GENS 4001 Astronomy

Part 1:
The Solar System–
Introduction

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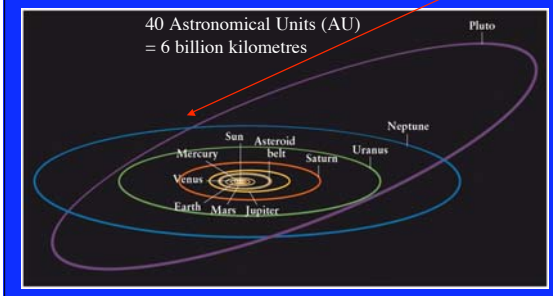
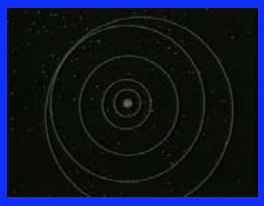
The Solar System to Scale

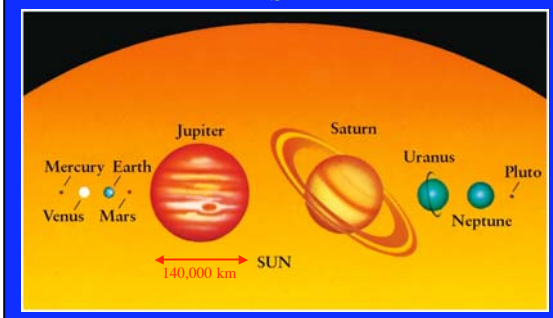


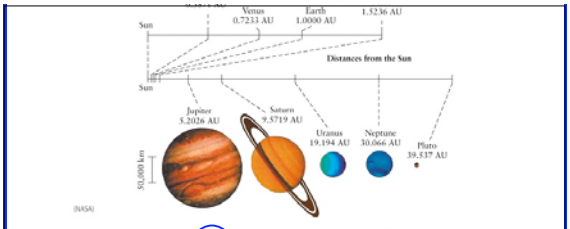
Planetary Orbits:
Obeying Kepler's Laws of Motion



- Planets move in Ellipses around the Sun
- Speeds are greater the closer the planet is to the Sun
  ($V \propto 1/\sqrt{R}$, $T^2 \propto R^3$)

The Sun and the Planets:
to Scale





The Outer Planets

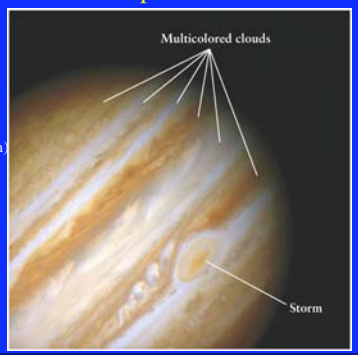
	Jupiter	Saturn	Uranus	Neptune	Pluto
Average distance from Sun (10^6 km)	778.30	1431.9	2877.4	4497.8	5914.7
Average distance from Sun (AU)	5.2026	9.5719	19.194	30.066	39.537
Orbital period (years)	11.856	29.369	84.099	164.86	248.60
Orbital eccentricity	0.048	0.053	0.043	0.010	0.250
Inclination of orbit to the ecliptic	1.30°	2.48°	0.77°	1.77°	17.12°
Equatorial diameter (km)	142,984	120,536	51,118	49,528	2300
Equatorial diameter (Earth = 1)	11.209	9.449	4.007	3.883	0.180
Mass (kg)	1.899×10^{27}	$.685 \times 10^{26}$	8.682×10^{25}	1.024×10^{26}	1.31×10^{22}
Mass (Earth = 1)	317.8	95.16	14.53	17.15	0.002
Average density (kg/m^3)	1326	687	1318	1638	2000

Table 7-2 The Seven Giant Satellites

	Moon	Io	Europa	Ganymede	Callisto	Titan	Triton
Parent planet	Earth	Jupiter	Jupiter	Jupiter	Jupiter	Saturn	Neptune
Diameter (km)	3476	3642	3130	5268	4806	5150	2706
Mass (kg)	7.35×10^{22}	8.93×10^{22}	4.80×10^{22}	1.48×10^{23}	1.08×10^{23}	1.34×10^{23}	2.15×10^{22}
Average density (kg/m^3)	3340	3530	2970	1940	1850	1880	2050
Substantial atmosphere?	No	No	No	No	No	Yes	No

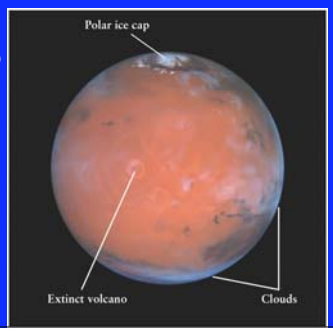
A typical Jovian Planet:
Jupiter

- Large (140,000 km)
- Gaseous
- Rapid Rotation
- Many Moons

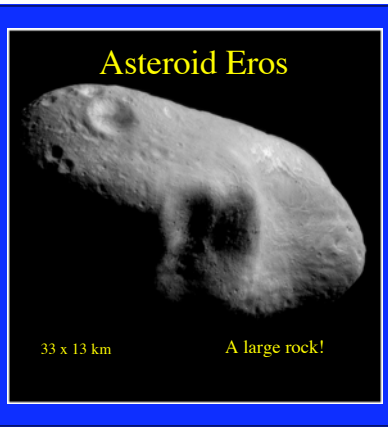


A typical Terrestrial Planet:
Mars

- Small (7,000 km)
- Rocky
- Slow Rotation
- Few Moons



Asteroid Eros



33 x 13 km

A large rock!

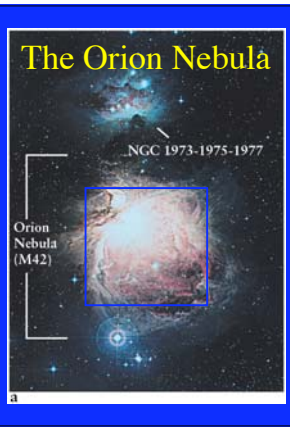
Comet Hale-Bopp (1997)

A dirty snowball (sand + ice)

Nucleus just ~10 kilometres across, Tail millions of km long

Star Formation in the Eagle Nebula

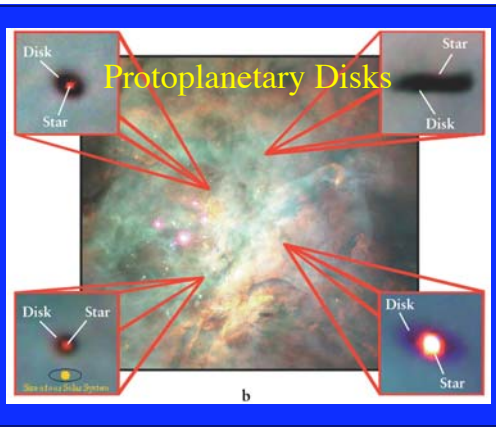
The Orion Nebula



The Orion Nebula:
a star forming region

b

Protoplanetary Disks



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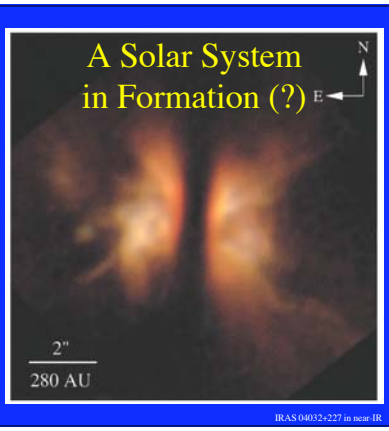
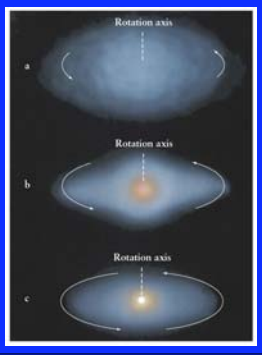
A Solar System in Formation (?)



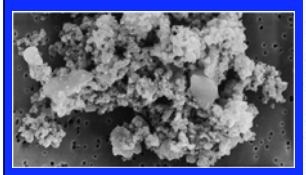
IRAS 04032+227 in near-IR

Birth of the Solar System



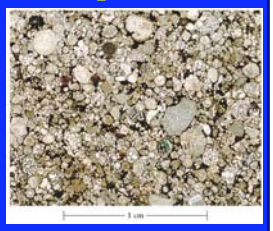
- Collapse of a slowly rotating cloud of interstellar gas.
- Central condensation forms as clouds flattens and spins up.
- Young Sun shines within disk of gas and dust, in which planets are forming.

Stardust – the seeds for planets!



0.02 mm

Cosmic Dust Grain



Chondrules inside a meteorite

Formation of the Planets– I: Protoplanetary Cloud (0 years)

a

Formation of the Planets – II: Planetesimals (50 million yrs)

Formation of the Planets – III: Planets (100 million years)

Numerical simulation of the Birth of the Solar System

Extra-solar Planets