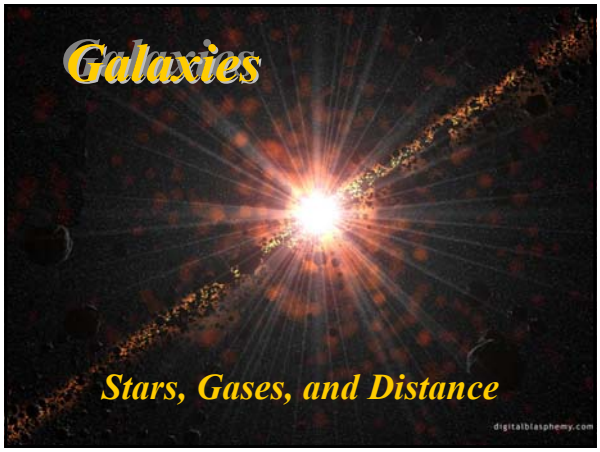
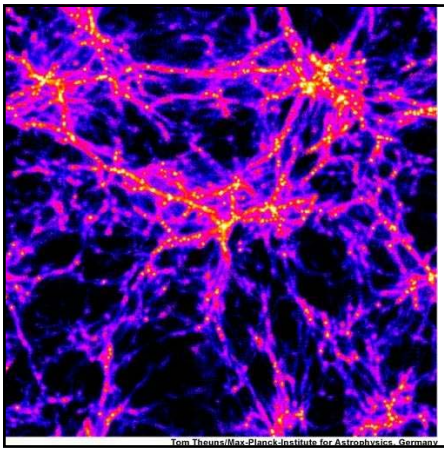




Tom Theuns/Max-Planck-Institute for Astrophysics, Germany

THEORY: Computer model of the early universe.

" Gravity arranges matter in thin filaments. High-density regions (yellow) undergo collapse and ignite bursts of star formation. These proto-galaxies stream along the filaments (red shows medium density) and meet at nodes, causing a buildup of galaxies. Low-density areas are blue" (Britt, 2001).

- As the universe expanded and cooled, the four fundamental forces became distinct
  - gravity
  - electromagnetism
  - strong nuclear forces
  - weak nuclear forces
- Quarks, then atomic particles and their antimatter partners, appeared.

- As matter and antimatter met, they annihilated each other, leaving behind energy and a slight excess of ordinary matter -- almost exclusively the lightest elements, *hydrogen and helium*.
- The faint residual heat from the Big Bang can be observed coming from everywhere in the sky.

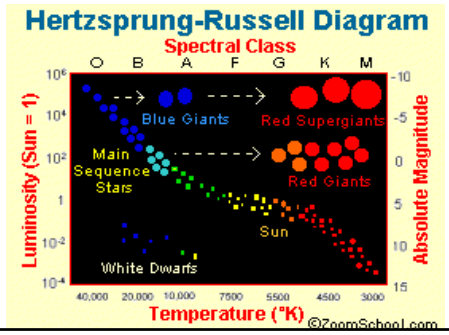
- Looking at the sun's emissions of various chemicals at specific temperatures allows scientists to better grasp what's going on. Our star becomes a multicolored laboratory.
- This image from SOHO's Extreme ultraviolet Imaging Telescope (EIT) combines images in three different wavelengths to show solar features unique to each. It reveals ionized iron at three distinct temperatures all exceeding about 1.8 million degrees Fahrenheit (1 million degrees C).

Space.com

Life of a Star

This section taken from information at Zoom School.com

http://www.enchantedlearning.com/subjects/astronomy/stars/startypes.shtml



Luminosity is the total brightness of a star

TYPE	Star
Ia	Very luminous supergiants
Ib	Less luminous supergiants
II	Luminous giants
III	Giants
IV	Subgiants
V	Main sequence stars (dwarf stars)
VI	Subdwarf
VII	White Dwarf

Giants and Dwarfs

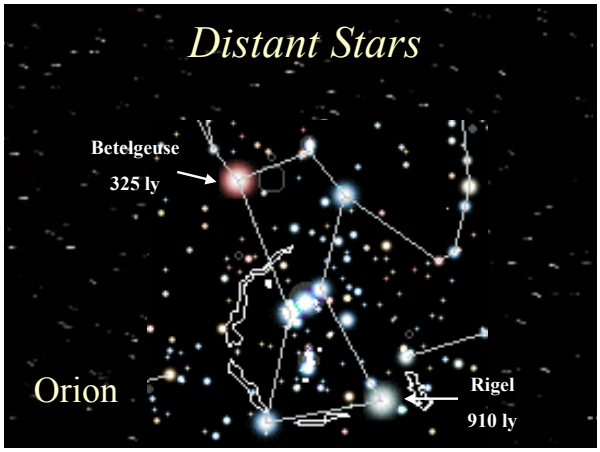
- **Giant and Supergiant Stars - Old, Large Stars**
- **RED GIANT**
  A red giant is a relatively old star whose diameter is about 100 times bigger than it was originally, and had become cooler (the surface temperature is under 6,500 K).
- They are frequently orange in color.
- Betelgeuse is a red giant. It is about 20 times as massive as the Sun about 14,000 times brighter than the Sun, and about 600 light-years from Earth.

Blue Giant

- A blue giant is a huge, very hot, blue star.
- It is a post-main sequence star that burns helium.

Supergiant

- A supergiant is the largest known type of star; some are almost as large as our entire solar system.
- Betelgeuse and Rigel are supergiants. These stars are rare. When supergiants die they supernova and become black holes.



Dwarf Stars

Dwarf stars are relatively small stars, up to 20 times larger than our sun and up to 20,000 times brighter.

Our sun is a dwarf star.

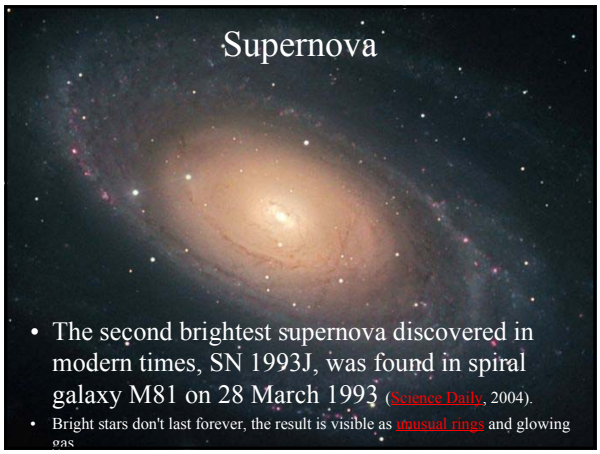
- **YELLOW DWARF**
  Yellow dwarfs are small, main sequence stars. The Sun is a yellow dwarf.
- **RED DWARF**
  A red dwarf is a small, cool, very faint, main sequence star whose surface temperature is under about 4,000 K. Red dwarfs are the most common type of star. Proxima Centauri is a red dwarf.

White Dwarf

- A white dwarf is a small, very dense, hot star that is made mostly of carbon.
- These faint stars are what remains after a red giant star loses its outer layers. Their nuclear cores are depleted. They are about the size of the Earth, but tremendously heavier. They will eventually lose their heat and become a cold, dark black dwarf.
- Our sun will someday turn into a white dwarf and then a black dwarf.
- The companion of Sirius is a white dwarf.

Brown Dwarf

- A "star" whose mass is too small to have nuclear fusion occur at its core (the temperature and pressure at its core are insufficient for fusion).
- A brown dwarf is not very luminous.



Neutron Stars

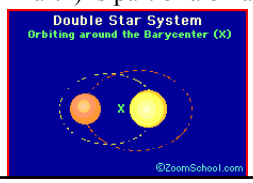
- A neutron star is a very small, super-dense star which is composed mostly of tightly-packed neutrons. It has a thin atmosphere of hydrogen. It has a diameter of about 5-10 miles (5-16 km) and a density of roughly 10^{15} gm/cm^3.

PULSAR
A pulsar is a rapidly spinning neutron star that emits energy in pulses.

Binary Star

•A binary star is a system of two stars that rotate around a common center of mass (the barycenter). About half of all stars are in a group of at least two stars.

•Polaris (the pole star of the Northern Hemisphere of Earth) is part of a binary star system.

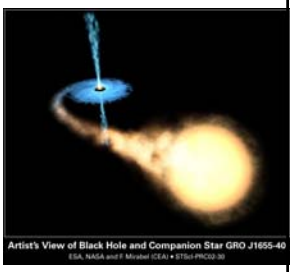


Binary Stars

- **Double Star**
  A double star is two stars that appear close to one another in the sky.
- Some are true binaries (two stars that revolve around one another); others just appear together from the Earth because they are both in the same line-of-sight.

Black Holes

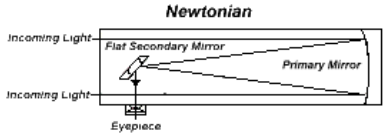
- When a star about 30 times the mass of the Sun dies, the resulting core is called a black hole or dark body.
- This a small, very dense object with a force of gravity so strong that nothing can escape from it, not even light.



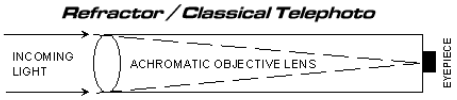
http://hubblesite.org/newscenter/newsdesk/archive/releases/2002/30/text/

Telescope Basics

- Reflecting

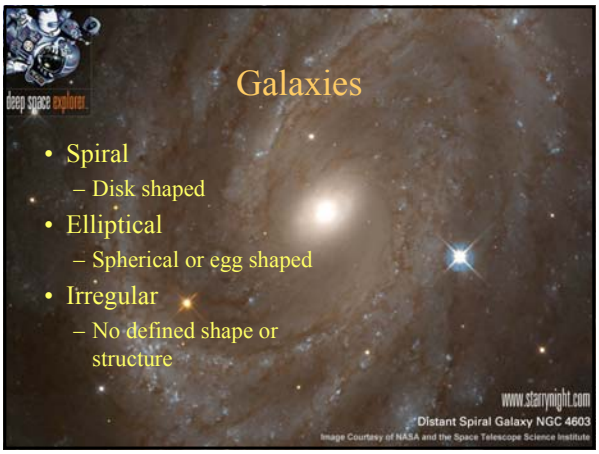


- Refracting



Galaxies

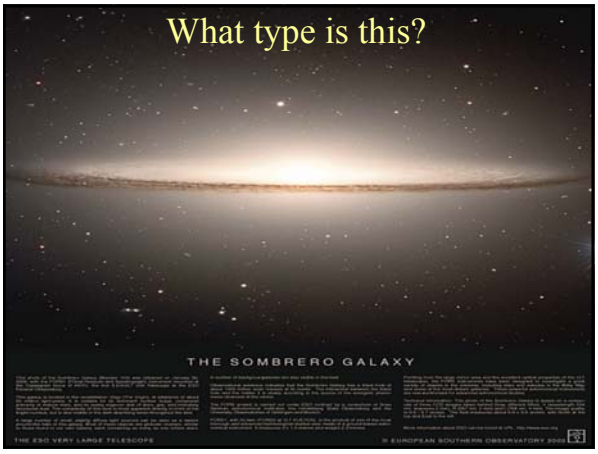
- Spiral
  - Disk shaped
- Elliptical
  - Spherical or egg shaped
- Irregular
  - No defined shape or structure



M81 is like a twin of the Milky Way

"… near the Big Dipper in the night sky and can be found with binoculars. It is 12 million light-years away. White objects in the image are foreground stars in our own galaxy" (Britt, 2003).

"…random motion will cause two protogalaxies to pass so close to each other that they will experience fatal attraction… they will fall into each other" (Møller as cited by Britt, 2001).



Light Year

The distance light travels in one year

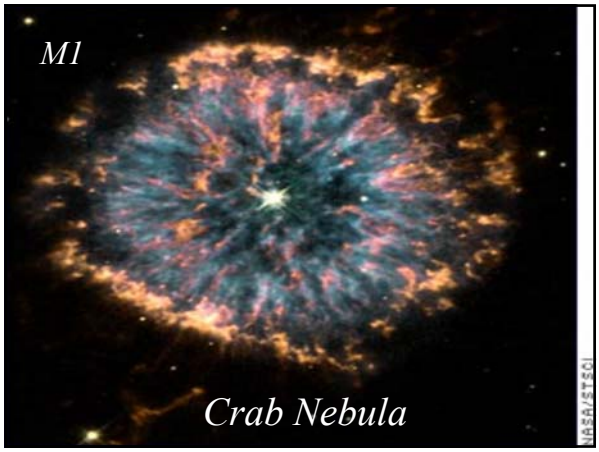
- Light travels at 3.0 x 10^8 m/s in empty space
- One Light year = 9.5 x 10^{15} m
- A car at highway speed would take over 10 million years to travel that distance
- 3 nearest stars are 4.3 ly away

Image Courtesy of Keek Veenenbos

Red Shift & Blue Shift

- Red Shift- cooler star
  - greater intensity at longer wavelengths
- Blue Shift- hotter star
  - more intense at shorter wavelengths

- When light passes through a prism it displays many different colors
- The color of a star is related to its temperature


M1
Crab Nebula


Orion Nebula
• M42, Flame Nebula, and Horse Head in Orion


The Eagle Nebula
Young stars

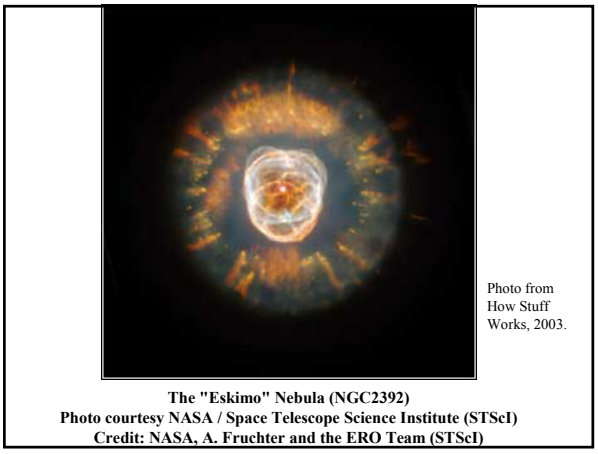
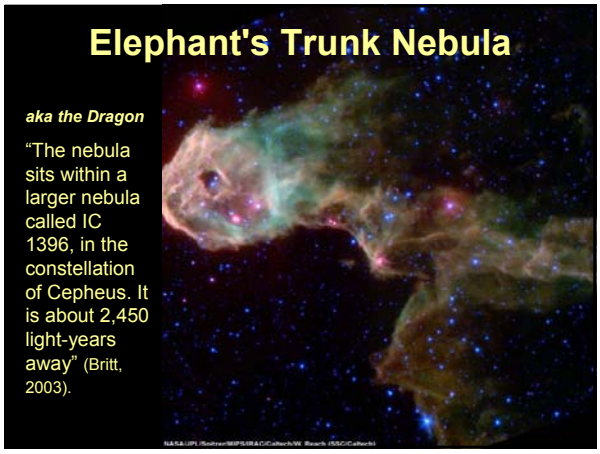
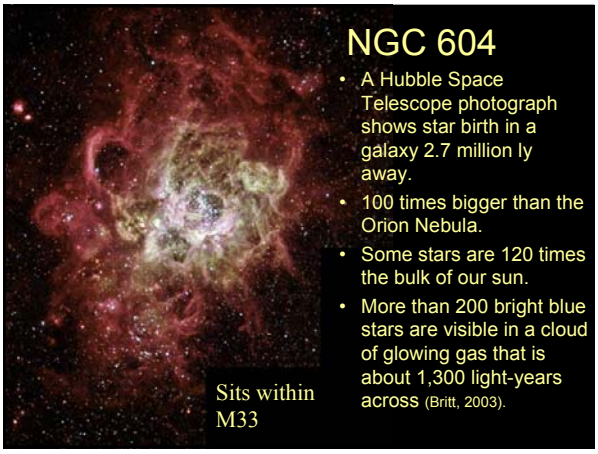
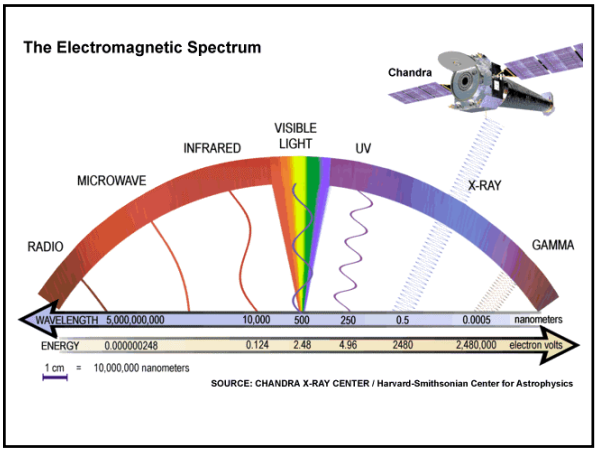


Photo from How Stuff Works, 2003.
The "Eskimo" Nebula (NGC2392)
Photo courtesy NASA / Space Telescope Science Institute (STScI)
Credit: NASA, A. Fruchter and the ERO Team (STScI)


Elephant's Trunk Nebula
aka the Dragon
"The nebula sits within a larger nebula called IC 1396, in the constellation of Cepheus. It is about 2,450 light-years away" (Britt, 2003).


NGC 604
• A Hubble Space Telescope photograph shows star birth in a galaxy 2.7 million ly away.
• 100 times bigger than the Orion Nebula.
• Some stars are 120 times the bulk of our sun.
• More than 200 bright blue stars are visible in a cloud of glowing gas that is about 1,300 light-years across (Britt, 2003).
Sits within M33

Although light from a glowing object contains many colors, the color that we see when we look directly at any hot object, including a star, is determined by the wavelength at which the object emits the most light.



Difference in Telescopes…

- Chandra sees the universe in x-rays.
- Hubble sees the universe in visible light, ultraviolet, and infrared.
- Spitzer is devoted to infrared observations at specific wavelengths Hubble can't detect.

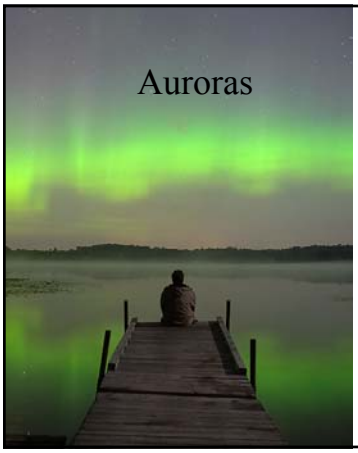
Northern Lights

fun facts

- visible manifestation of the high-energy electrons
- reds and greens of oxygen and hydrogen
- purples and pinks of nitrogen
- Typical 3-hour aurora discharges about 100 million kW hours of electric energy
- enough energy to power a medium-sized city of 250,000 for nearly 9 days
- = about 6 days of energy output by large nuclear power plant

- Oxygen at lower altitudes, about 60 miles up, produces a brilliant yellow-green, the brightest and most common auroral color.
- Ionized nitrogen molecules produce blue light, and neutral nitrogen glows red.
- The nitrogens create the purplish-red lower borders and rippled edges seen in some of the most dazzling aurora.

Britt (2003). Space.com



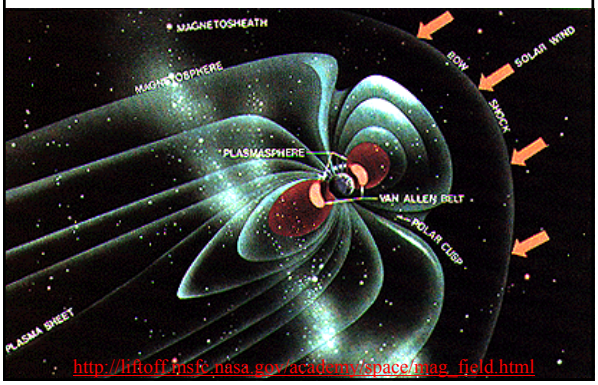
•*aka* Northern Lights

•So, what causes auroras?

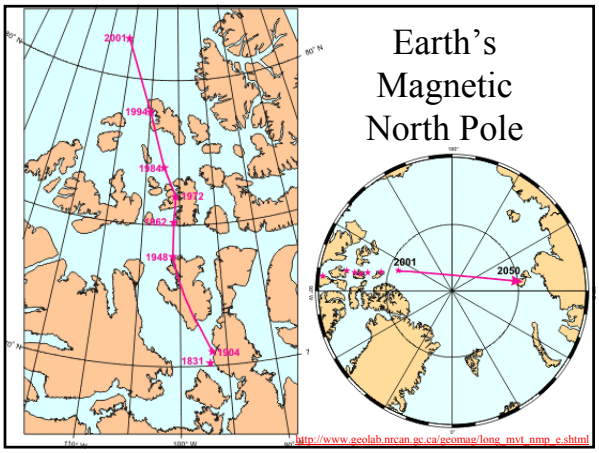
Picture by Chris VenHaus

- The Northern Lights are created when a solar storm interacts with Earth's magnetic field.
- The field lines emanate from the planet's poles and extend far beyond the atmosphere.

Earth's Magnetic Field



http://ltpoff.gsfc.nasa.gov/academy/space/mag_field.html

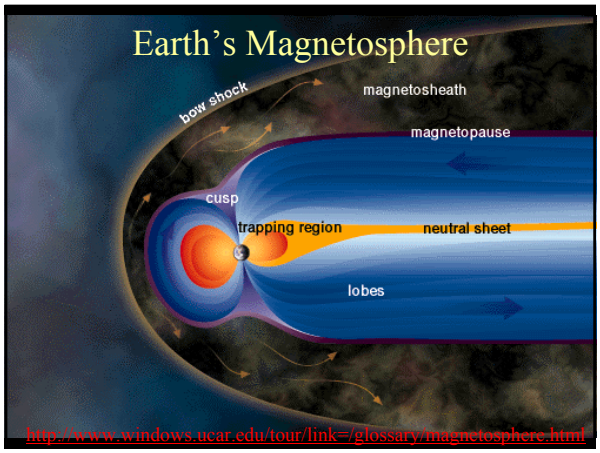


Earth's Magnetic North Pole

http://www.geolab.nrcan.gc.ca/geomag/long_mvt_nmp_e.shtml

- The Earth has a magnetic field with north and south poles.
- The magnetic field of the Earth is surrounded by the magnetosphere.
- The magnetosphere keeps **most** of the particles from the sun, carried in solar wind, from hitting the Earth.
- However, some particles from the solar wind can enter the magnetosphere. When this happens the particles create the auroral light shows we see in the evening sky.
- These particles can also interfere with electronic equipment, ie cell phones, computers, etc.

(UCAR, 2000)

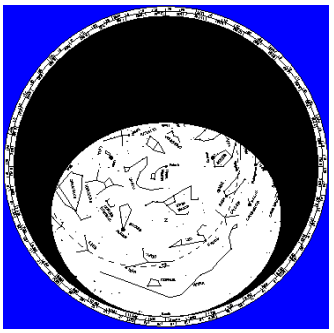


http://www.windows.ucar.edu/tour/link=/glossary/magnetosphere.html

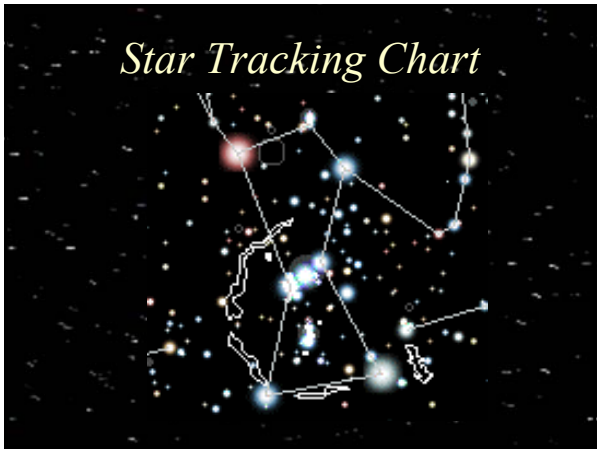
- The Sun and other planets have magnetospheres, but the Earth has the strongest one of all the rocky planets.
- The Earth's north and south magnetic poles reverse at irregular intervals of hundreds of thousands of years.
- In addition, the poles wander over shorter periods of time (hundreds of years).

(UCAR, 2000)

Planisphere



http://www.washjeff.edu/physics/plan.html



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- University Corporation for Atmospheric Research (2000). *Windows to the Universe*. Retrieved 12/19/03 from website http://www.windows.ucar.edu/

Other Resources:

- http://www.geolab.nrcan.gc.ca/geomag/where_nmp_e.shtml
- http://www.washjeff.edu/physics/plan.html
- http://www.celestron.com/education/tel4ast.htm