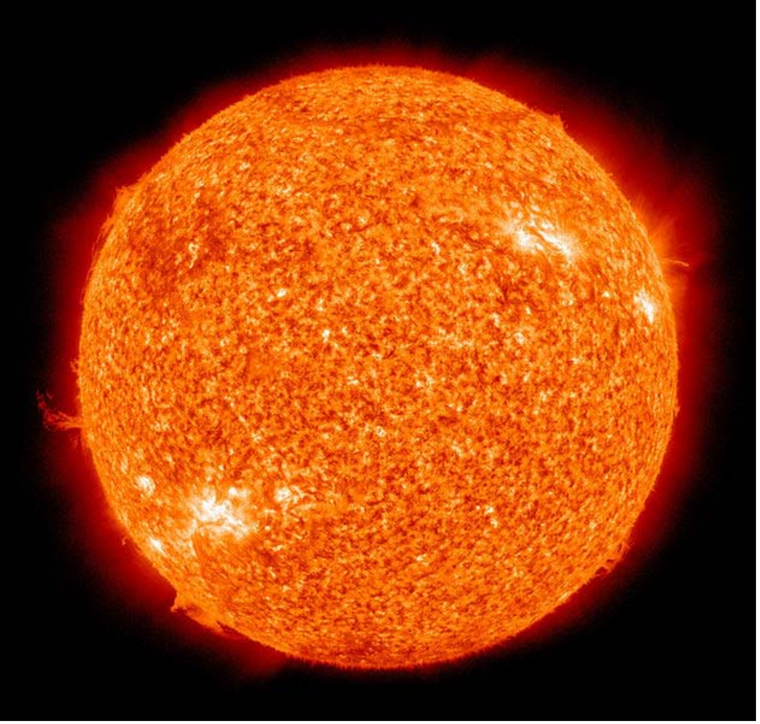


Main composition of the Sun

Hydrogen	73.46%
Helium	24.85%
Oxygen	0.77%
Carbon	0.29%
Iron	0.16%

Spectacular loops and prominences are often visible on the Sun's limb.

http://nineplanets.org/sol.html



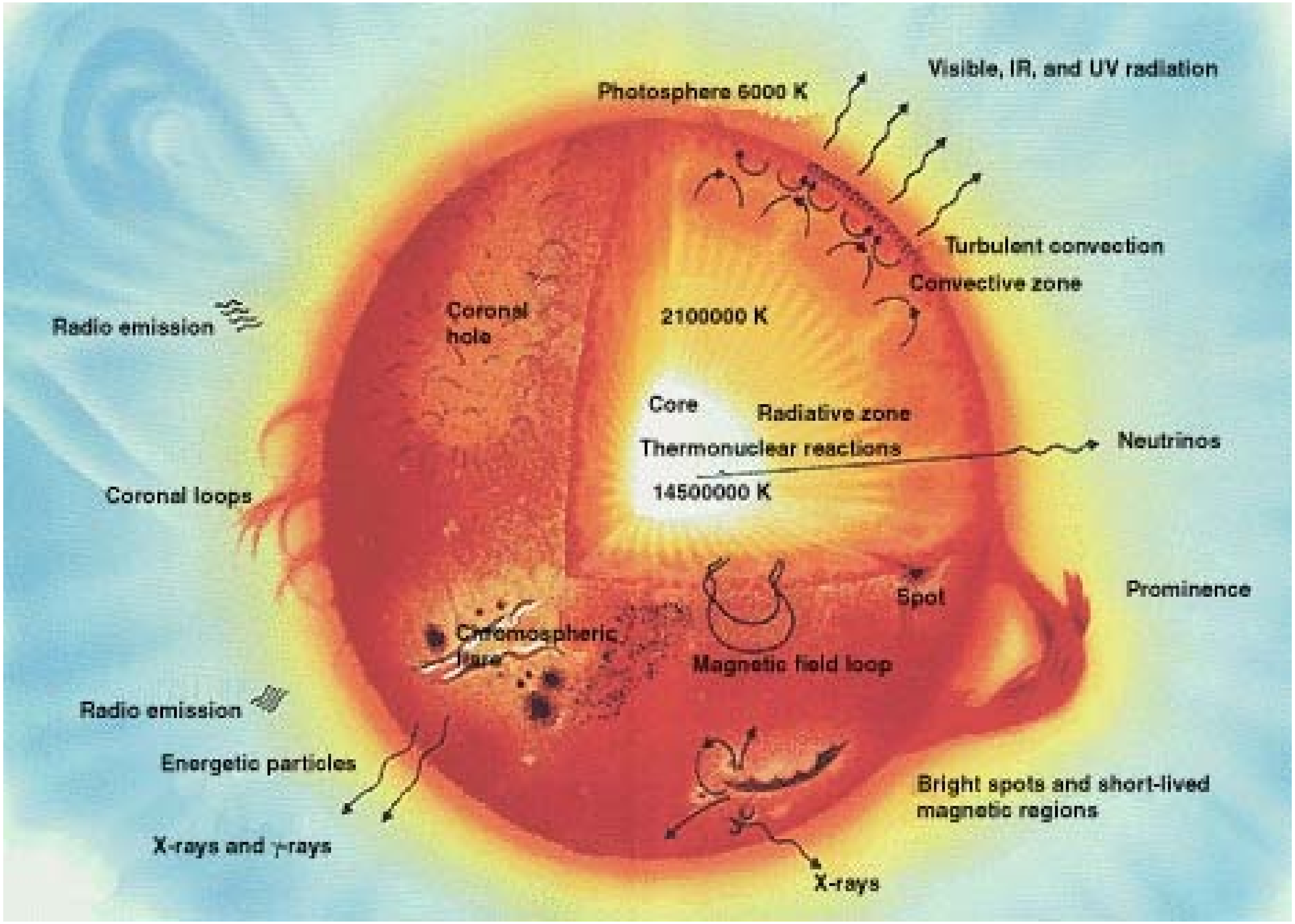
The sun is one of over 100 billion stars in the Milky Way Galaxy. It is about 25,000 light-years from the center of the galaxy, and it revolves around the galactic center once about every 250 million years.

The sun is a star with a diameter of approximately 1,390,000 km, about 109 times the diameter of Earth. The largest stars have a diameter about 1,000 times that of the sun.

Fewer than 5 percent of the stars in the Milky Way are brighter or more massive than the sun. But some stars are more than 100,000 times as bright as the sun, and some have as much as 100 times the sun's mass. At the other extreme, some stars are less than 1/10,000 as bright as the sun, and a star can have as little as 7% of the sun's mass. There are hotter stars, which are much bluer than the sun; and cooler stars, which are much redder.

http://www.nasa.gov/worldbook/sun_worldbook.html

Comprising about 99.8632% of the total mass of the Solar System – most of the remainder is Jupiter.

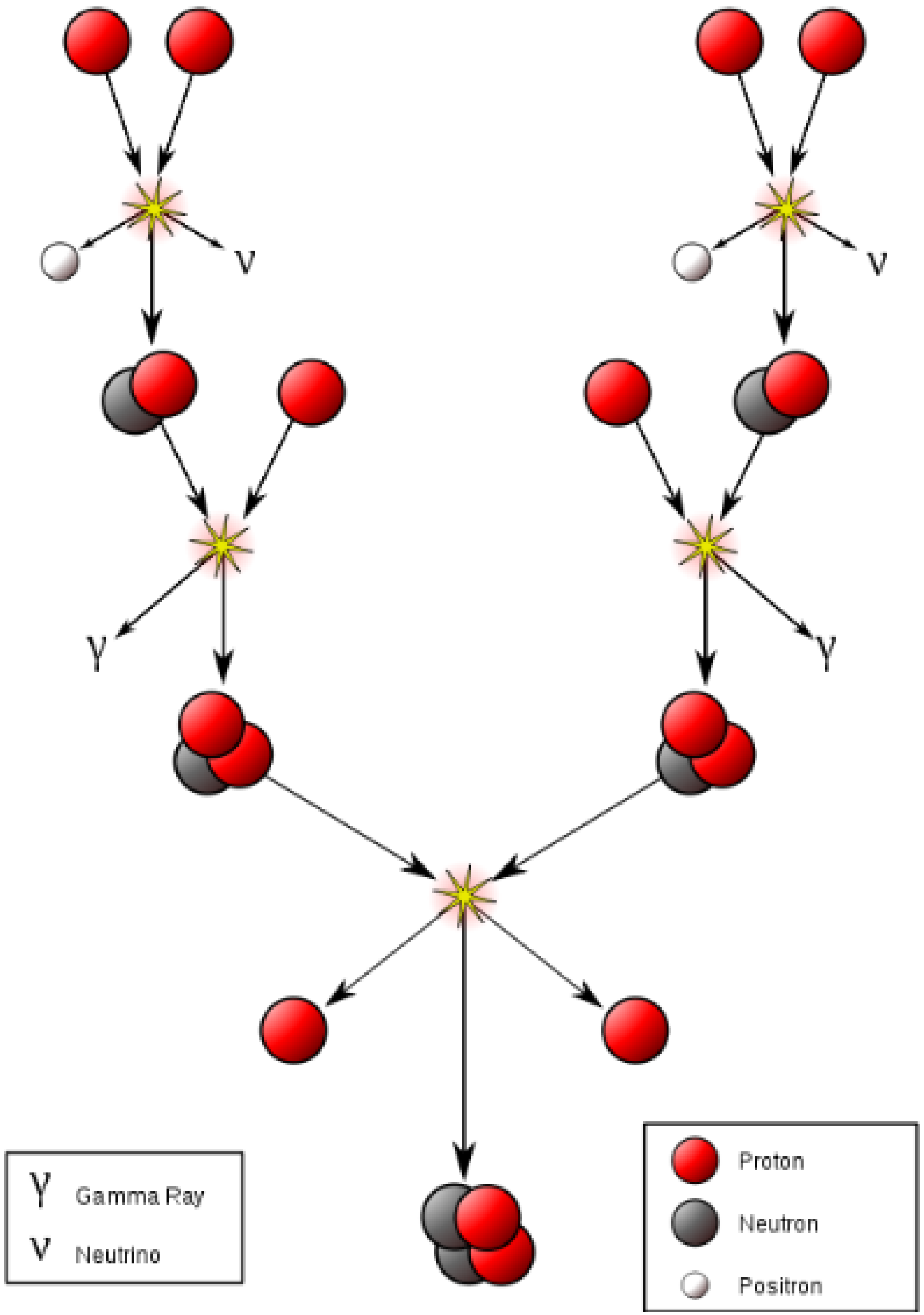


http://en.wikipedia.org/wiki/Sun

Nuclear Fusion in the Sun (and other stars) – the proton-proton chain reaction:

The decrease in mass (from 4 protons to 2 protons and 2 neutrons, Helium) is only 0.7% but the energy release is large because of the equation $e=mc^2$.

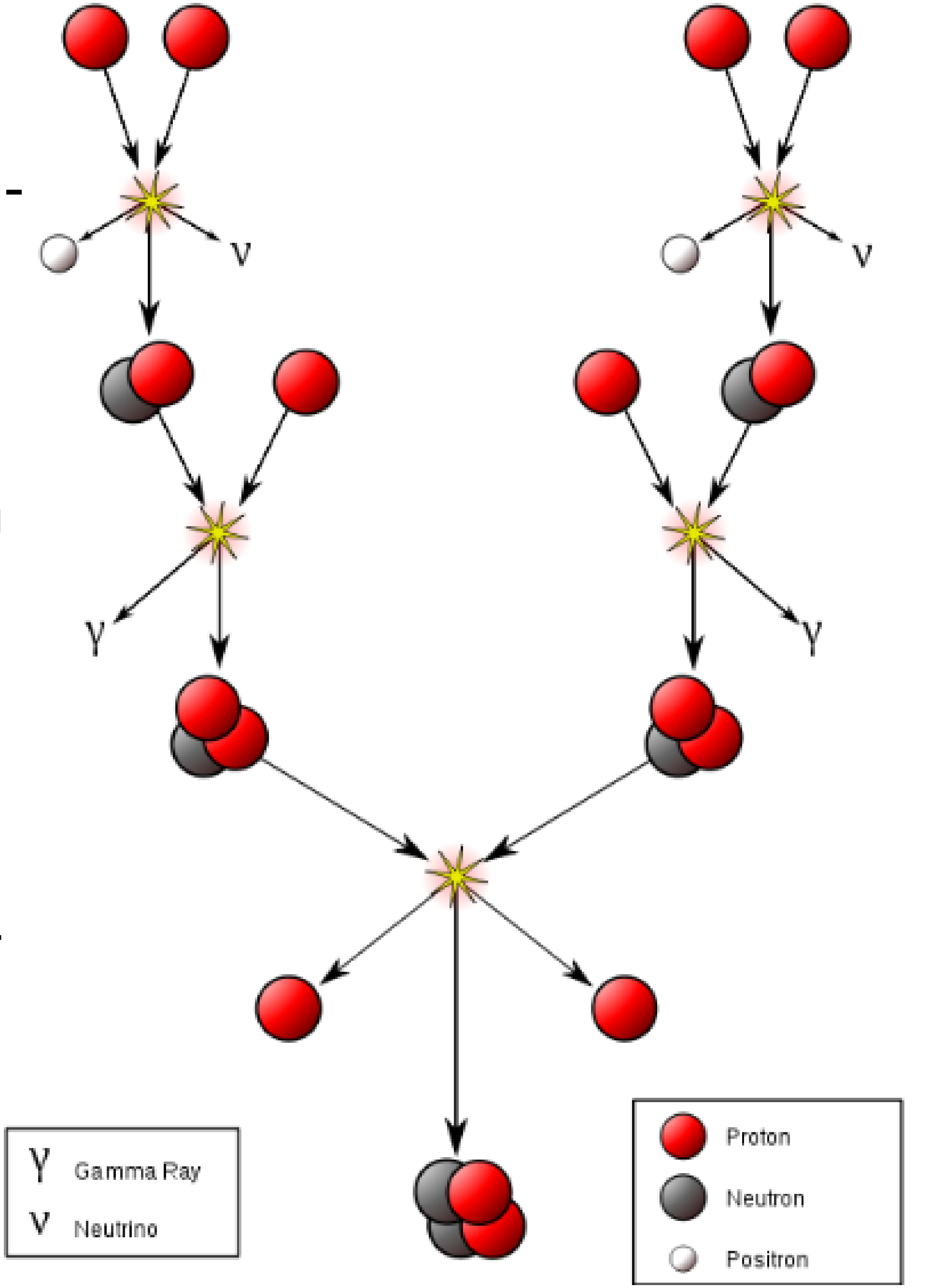
Also note that at the end of the reaction, there are still two protons remaining, so the reaction continues as a chain reaction always releasing energy.



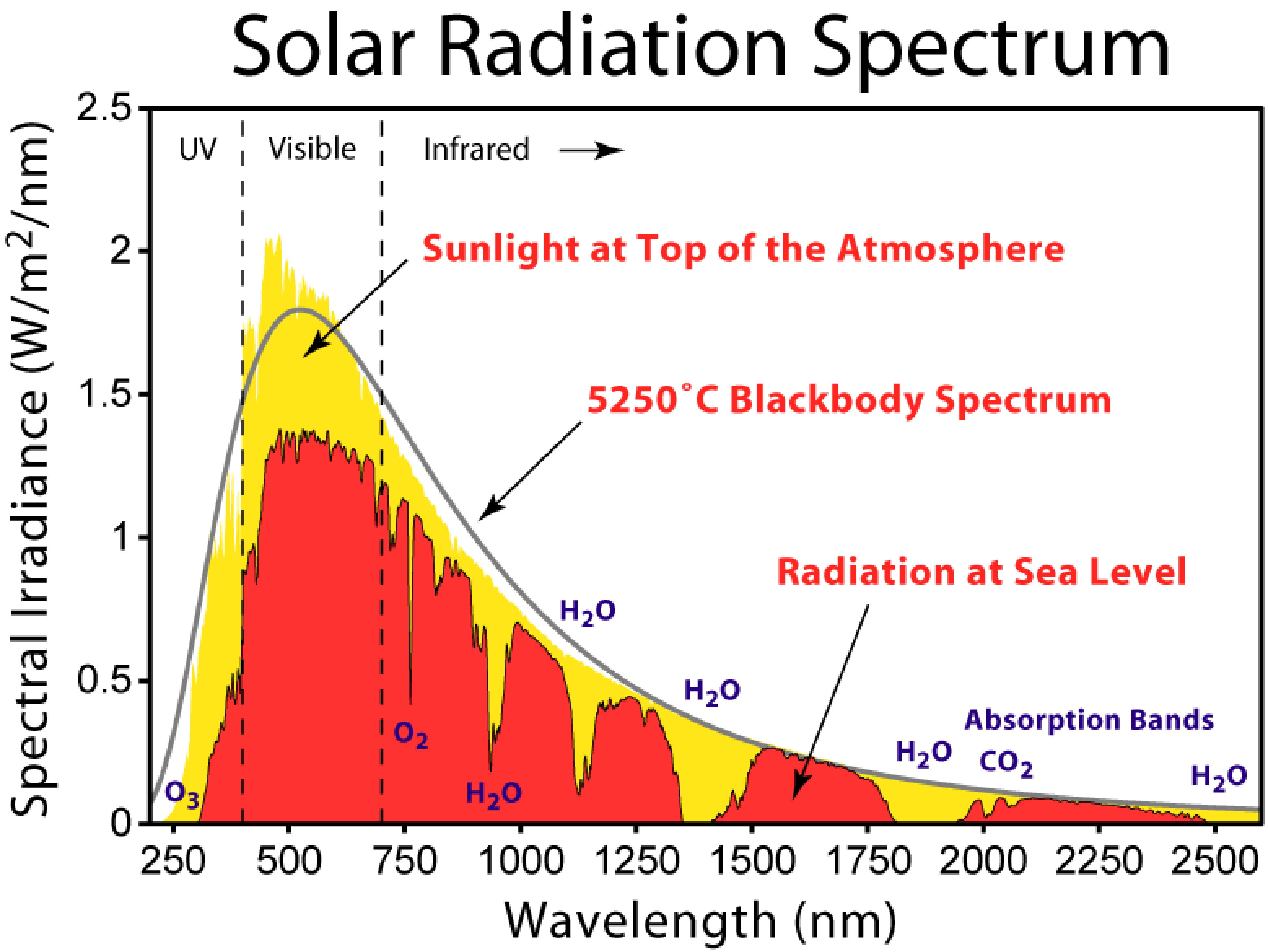
http://en.wikipedia.org/wiki/Nuclear_fusion

Nuclear Fusion in the Sun (and other stars) – the proton-proton chain reaction:

The proton–proton chain reaction occurs around 9.2×10^{37} times each second in the core of the Sun. The Sun releases energy at the mass-energy conversion rate of 4.26 million metric tons per second, (3.846×10^{26} W) or 9.192×10^{10} megatons of TNT per second. (http://en.wikipedia.org/wiki/Sun)

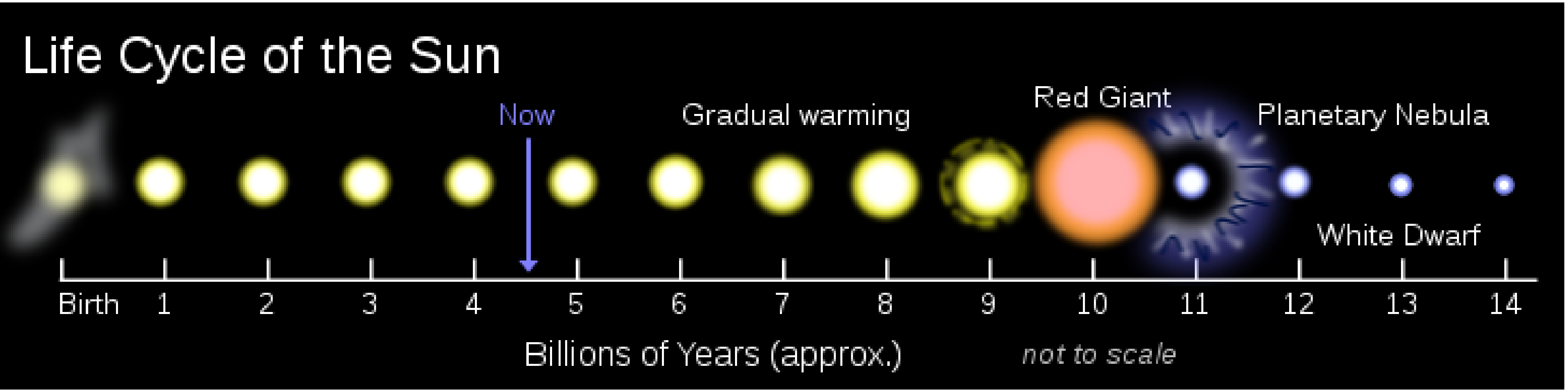


http://en.wikipedia.org/wiki/Nuclear_fusion



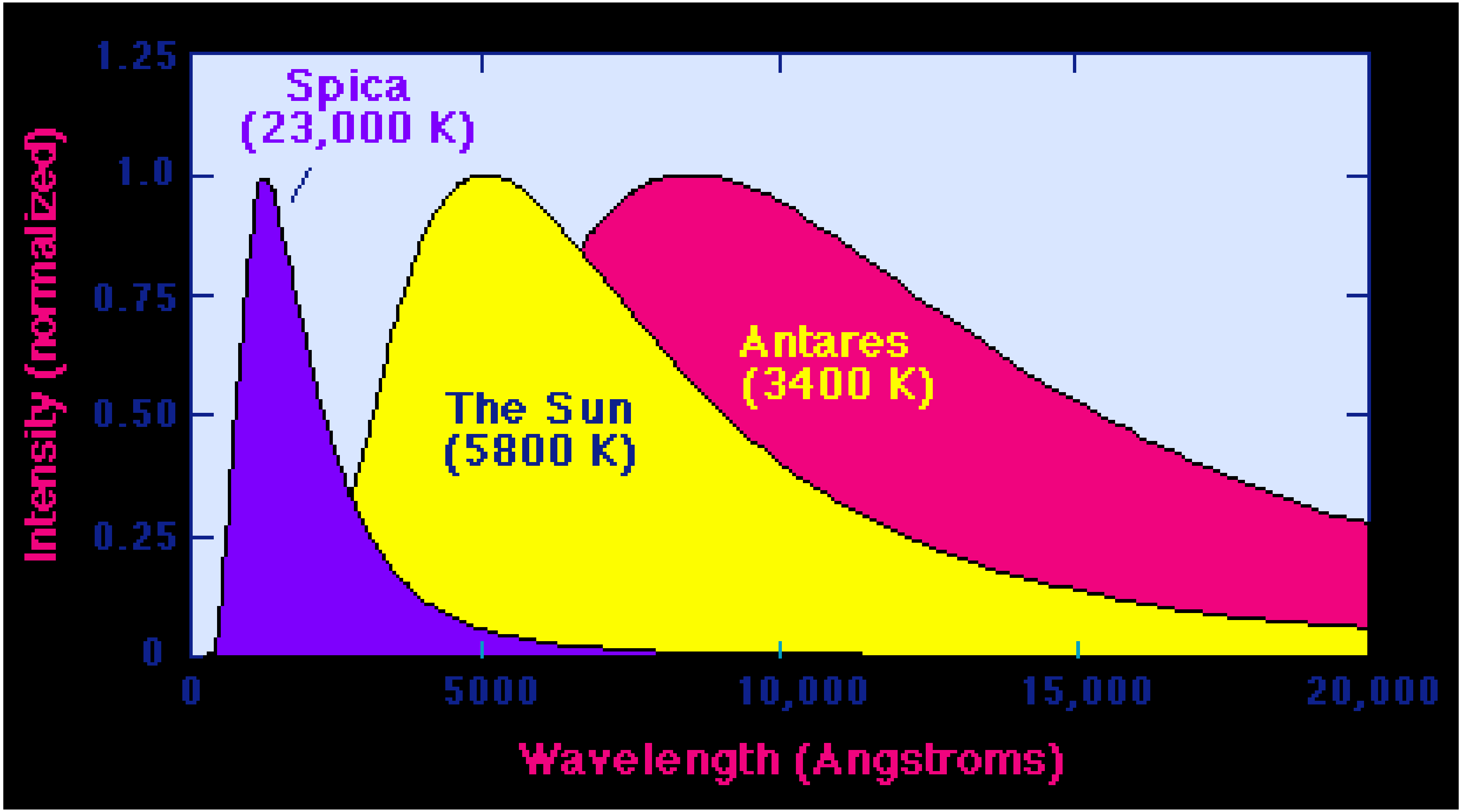
http://en.wikipedia.org/wiki/File:Solar_Spectrum.png

Life Cycle of the Sun



In about another 5 billion years, the hydrogen will be nearly depleted and the Sun's core will collapse and heat up resulting in helium fusion and the Sun will become a Red Giant with a size that will probably extend out to the present orbit of Mars.

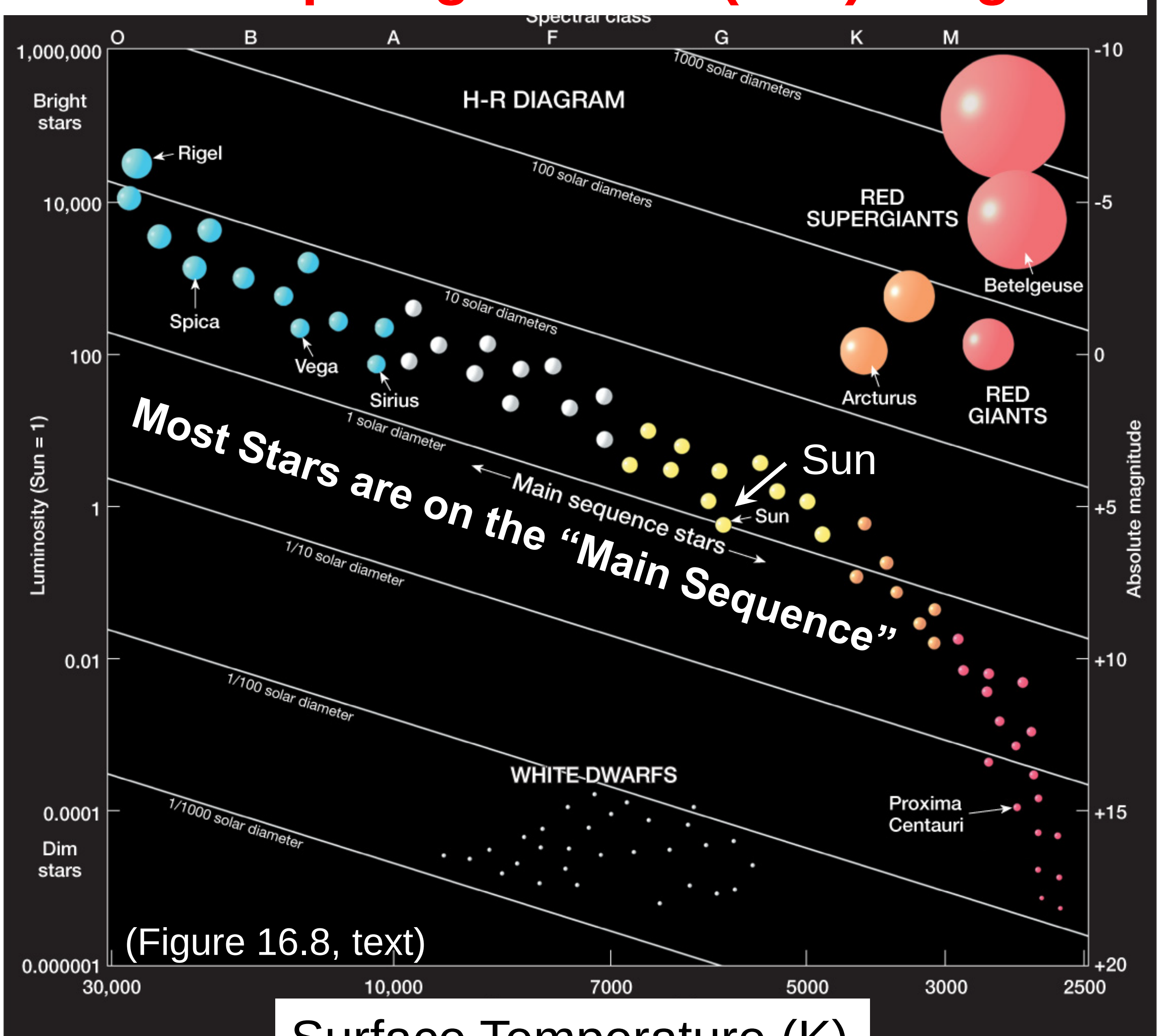
http://en.wikipedia.org/wiki/Sun



Very bright stars have more shorter-wavelength radiation and higher temperatures. These measurements are from spectrometers.
http://csep10.phys.utk.edu/astr162/lect/sun/spectrum.html

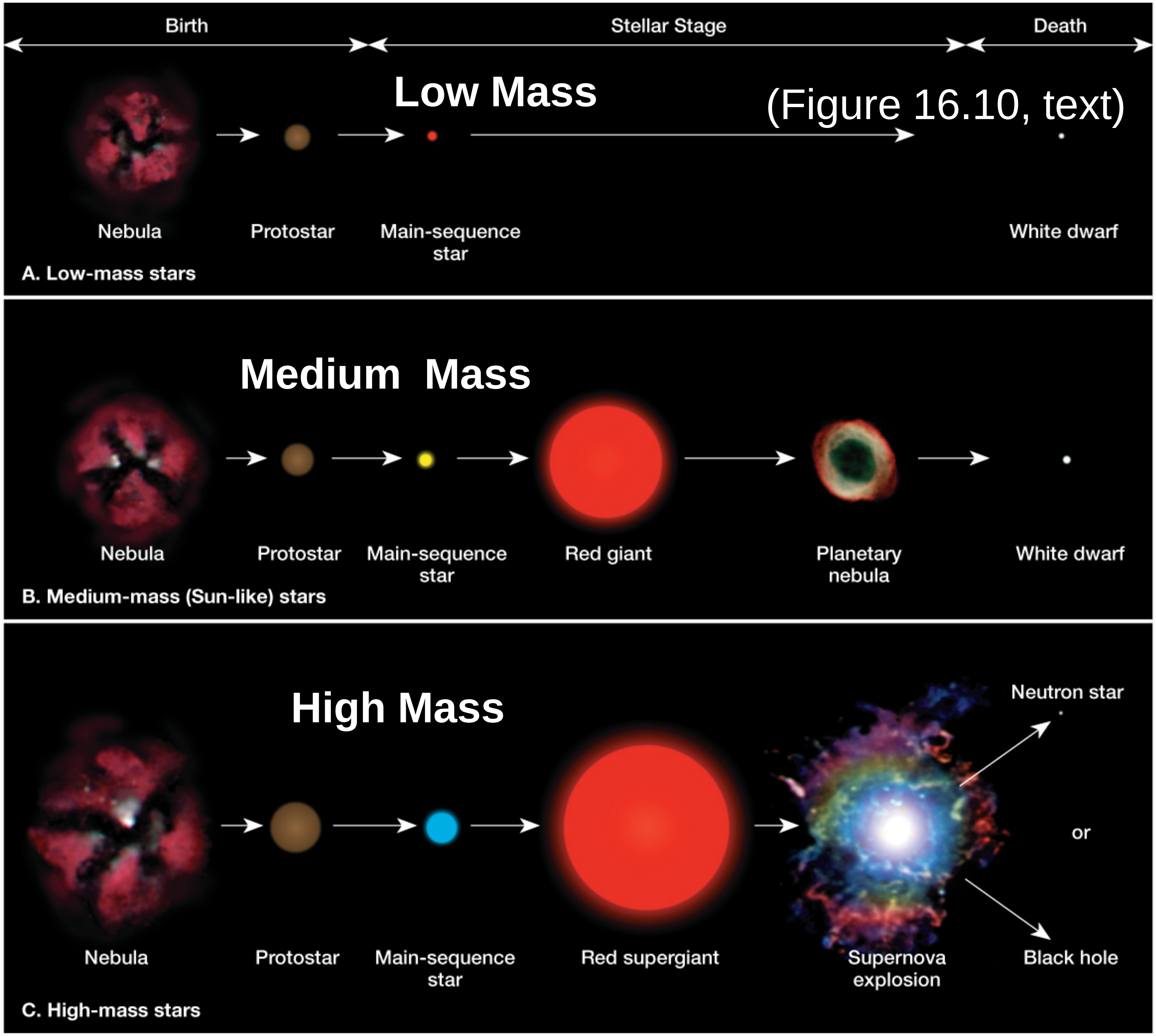
The Hertzsprung-Russell (H-R) Diagram

Luminosity (Sun = 1)



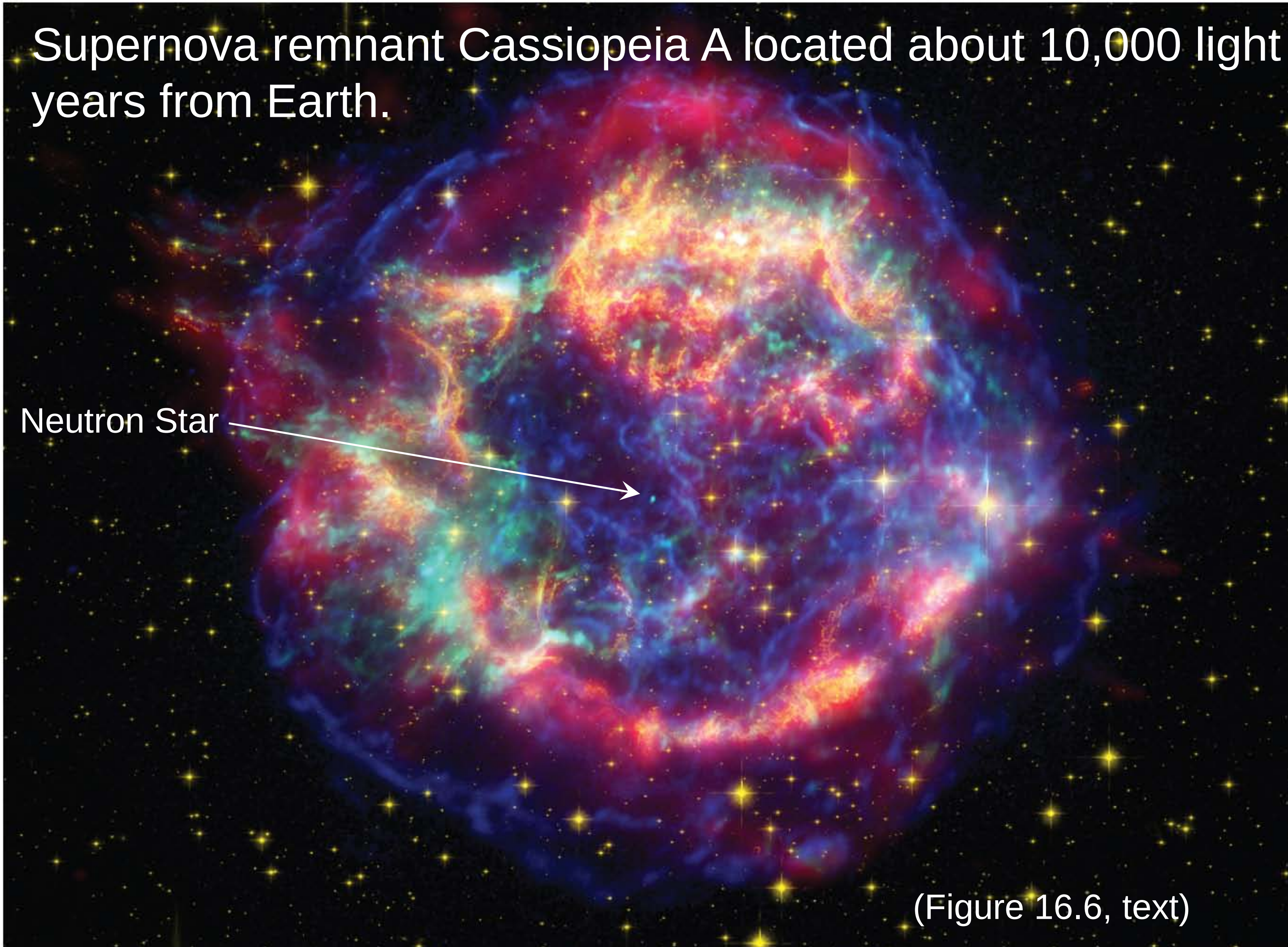
Absolute Magnitude

Surface Temperature (K)



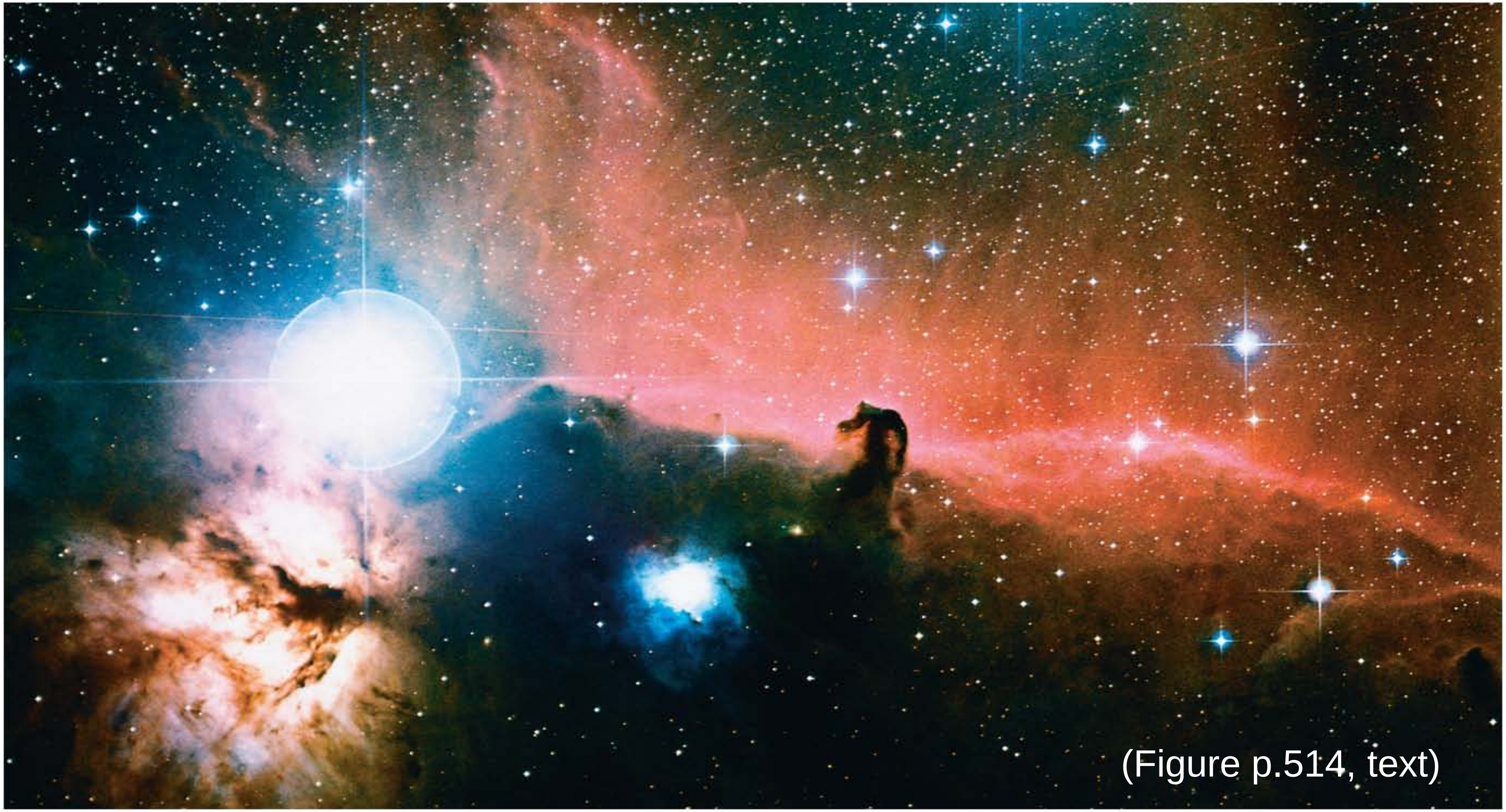
Life cycle of stars

Supernova remnant Cassiopeia A located about 10,000 light years from Earth.

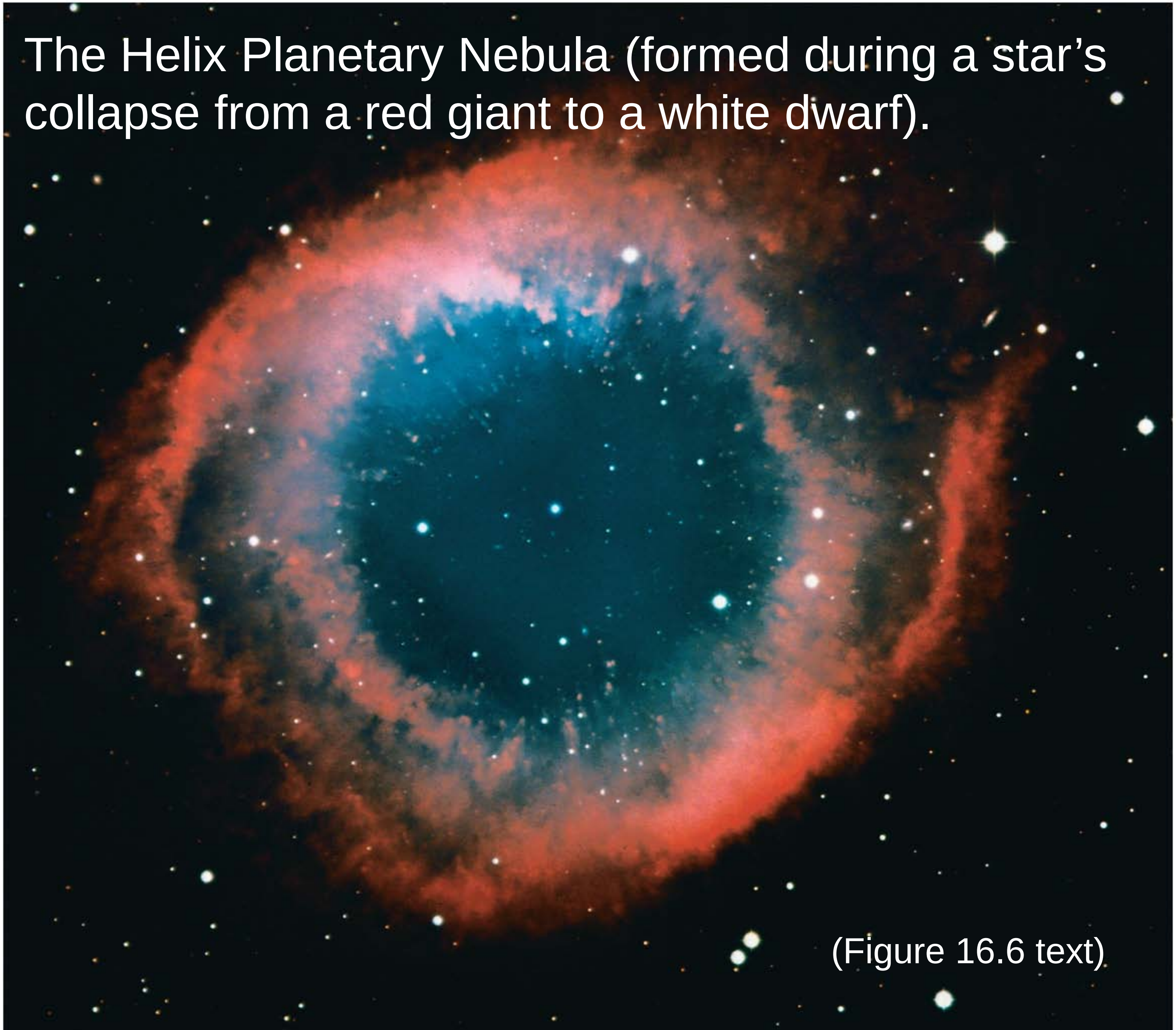


(Figure 16.6, text)

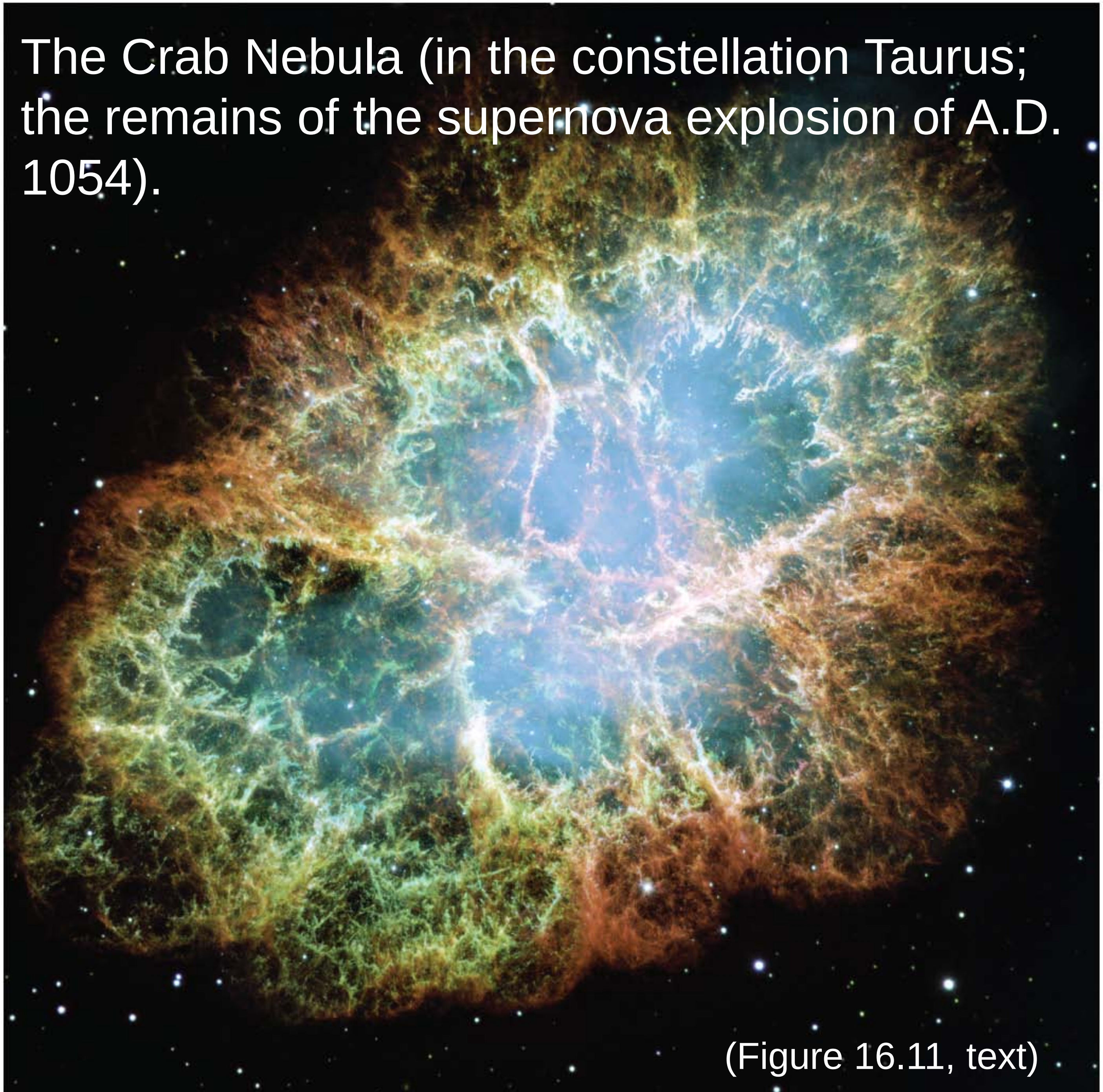
Horsehead (mostly dark) Nebula in constellation Orion.



The Helix Planetary Nebula (formed during a star’s collapse from a red giant to a white dwarf).



(Figure 16.6 text)



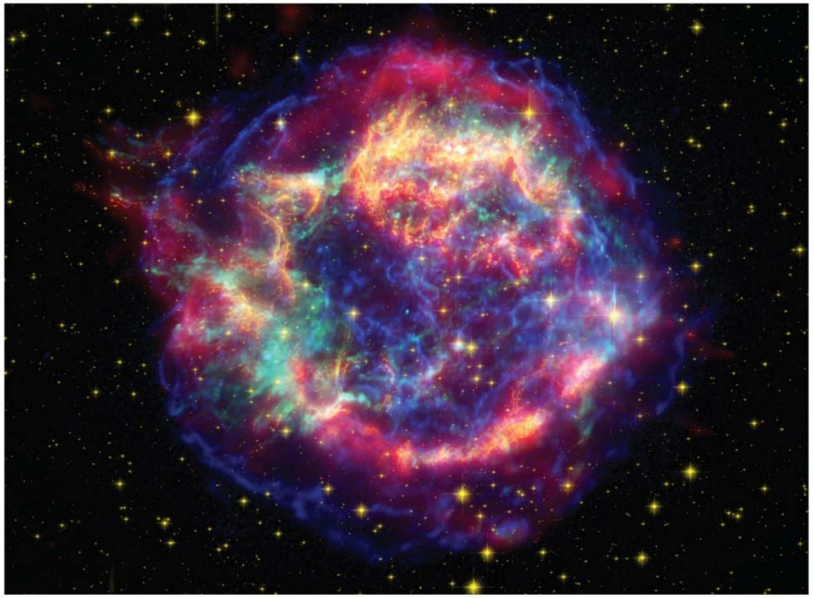
The Crab Nebula (in the constellation Taurus; the remains of the supernova explosion of A.D. 1054).

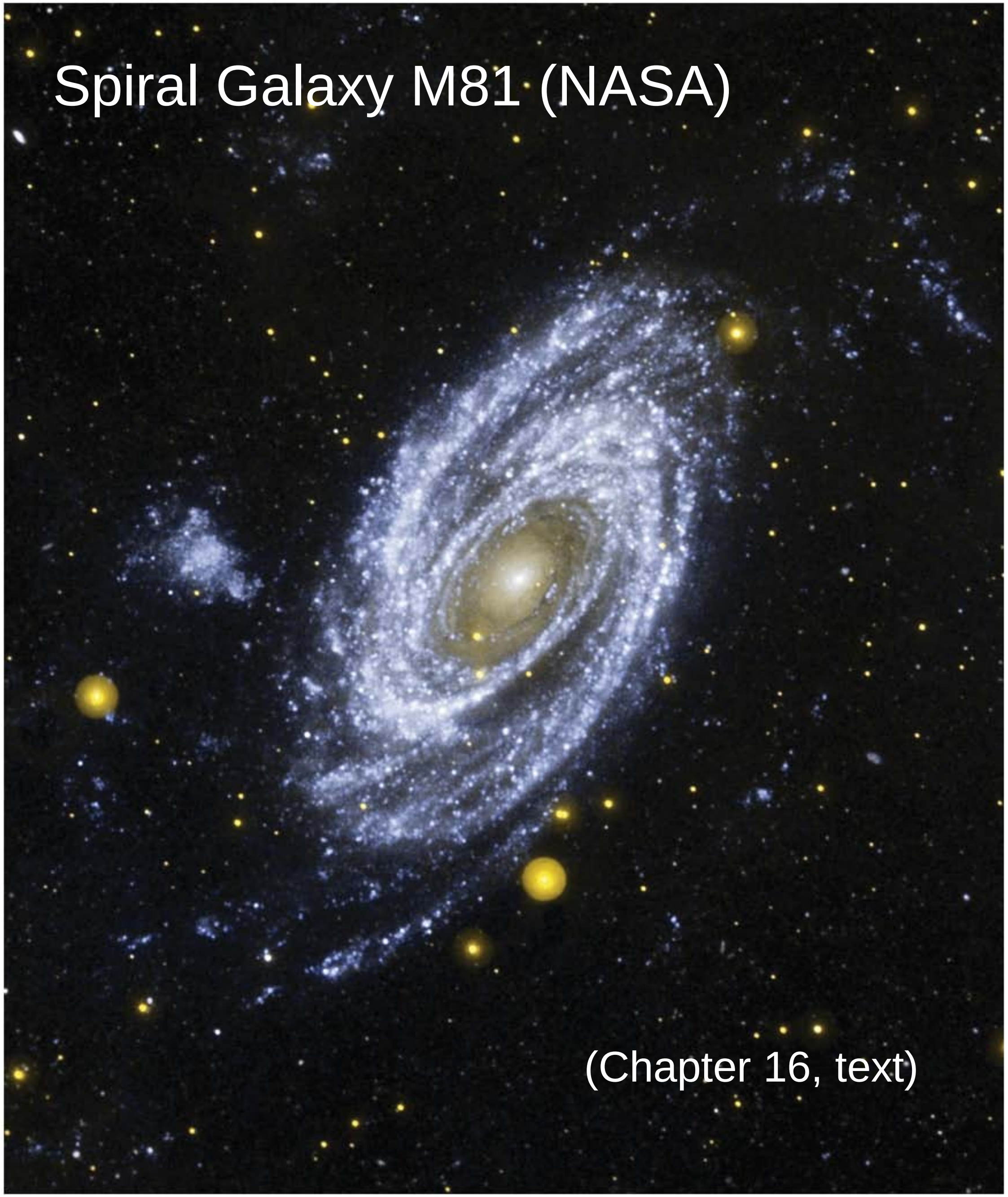
(Figure 16.11, text)

Galaxies – Typically consist of 1 billion to over 100 billion stars. Most are relatively flat. Stars in the galaxy revolve around a central area, and thus don't collapse from gravity (similar to the solar system). Most galaxies (including the Milky Way) probably have black holes in the center of the galaxy accounting for a substantial part of its mass.

Types of Galaxies: Elliptical, Spiral, Irregular, Dwarf

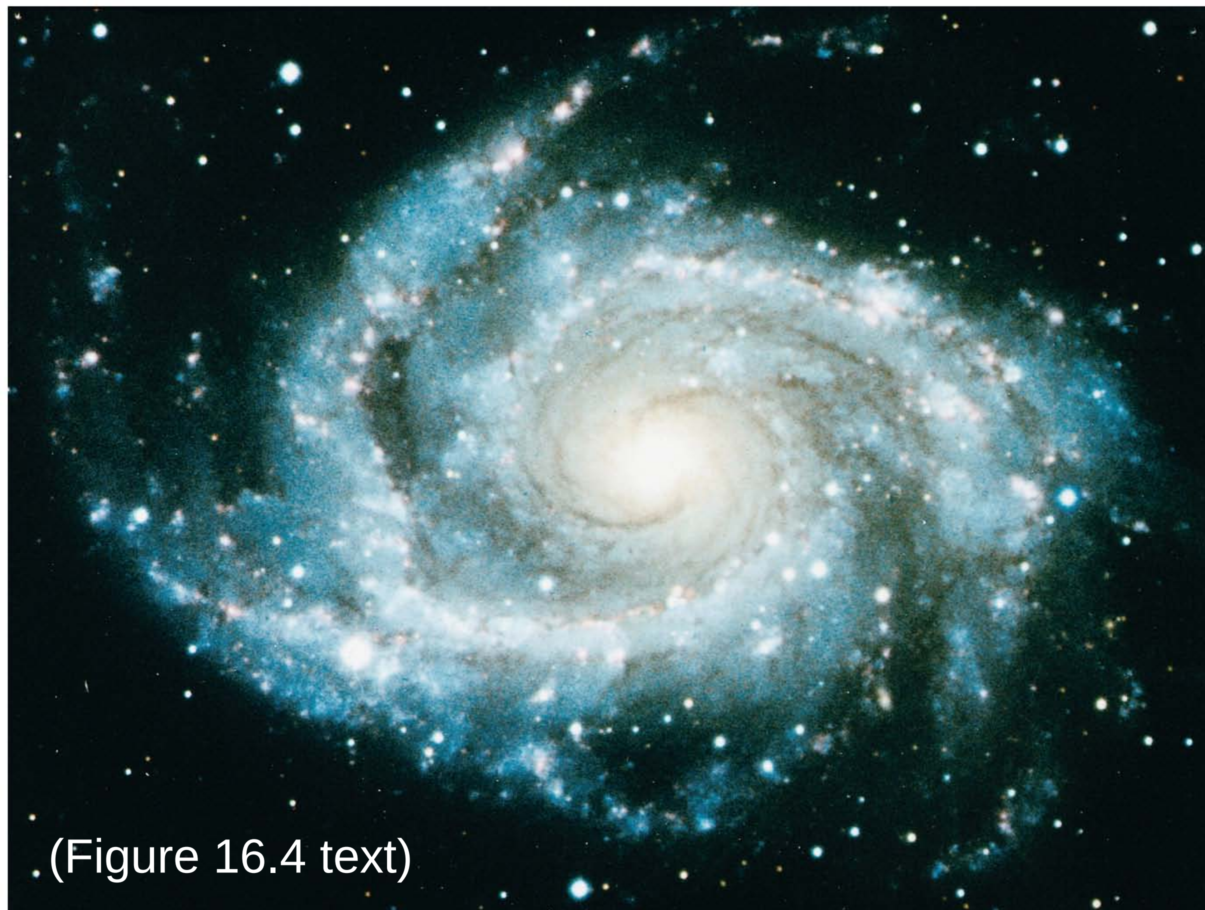
A tour of some galaxies…



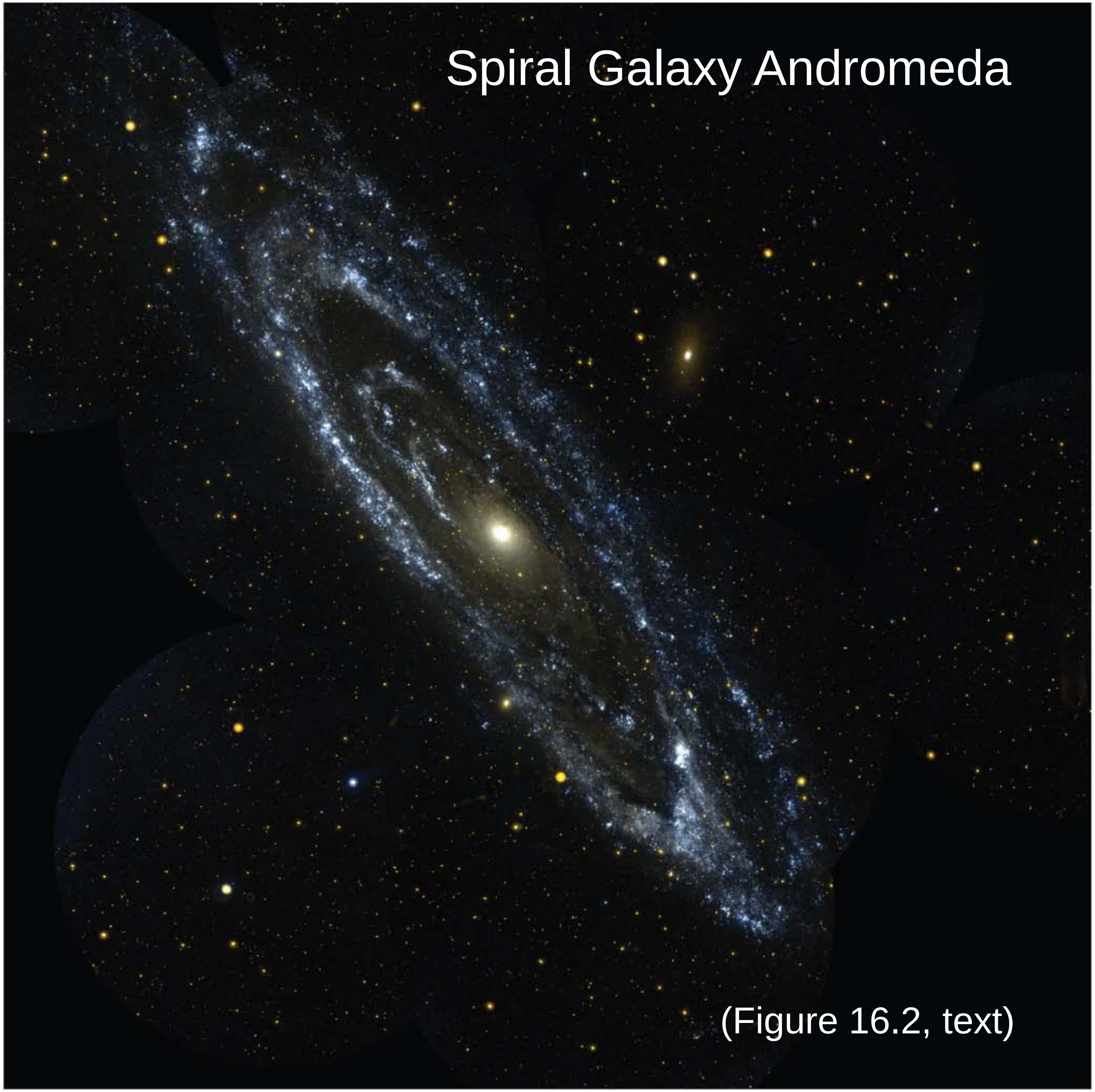

Spiral Galaxy M81 (NASA)
(Chapter 16, text)

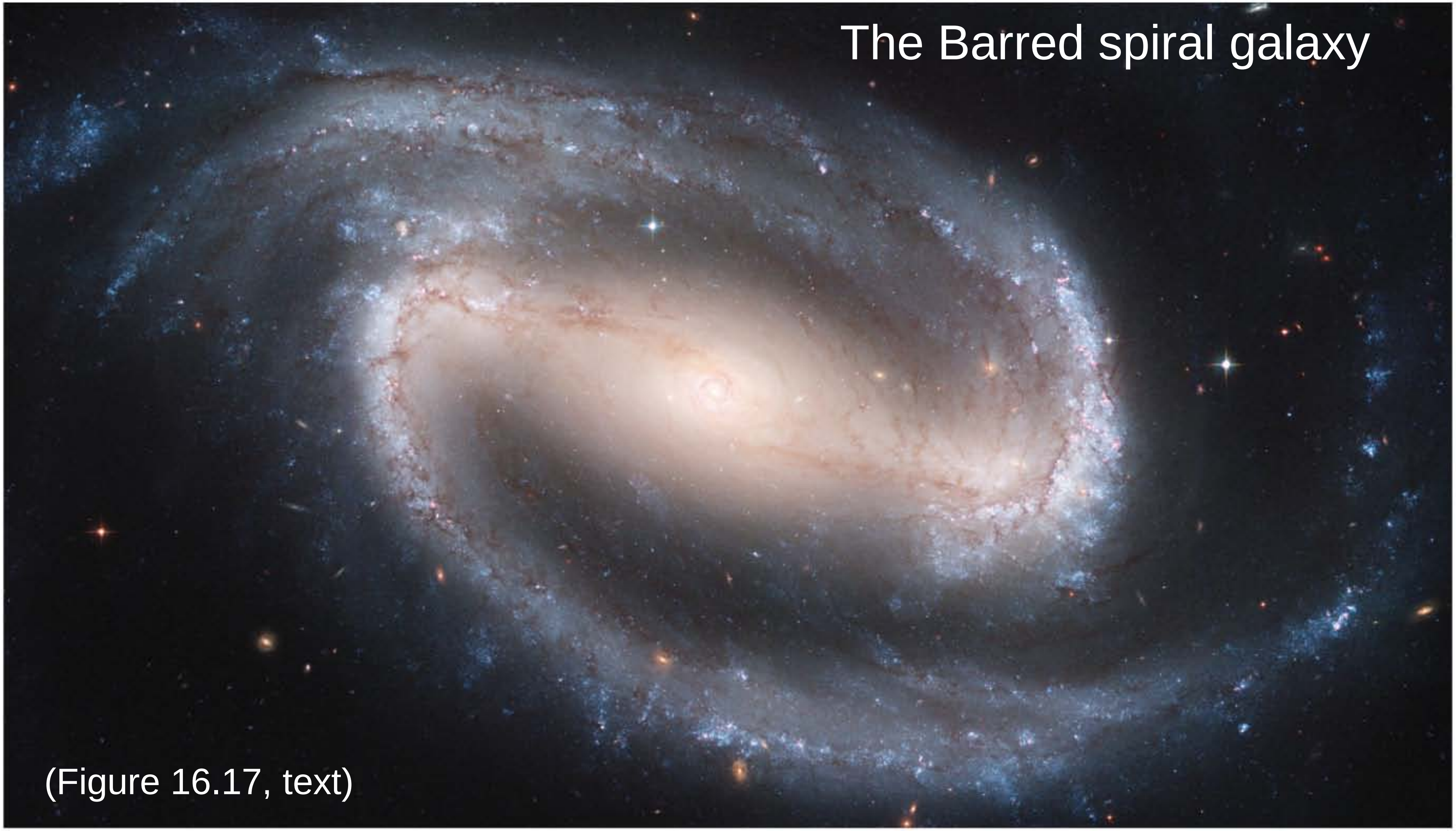
Above: The Milky Way (panorama from Earth).

Right: Spiral galaxy NGC 2997 (similar to Milky Way).



Panoramic Photo (seven frames stitched together; time lapse exposure; a quarter Moon provided the light to illuminate the mesas and foreground) of the Milky Way galaxy above Monument Valley, AZ (from Dec./Jan. 2012 issue of *National Wildlife*, www.nwf.org; http://www.nwf.org/News-and-Magazines/National-Wildlife/PhotoZone/Archives/2011/2011-National-Wildlife-Photo-Contest-Winners.aspx)


Spiral Galaxy Andromeda
(Figure 16.2, text)


The Barred spiral galaxy
(Figure 16.17, text)

Elliptical galaxy ESO 325-G004. Most elliptical galaxies are very old and probably result from two galaxies colliding.

http://en.wikipedia.org/wiki/Elliptical_galaxy

Cosmic Web (structure of the universe, how the galaxies are distributed in the universe) Videos –

Where the Galaxies Are – Margaret Geller, 1991

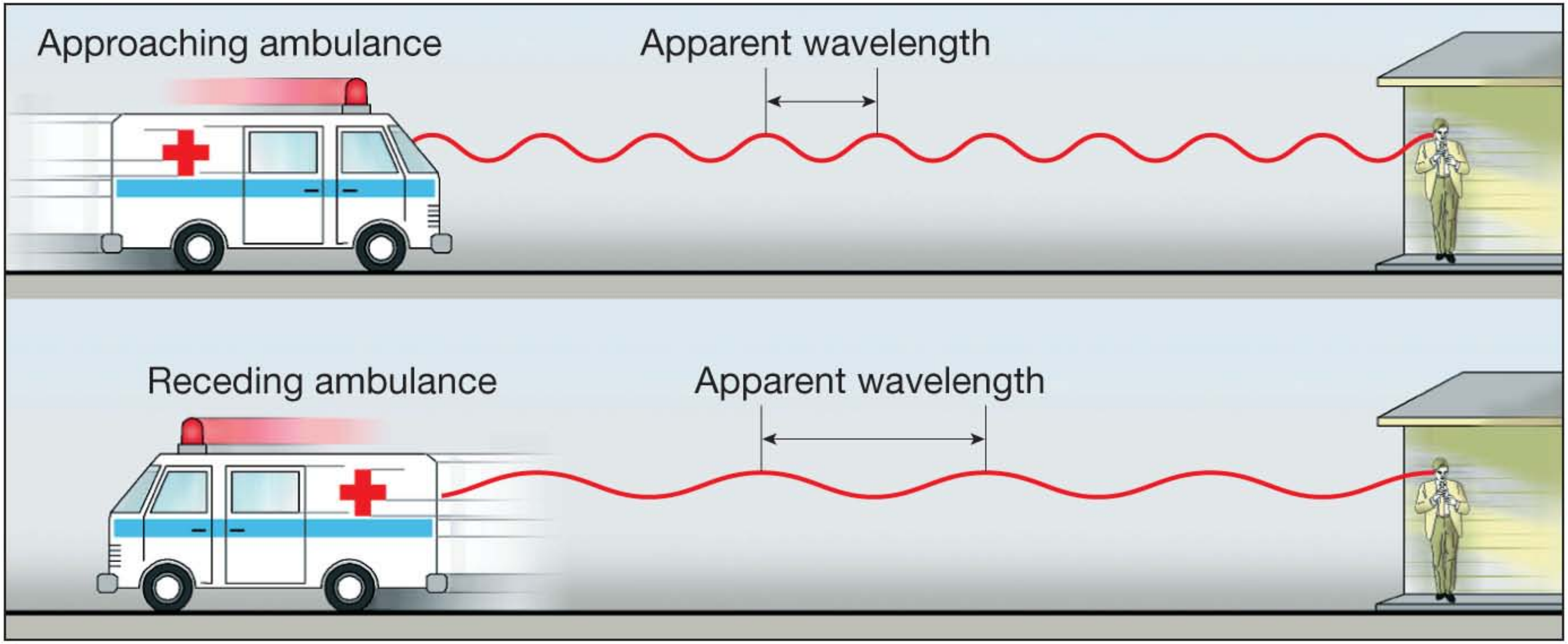
NASA /Goddard Space Flight Center Scientific Visualization Center:

Cosmic Origins Spectrograph: Large Scale Structure of the Universe

http://svs.gsfc.nasa.gov/vis/a010000/a010200/a010223/index.html

Journey Through the Cosmic Web

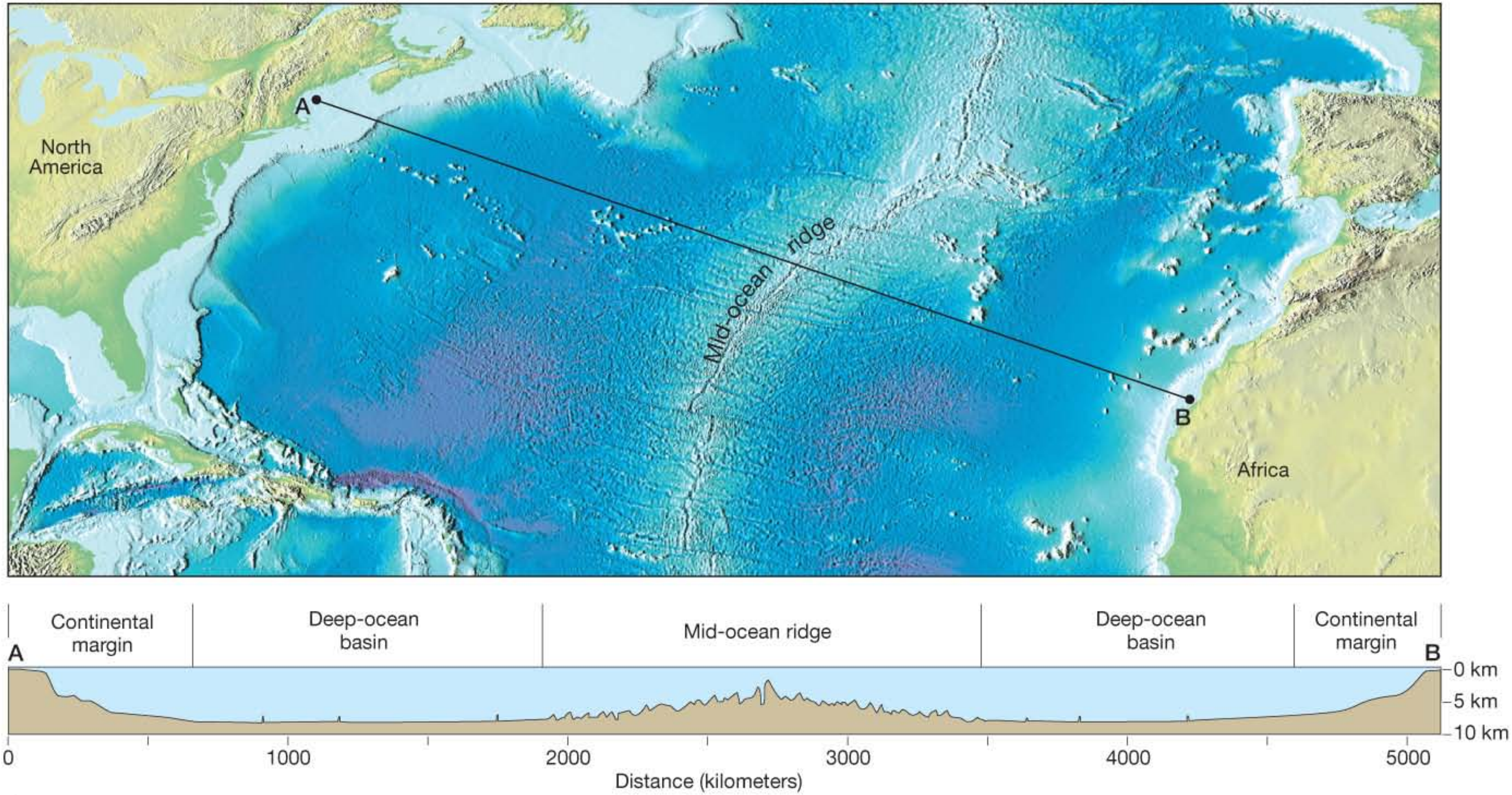
http://svs.gsfc.nasa.gov/vis/a010000/a010100/a010118/index.html



Example of Doppler Effect – Observer senses different wavelengths (hears different sounds) from approaching and receding ambulance. Note that the ambulance moving away results in longer wavelengths. The faster the ambulance is moving away, the lower the wavelength. The Doppler effect can be used to determine distances to very distant stars and galaxies by measuring the shift of hydrogen spectral peaks to longer wavelengths (a "red shift").

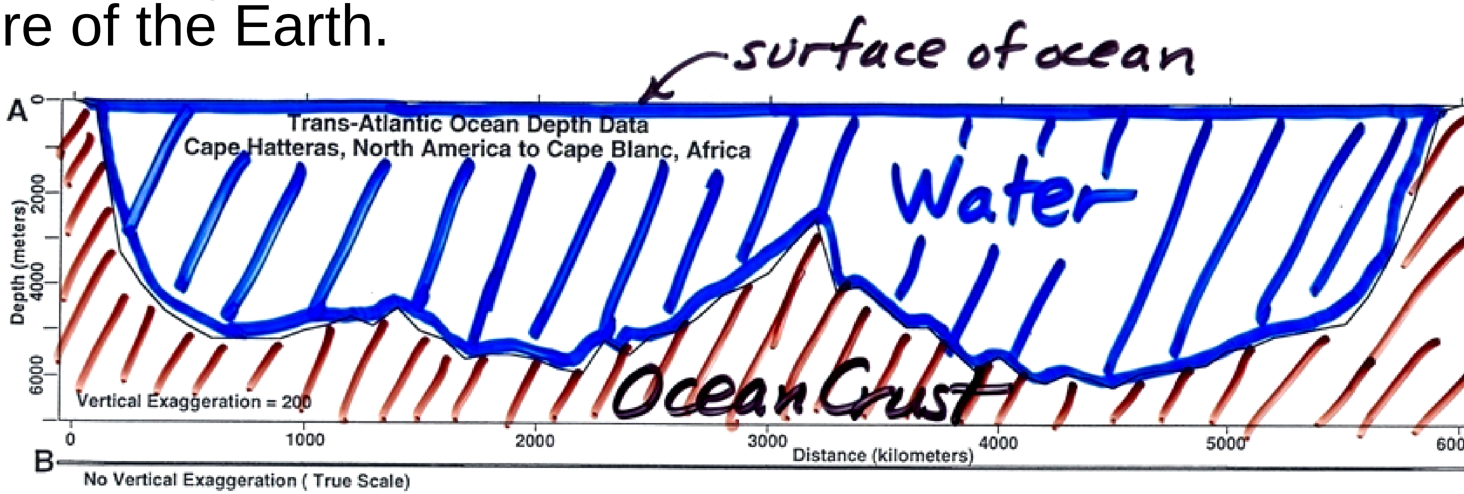
(Figure D.4, Appendix D, text)

Review of Ocean Bathymetry Exercise – Bathymetric Profile (Hwk #4) – and the concept of vertical exaggeration in figures.

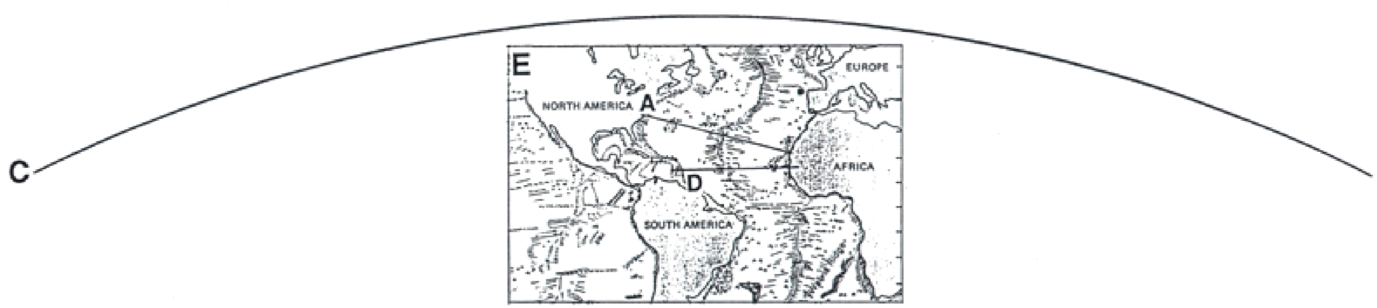


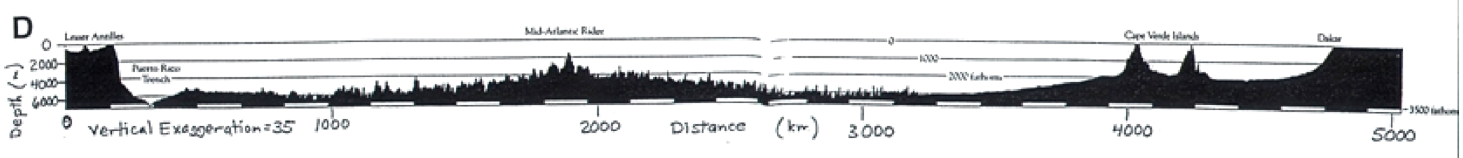
Bathymetric profile (ocean depth) across the Atlantic Ocean, Figure 9.15, text.

A. The bathymetry profile from homework #4; the ocean topography is vertically exaggerated (VE) about 200 times so that we can see details. B. The same figure at 1-to-1 (no VE) or true scale. Note that we cannot see any details of the bathymetry because the horizontal distance is so large compared to the depth. C. Same as B except including the curvature of the Earth.

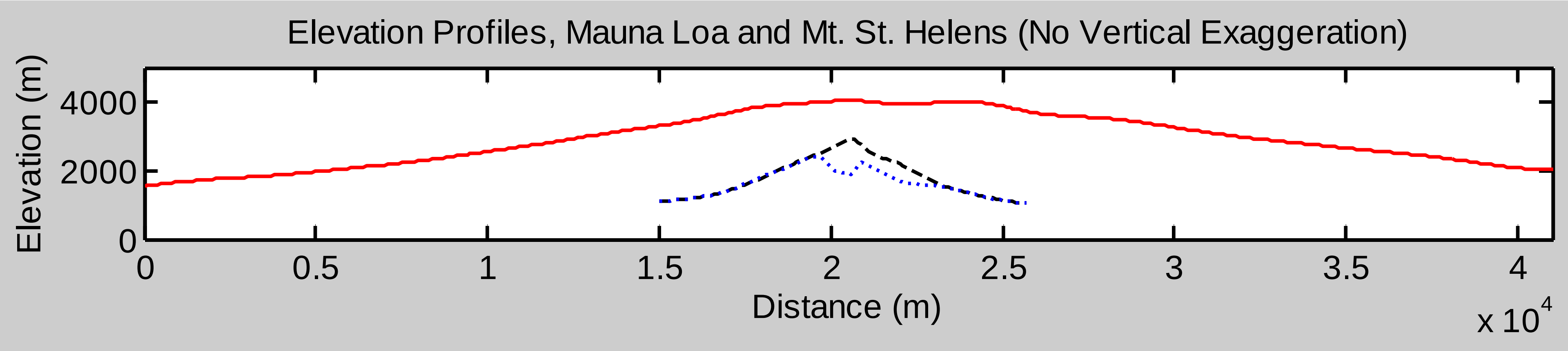


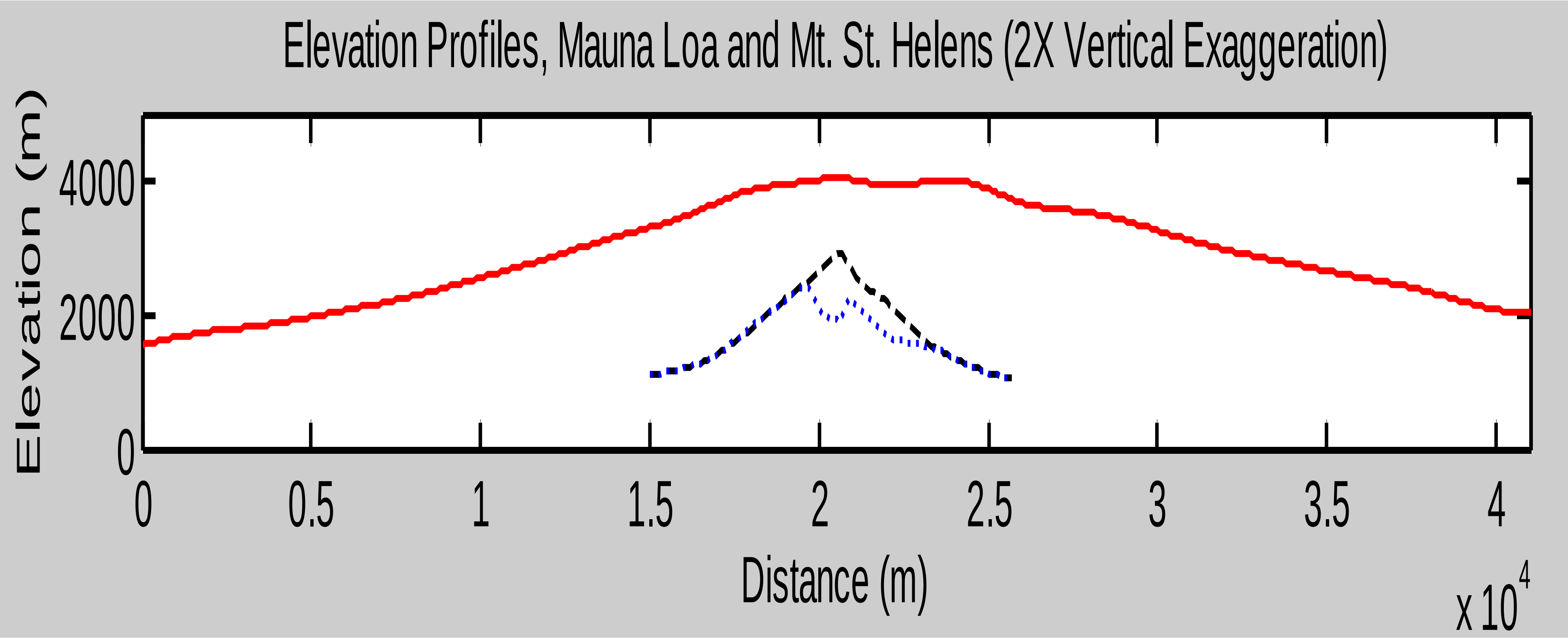
D. Detailed bathymetry (VE = 35) for profile D (see map E).





Example of elevation profiles for Mt. St. Helens and Mauna Loa volcanoes at true scale (top) and 2x VE (bottom).





Seeing Volcanoes in 3-D – Mt. St. Helens, before and after the 1980 eruption

Styrofoam topography models – each layer represents a contour line of elevation

What is Vertical Exaggeration?

True scale, or 1 to 1, or no vertical exaggeration

Vertical scale times 3

Horizontal scale same

3X vertical exaggeration

Google Earth perspective view of Mt. St. Helens, WA, volcano with no vertical exaggeration (1-to-1 scale), view looking ~ South.

Google Earth perspective view of Mt. St. Helens volcano with 2x vertical exaggeration.