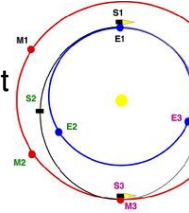


Reading: Chap. 7, Sect. 1-2;
 Chap. 8, Sect. 8.1-2;
 Chap. 9, Sect. 9.3

Exam 1 - Grading complete soon; MC worth 75 (correct x 3) Essay worth 25
 Homework #5: Available now, due next Friday/Monday (Oct. 11, 14)

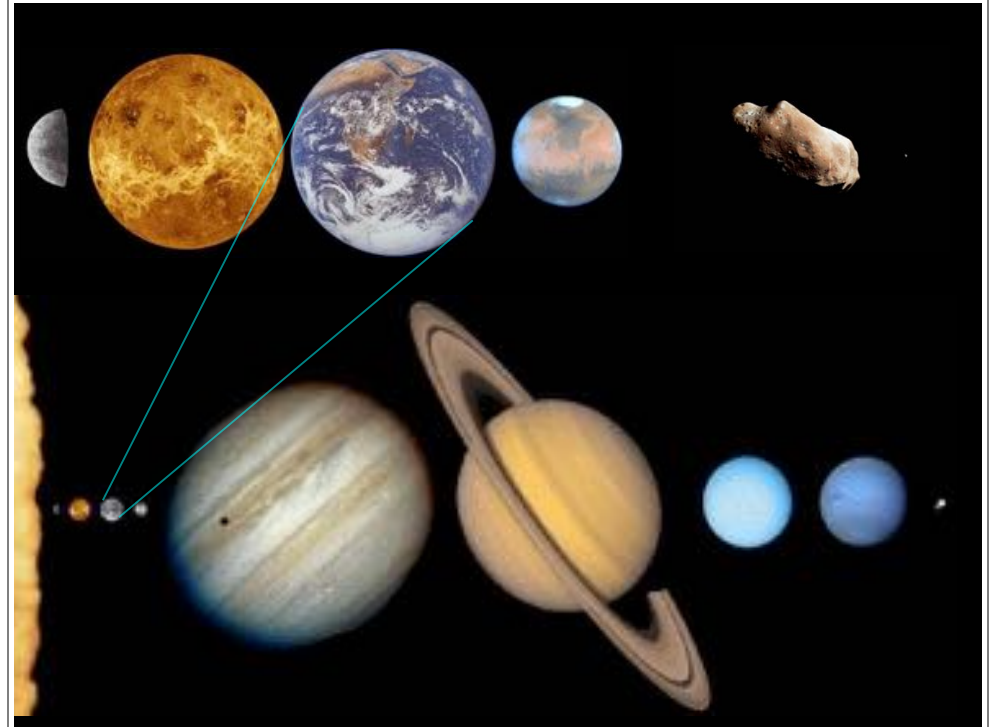
Last time: Rocket Science

- break free from Earth’s gravity (**escape velocity**)
- **coast** in “transfer orbit” to reach nearby planet’s orbit
- **get captured** by the gravity of destination planet
- Outer Planets, Mercury: **Gravity Assist**



Today: Overview of our Solar System - outside and inside

- Overview of our Solar System
 - Inner (Terrestrial) planets & Outer (Jovian)
 - Asteroids, Comets, KBOs, other small bodies
- Probes of planetary interiors
 - **Density, rotation, magnetic fields**



Our Planetary System: An Overview

Inner, rocky (terrestrial) planets	Mercury	3 flybys, orbiter
	Venus	orbiters, landers, radar
	Earth/Moon (binary)	samples + !
	Mars (2 small moons)	orbiters, landers
	asteroids	flybys, orbiters, & landings
Outer, gaseous/icy (Jovian) planets	Jupiter (> 20 moons)	orbiter
	Saturn (> 20 moons)	orbiter
	Uranus (lots of moons, rings)	one flyby
	Neptune (>2 moons, ring arcs)	one flyby
?	Pluto / Charon	Earth-based,
	Kuiper belt objects	flyby(s) in 2015
close + way out	Comets	several flybys, lander, impactor

Probes of planetary interiors

- **Density**
 - observe mass, radius -> compute density
 - compressible? High internal pressure?
- **Shapes (oblateness) and rotation of bodies**
 - flattening via fast rotation -> compressible?
 - odd rotation -> past collision or merger?
- **Magnetic fields**
 - molten metallic (iron?) cores?
- **Seismic probes**
 - Earth, Moon, planet quakes
- **Direct samples of surface**
 - composition, phase

Planetary Properties

size, mass, density, rotation

	Diameter (Earth=1)	Mass (Earth=1)	Density (Water=1)	Rotation (Period)	Inclination (degrees)	Oblate?
Our Sun	109	330,000	1.4	25 d	-	0.000002
Mercury	0.38	0.055	5.4	58.7	0	0
Venus	0.985	0.82	5.2	-243 d	177	0
Earth	1	1	5.5	1d	23.5	0.0034
Moon	0.27	0.012	3.3	27 d	-	0
Mars	0.53	0.11	3.9	1.03 d	25	0.0074
Jupiter	11.2	318	1.3	9.9 h	3	0.0648
Saturn	9.5	95	0.7	10.7 h	27	0.0978
Uranus	4	14.5	1.3	17.2 h	98	0.023
Neptune	3.8	17.1	1.6	16.1 h	29	0.017
Pluto	0.18	0.0022	2	6.4 d	120	0
Sedna	0.14	-	-	10 h	-	-
2003 UB13	0.23	-	-	-	-	-

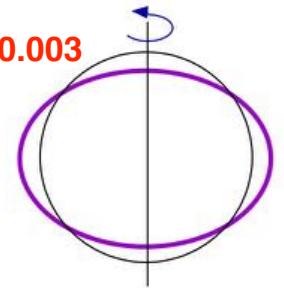
Probing an Inner Planet: Planet 3

- Density:** (we call it 'Earth')
 - density of your average rock = 3.0 gm/cm^3
 - mean density of Earth = mass/volume = 5.5 gm/cm^3
- Interior of the Earth must be MUCH denser than rock at surface**

- Shape:**
 - diameter at equator = 12,756 km
 - diameter at poles = 12,718 km

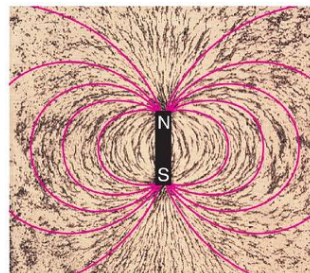
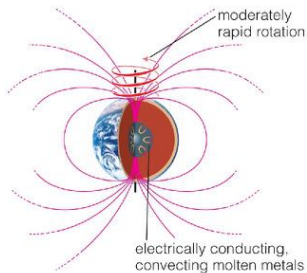
Earth is flattened at poles: oblateness = 0.003

- Caused by rotational deformation:**
 - speed of rotation
 - distribution of matter
 - plasticity of matter



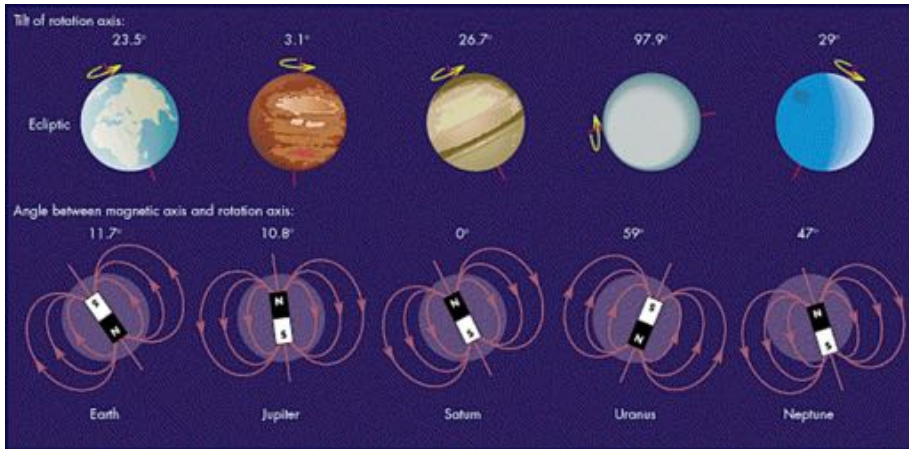
Magnetic Fields

- Earth's field strength = 0.4 Gauss
- nearly aligned with rotational axis (why compasses work)
- Caused by internal rotation of electrically conducting material**
 - molten iron core (Terrestrials)
 - metallic liquid hydrogen (Jovians)
 - solids in liquid water solution (Europa, Ganymede)
 - or fossil field (frozen into solidified metal)



	Mag. field	Rotation	Incl
Mercury	0.002	58.7 d	0
Venus	0.0003	-243 d	177
Earth	0.4	1 d	23.5
Moon	0.0001	27 d	-
Mars	0.0006	1.03 d	25
Jupiter	4	9.9 h	3
Saturn	0.08	10.7 h	27
Uranus	0.1	17.2 h	98
Neptune	0.1	16.1 h	30

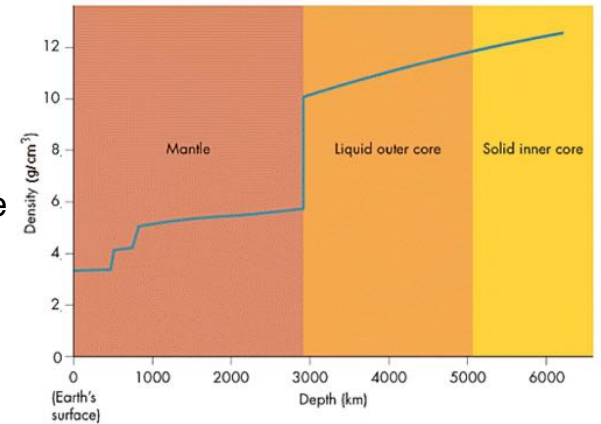




The Earth's Interior

- Dense molten iron **core** (density, magnetic field)
- Rocky but elastic **mantle** (oblateness)
- thin, light surface **crust** (density)

With some simple physics, **compute** what the inside of the Earth might be like



Testing the Model Directly: **Seismology**

- **earthquakes** send vibrations through the Earth
- speed of various kinds of waves depends on
 - density
 - temperature
 - phase (liquid or solid)

can map out structure of Earth (or planet) interior

