# Astro 301/ Fall 2006

# (50405)

# Introduction  to Astronomy

http://www.as.utexas.edu/~sj/a301-fa06


Instructor:  Professor  Shardha Jogee

TAs: Biqing For, Candace Gray, Irina Marinova


Lecture 2:  Tu Sep 5

## ***Some topics we will address***

Constituents of the Universe: stars, galaxies, planets, dark matter dark energy.

What physical laws govern the evolution of the Universe from the Big Bang to now?

When and how did stars, planets, galaxies, and black holes form?

How do stars form, shine and die? Why are we ‘stardust?’

How did galaxies like our own Milky Way form? How will they evolve?

What is the role of dark matter and dark energy?

## Recent and Upcoming Topics in class

-- Recap: Course Overview and Basic Math Skills

-- Natural units in Astronomy

-- Overview of Astronomical Objects
- Building blocks of matter: protons, electron, neutrons, and atoms
- Stars
- Brown Dwarfs, Planets, and Moons
- Death of Stars: Planetary Nebulae, White Dwarfs, Supernovae remnants
- Why is human life `star stuff'?'
- Different Type of Nebulae: Star-forming nebulae vs Planetary nebulae
- Galaxies and the Milky Way

-- Scales and Distances: From the infinitesimal to the grandest

-- Angular scales and sizes

-- Timescales : From the earliest epochs to the present day

# ***Basic Math Skills For This Course***

- For this class, you need to master **all the basic math skills in Appendix C** of the textbook (also posted on the class website) by the next lecture. e.g.,
  - Powers of 10 and Scientific Notation
  - Metric or SI units (e.g., m for length , kg for mass, s for time)
  - Unit conversions : e.g., from Angstrom, pc, ly to m, from years to seconds, etc

**Examples**

Radius of H atom = 0.00000000005 m = $5.0 \times 10^{-11}$ m

Radius of Earth = 6,380,000 m = $6.38 \times 10^{6}$ m

Radius of Sun = 696,000,000 m = $6.96 \times 10^{8}$ m

$10^{-4}$ = 1 divided by $10^{4}$ = $1/10^{4}$ = 1/ 10000 = 0.0001

1 km =1000 m = 0.62 mile= 1094 yards

1 kg = 1000 g = 2.205 pounds

1 h = 60 min = 3600 s

1 year = 365 days= 365 x24 h = 365x24x60 s = 31,500,000 s

- Symbols and conventions for the course: see in-class notes

# ***Lecture 2***

## Announcements

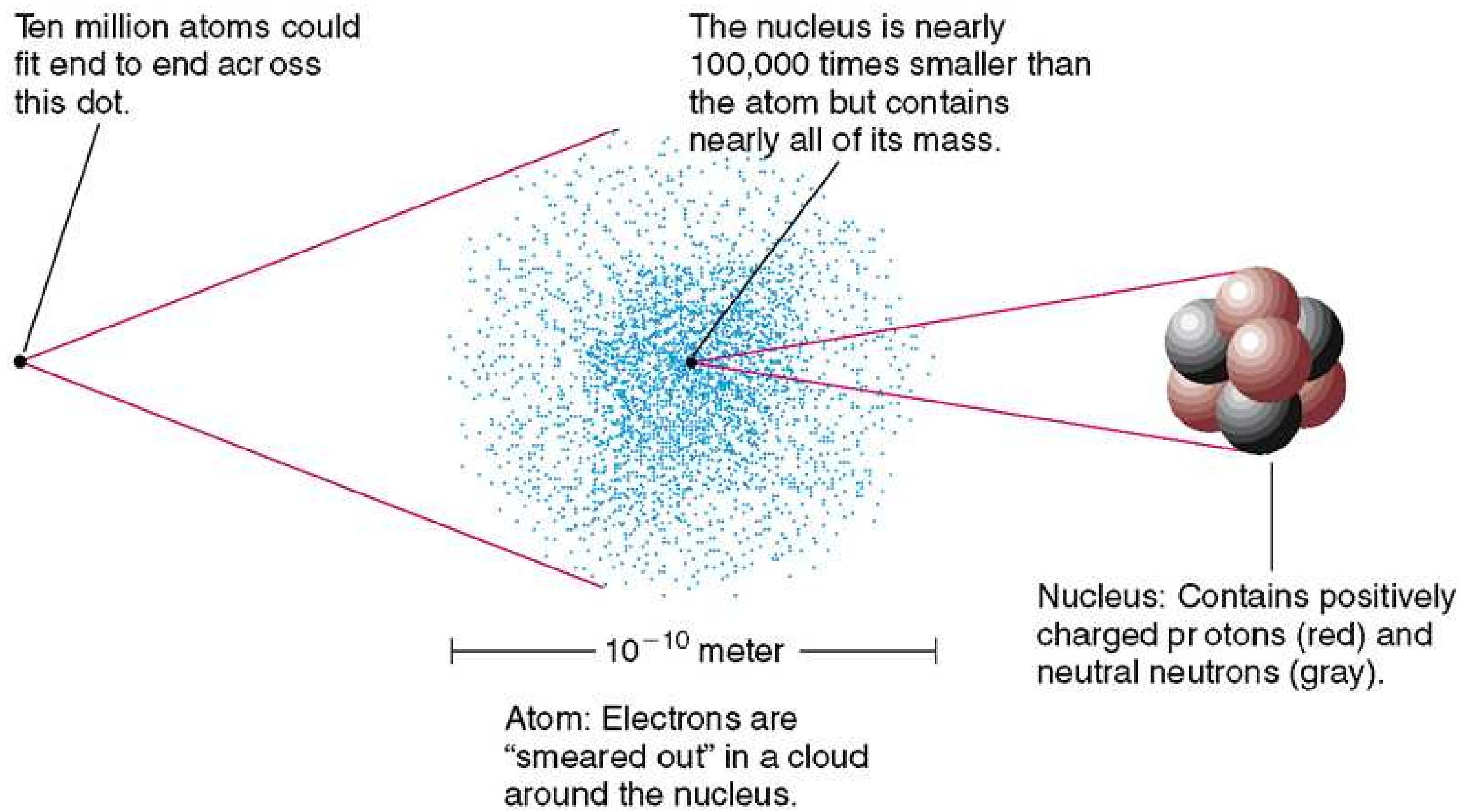
1. See class website for latest announcements

2. Quiz on Tu Sep 12 based on

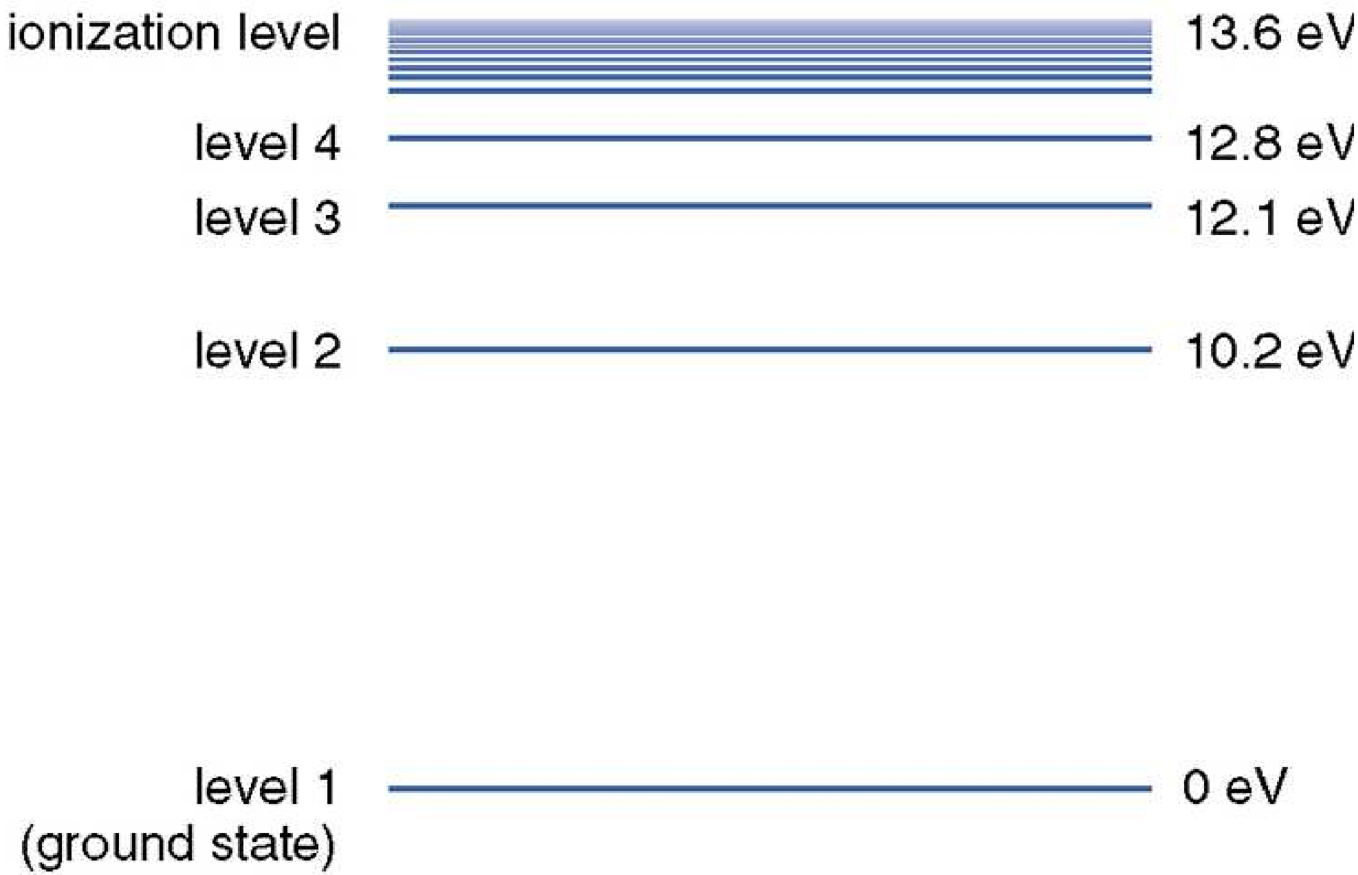
   - lectures in week 02 (Sep 5 and 7),
   - assigned reading for weeks 02 and 03.

# ***Overview of Astronomical Objects***

# ***Building blocks of matter: protons,electron,neutrons and atoms***



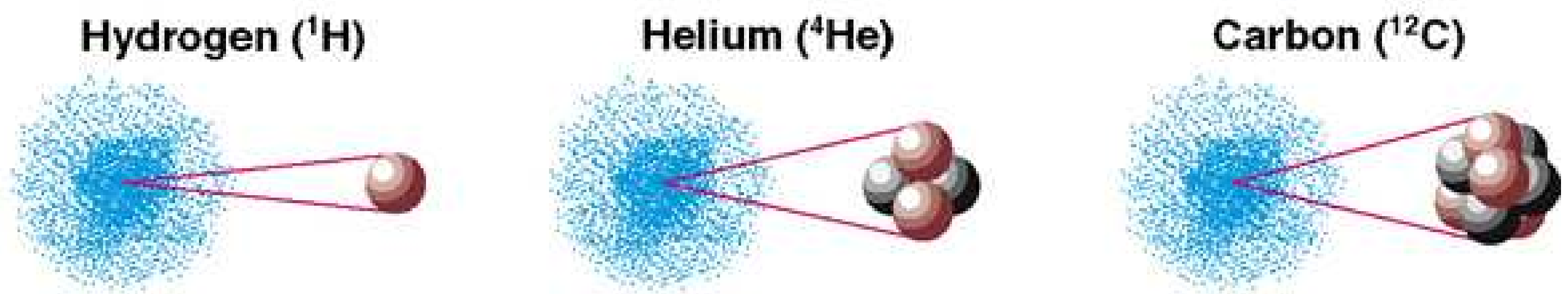

See in-class notes

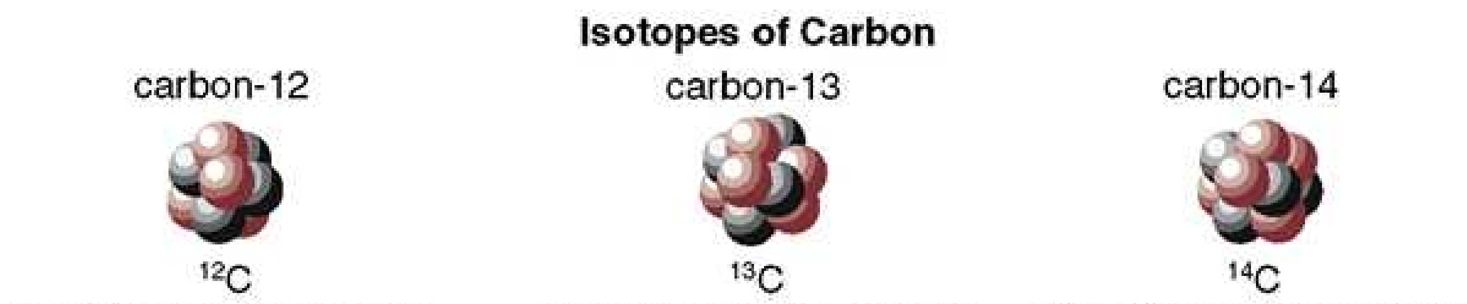



The electrons in the “electron cloud” around the nucleus can only have certain specific amount of energies . They are said to occupy discrete allowed energy levels. The allowed levels for the e in a Hydrogen atom is shown above.

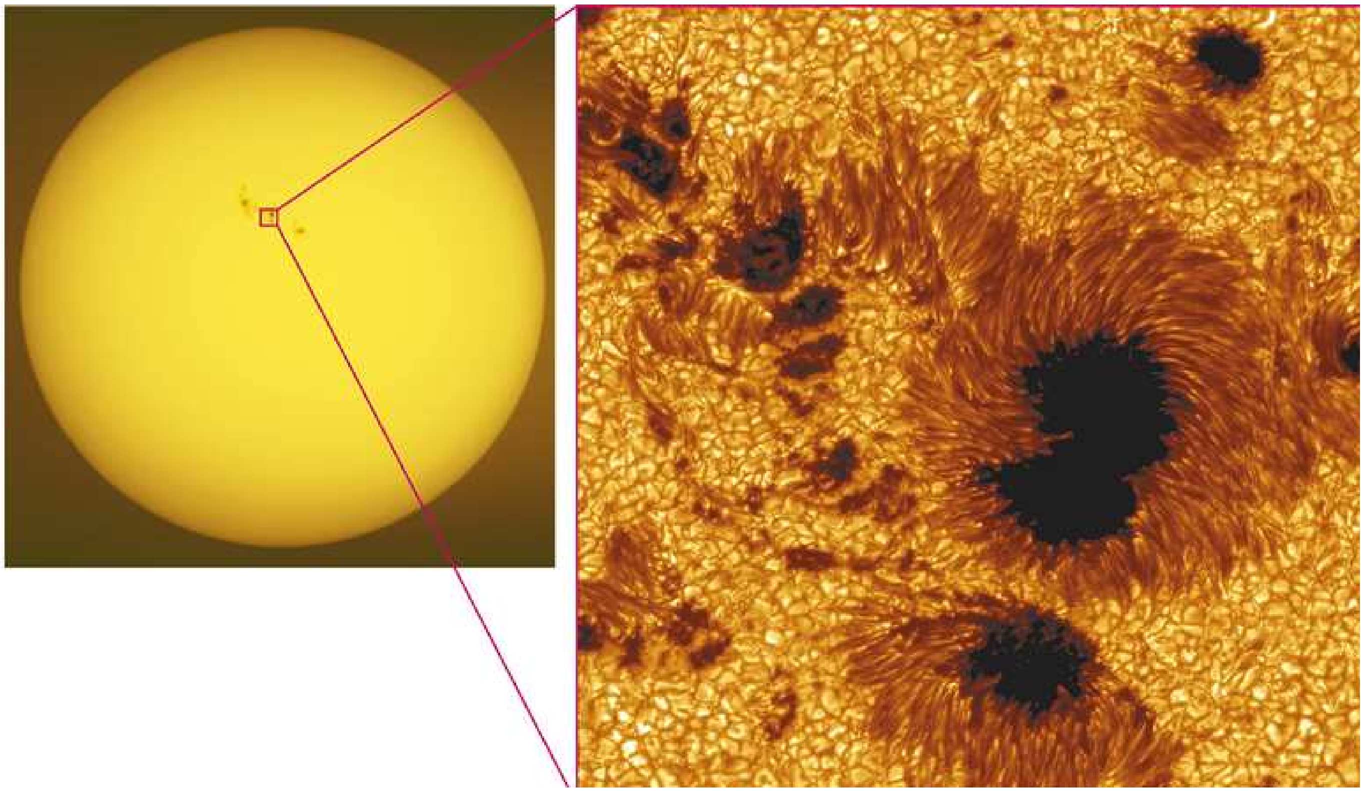
# ***Atomic Number X and Atomic Mass  Number A***

See in CLASS NOTES

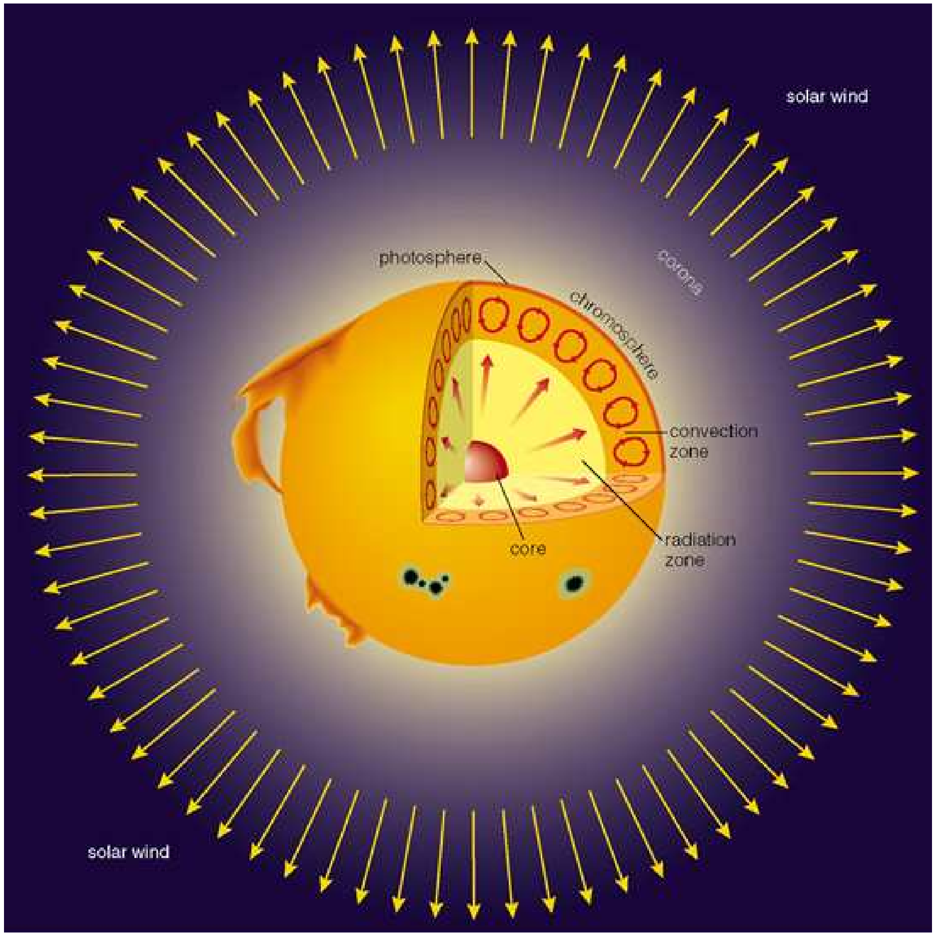


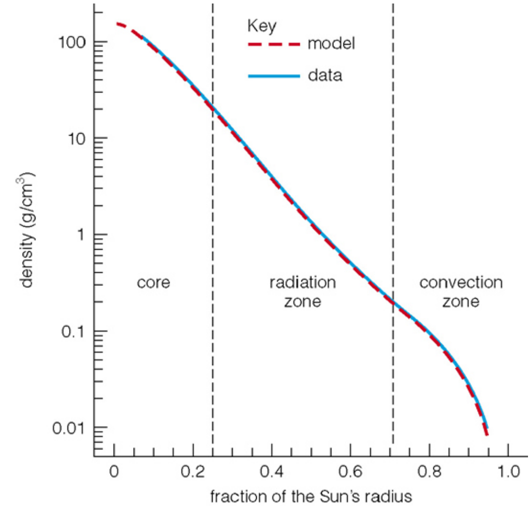



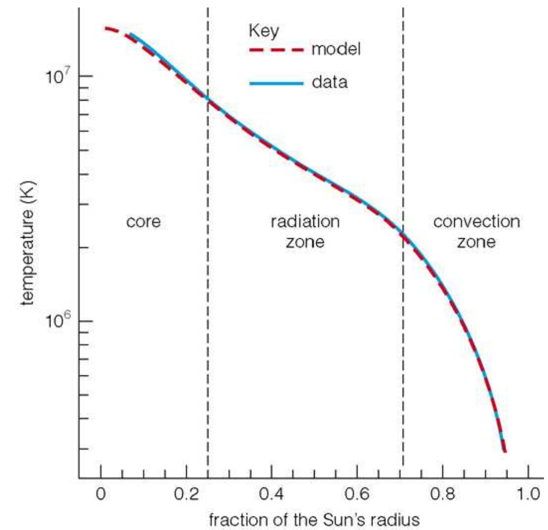
# Stars



# Structure of a star like the Sun



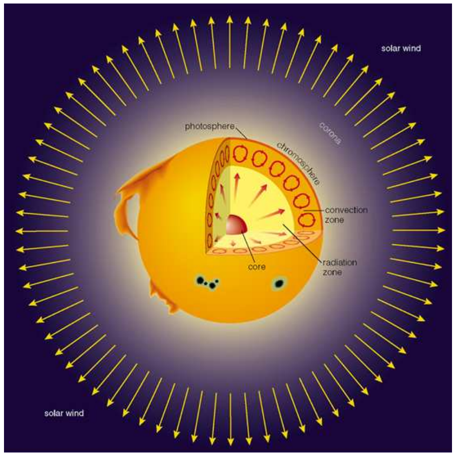



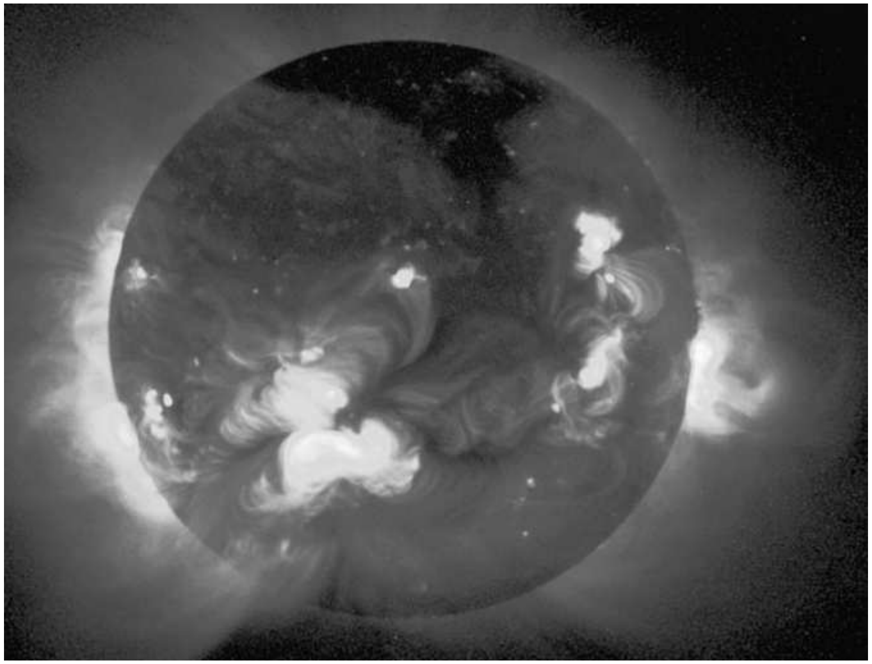




- Nuclear fusion occurs in core where temp and pressure are very high.
  T drops from 1.5 x $10^7$ K in the core down to 5800 K at the surface or photosphere
- The energy released is transported from core to the photosphere where it is released as light and heat.

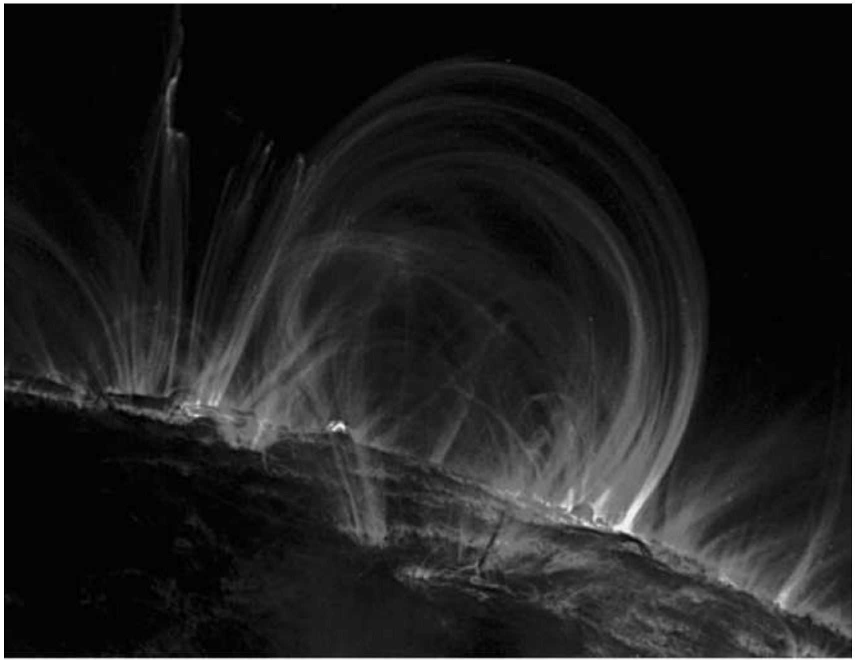
# ***Corona of the Sun***

T drops from core (1.5 x 10^7 K) to photosphere (5800 K), but rises again in the solar corona (10^6 K).
The hot gas in the corona emits most of the Sun's X-rays



X-ray image (Yonkoh Space Observatory)
Hot million-degree gas in Solar corona



X-ray image (NASA's TRACE mission): hot million degree gas trapped in magnetic field

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Lecture 3: Th Sep 6

# ***Lecture 3***

## Announcements

1. See class website for latest announcements

2. Quiz on Tu Sep 12 based on

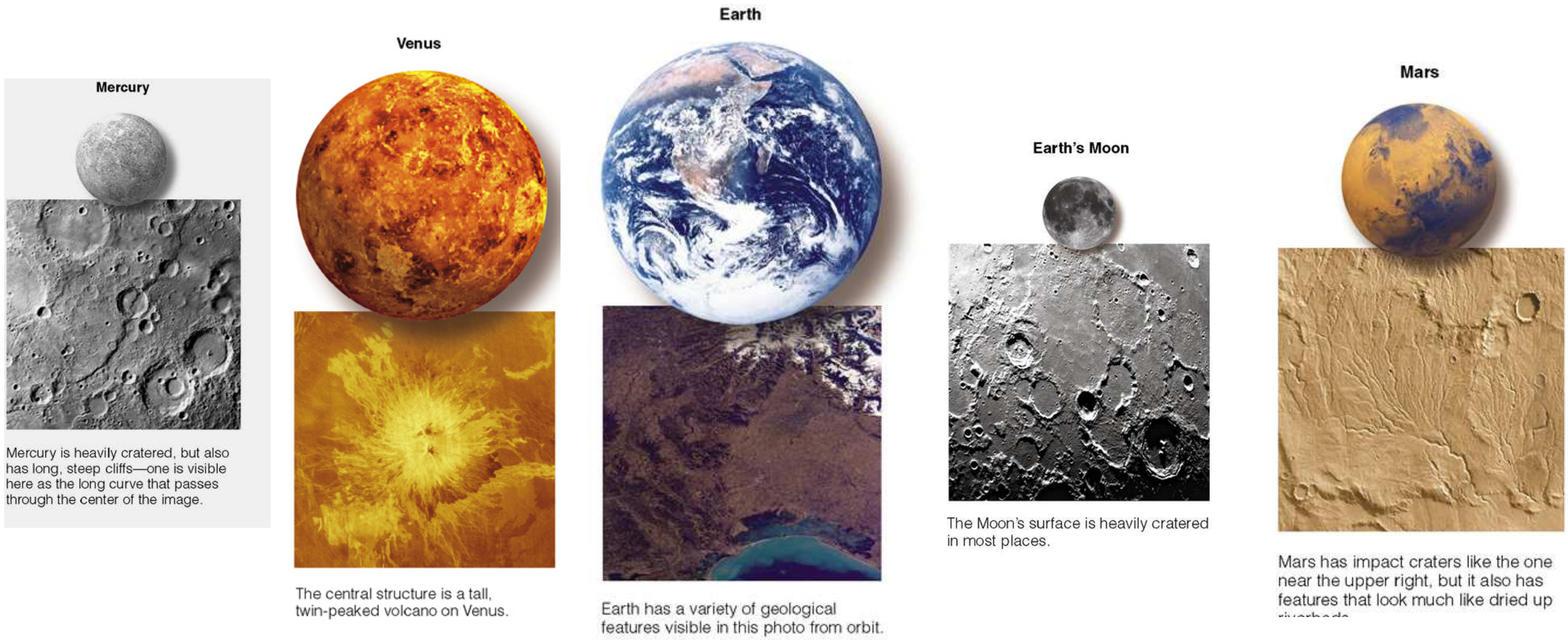
   - lectures in week 02 (Sep 5 and 7),
   - assigned reading for weeks 02 and 03.

For those with textbook edition 3 à  follow readling list in online calendar
1.1, 4.3, 1.2, 2.1 (Milky Way), 2.2 (Angular measures of size and distance)

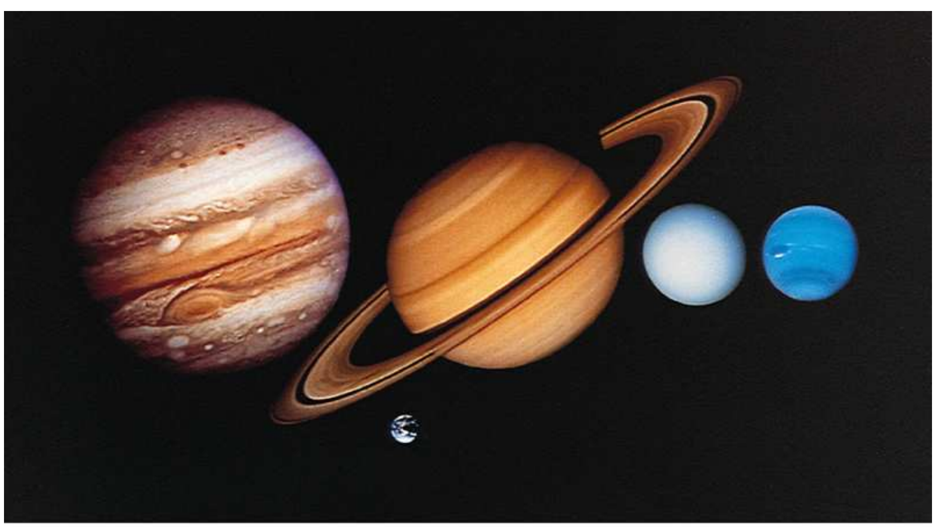
For those with textbook edition 4 à  we will post an alternate calendar tonight
1.1, 5.3, 1.2, 2.1 (Milky Way) , 2.1 (Angular size, physical size, and distance)

# ***Brown Dwarfs, Planets, and Moons***

# Planet : see in-class notes




Mercury,Venus,Earth,E's Moon, Mars

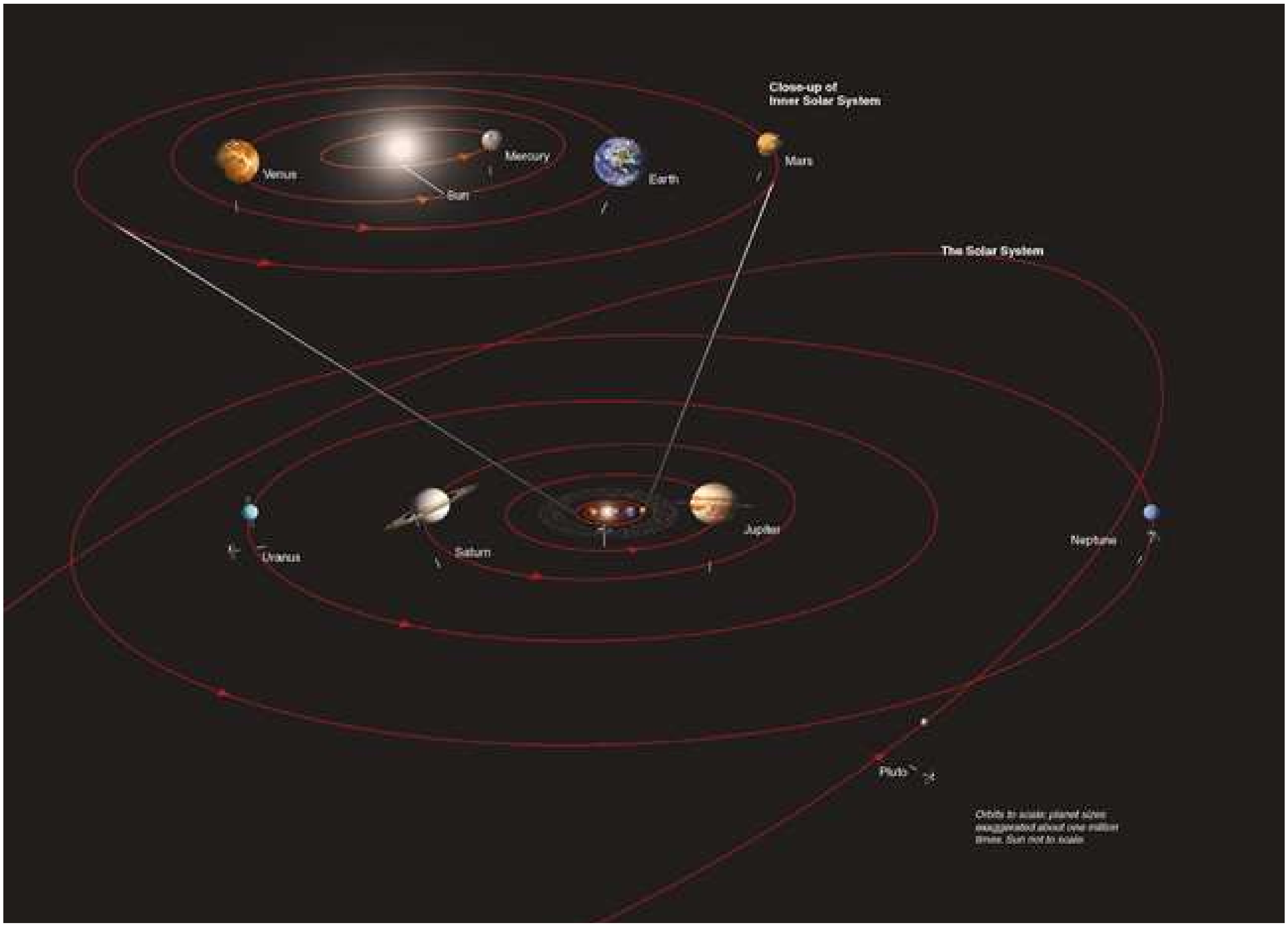


Jupiter, Saturn, Uranus, Neptune

# <u>Our Solar System</u>

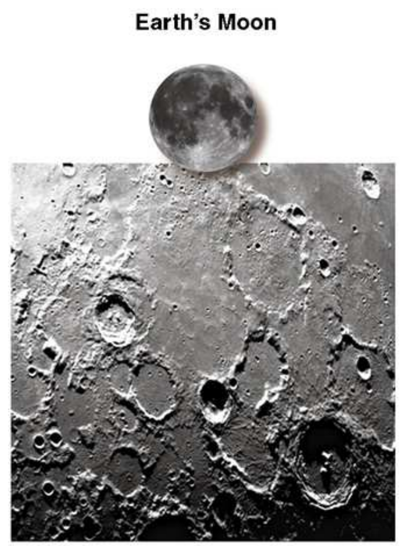
Sun (star) + 9 planets M, V, E, Mars, J S N U (P=dwarf planet)

Distance between Earth and Sun = $1.5 \times 10^{11}$ m = 1AU ; Pluto-Sun= 39.5 AU



Moon: see in-class notes


Titan, moon of Saturn is one of the largest moons in solar system. It is comparable in size to the planet Mars!




Earth's moon has a heavily cratered surface

# Cassini-Huygens mission to Saturnian system and Titan,

Huygens probe descending through Titan's Atmosphere (ESA)

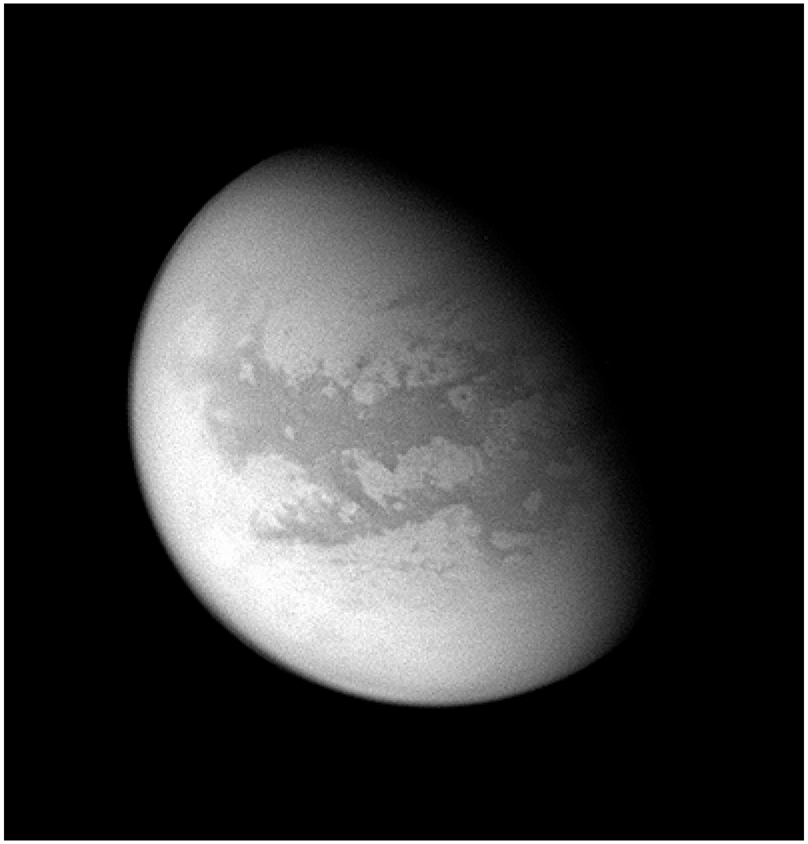
* Cassini-Huygens mission : Launch Oct 1997; reached Saturnian system in 2004;

*Will study Saturnian system: rings, moons, atmosphere of Titan (Saturn's largest moon) till 2008

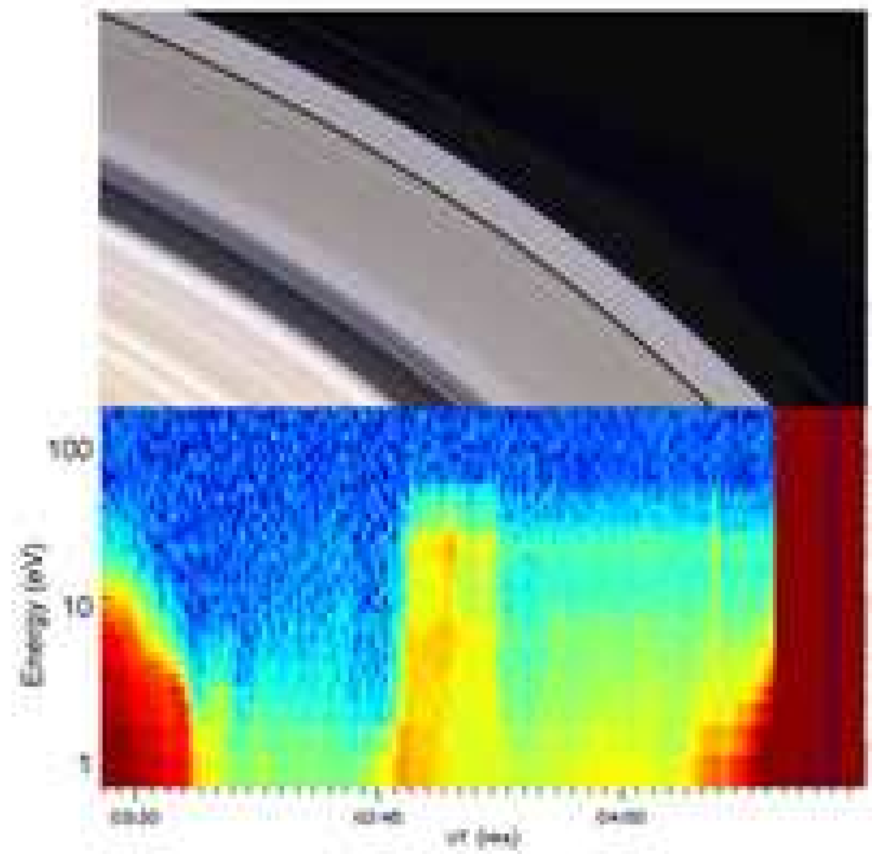
* Scientific probe Huygens : released in Nov 2004, parachutes through atmosphere and lands on Titan

-à first spacecraft to land in the outer Solar System. I

<u>Cassini-Huygens mission to Titan, the moon of Saturn</u>



Titan as seen from Cassini's fly-by on August 22, 2005

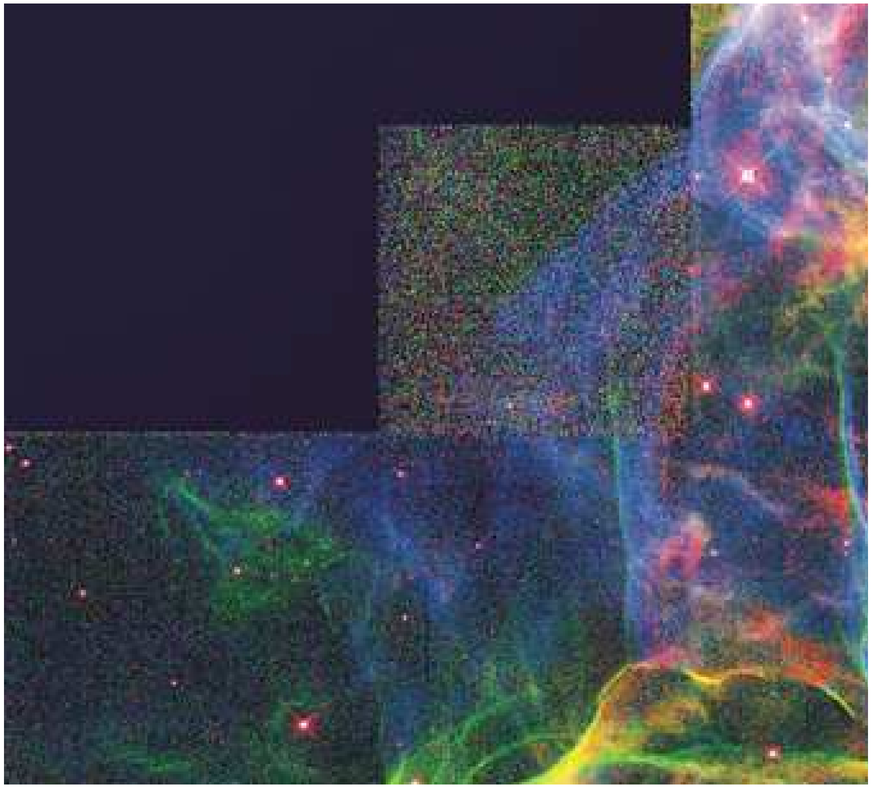



Saturn’s rings have own atmosphere, composed principally of molecular oxygen

# ***Death of Stars: Planetary Nebulae, Supernovae remnants***

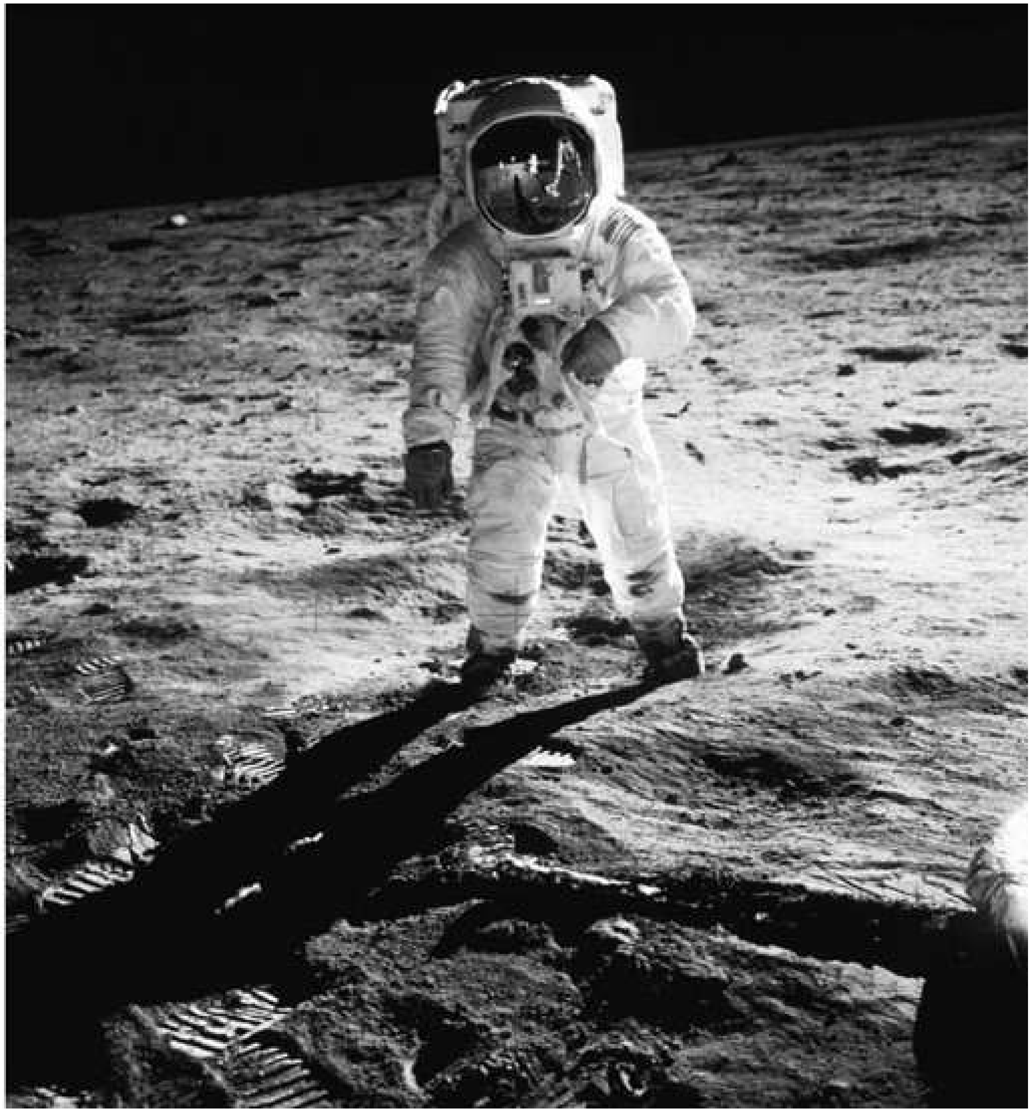
Supernovae Remnants and Neutron Stars or Black Holes

- See in class notes



SN remnant called Cygnus loop;
HST/optical image: Blue, green =O, Red= S

Supernova remnant called Crab
Nebula; VLT/Optical



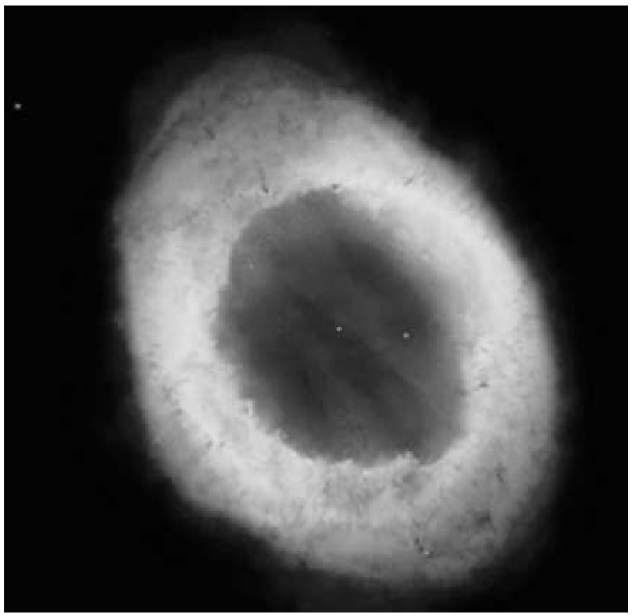
**To boldly go where no one has before….**

**Apollo II i1969). First landing on Earth’s moon!**

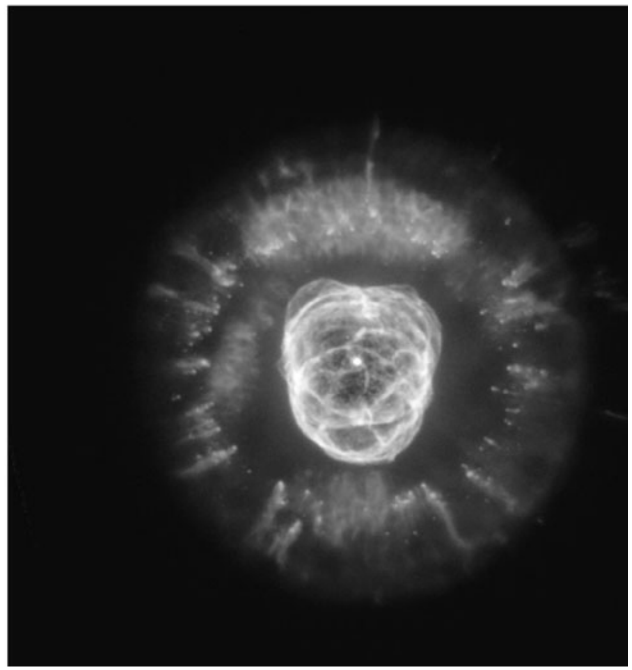
**“A small step for man, one giant leap for mankind”**

# Planetary Nebulae and White Dwarfs

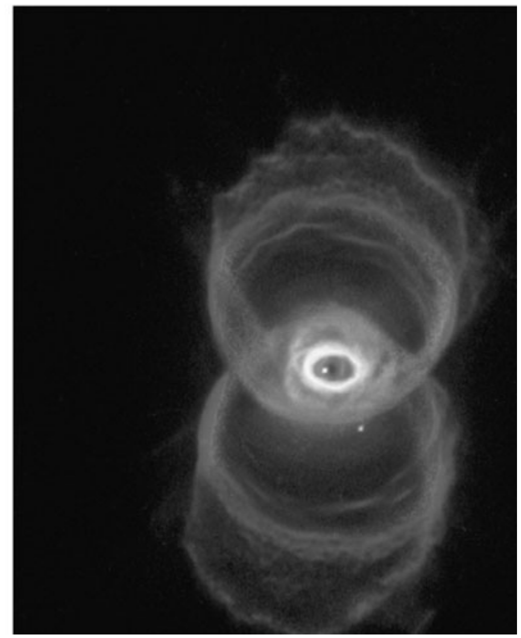
- See in class notes
- Planetary nebulae have nothing to do with planets!



Ring Nebula



Eskimo Nebula

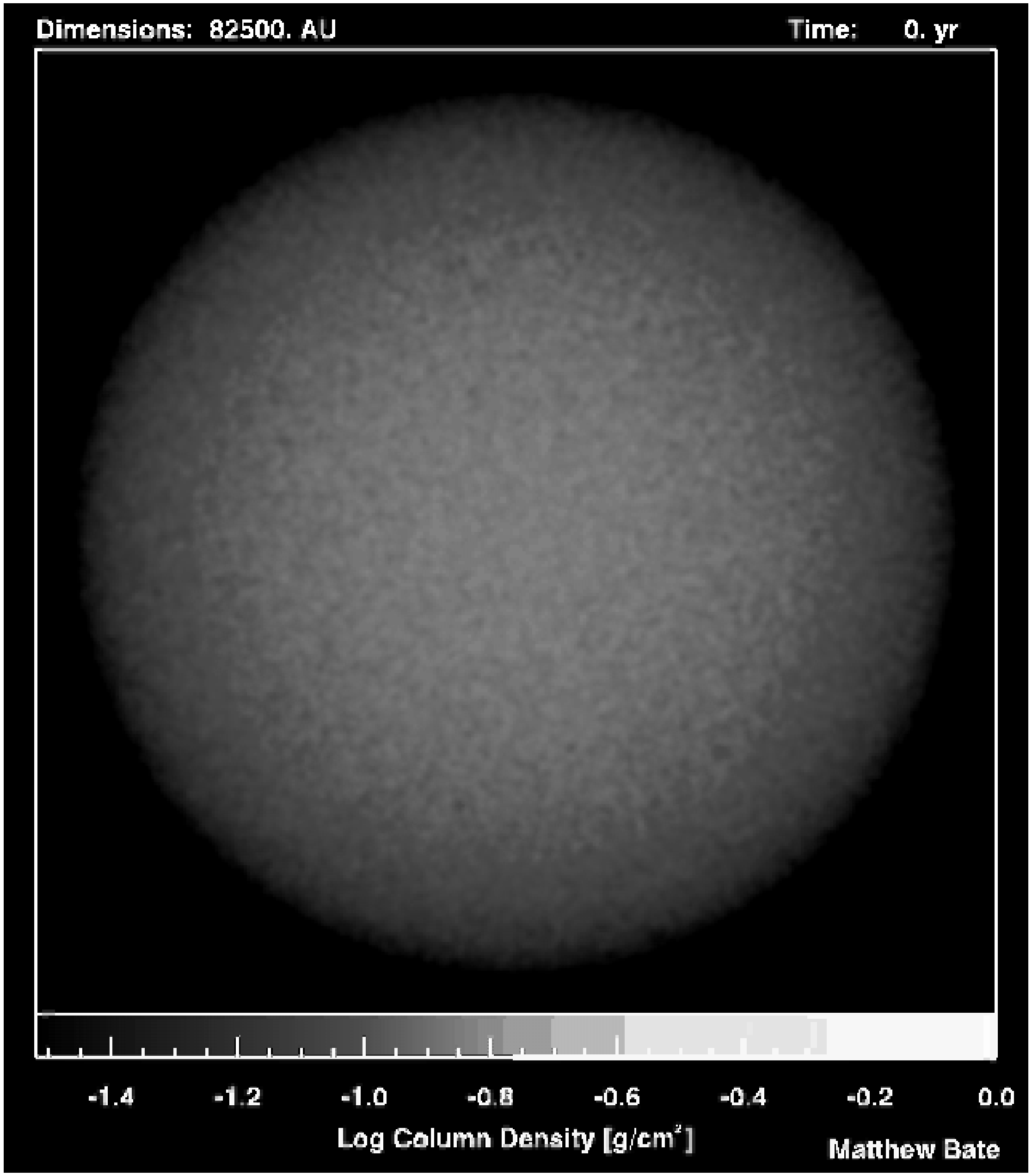


Hourglass Nebula

Why is human life `star stuff'?'

- See in class discussion

# *A metal-rich gas cloud collapses to form a star + its planetary system*




Simulation starts with a gas cloud having
mass ~ 50 x Mass of Sun
diameter = 1.2 ly (10^16 m)
temperature ~10 K

Cloud collapses under the force of gravity and fragments into dense gas clumps. These clumps form stars

Around some of these stars are swirling discs of gas which may go on later to form planetary systems like our own Solar System.