The Earth's Moon… key to the solar system

See chapter 9 of textbook

But first… finish up from last time: the application of Newtonian physics to orbital motion

- The solution to F=ma for a planet is an ellipse with the Sun at one focus (Kepler's 1st Law)
- The semimajor axis and orbital period are related by:

$$P^2 = \frac{4\pi^2 a^3}{G(M+m)}$$

Kepler's 3rd Law (or is it?) ??????

The application of Newtonian physics to orbital motion (continued)

Since the force is always in the direction of the center of the ellipse, the **torque** is always zero, and **angular momentum** is constant

⇨ Kepler's 2nd Law is a consequence

⇨ demonstration

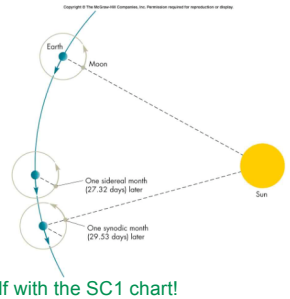
Summary---Newton's laws of motion, and Newton's equation for the gravitational force (Newtonian mechanics) allow us to understand, and calculate with tremendous precision, the orbits of planets and other objects in the solar system.

Why study the Moon?

- It is a prominent astronomical object
- Even a small telescope shows an incredible amount of detail on the surface
- It is the only astronomical object (other than the Earth) on which people have set foot.
- What we learned about the Moon helps us understand the whole solar system better

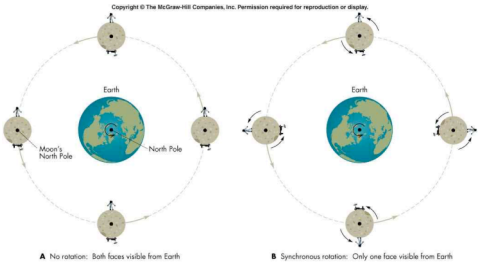
The period of the Moon (there are two of them!)

- The sidereal period (time to move 360 degrees with respect to the stars) = 27.32 days
- The synodic period (time between one full moon and the next) = 29.53 days
- Why the difference?



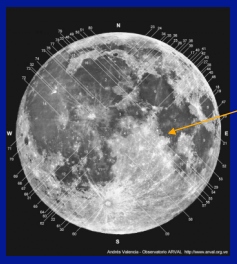
Check it out yourself with the SC1 chart!

The Moon rotates *synchronously,* one rotation period = sidereal revolution period



Synchronous rotation is important because it is universal for moons in the solar system

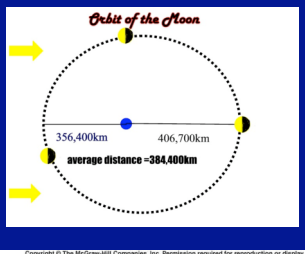
A consequence of synchronous rotation is that from Earth, we only see one side of the Moon



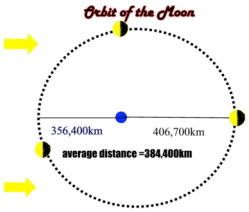
First Apollo landing here

The synchronous rotation of the Moon is a consequence of tides produced by the Earth (see textbook)

The orbit of the Moon

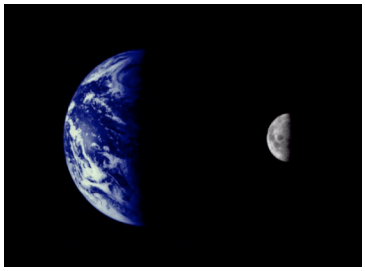


One more time…the orbit of the Moon



An ellipse with an eccentricity of 0.055, inclined to ecliptic at 5 degrees

How big is the Moon (diameter)? 3476 km versus 12756 for Earth



Nonetheless, the Moon is *relatively large compared to the Earth*

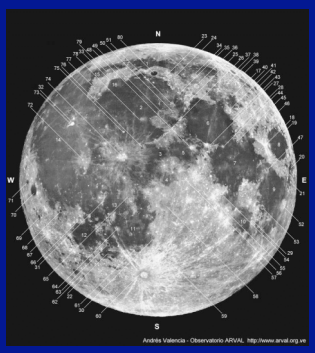
Masses (the other way of expressing how "big" an astronomical object is) and densities

- Moon, mass = 7.35E+22 kg, density = 3.34 g/cc
- Earth, mass = 5.97E+24 kg, density = 5.52 g/cc
- So the Moon has only 1.2 % of the mass of the Earth!
- To **really** keep things in perspective, consider the Sun, mass = 1.99E+30 kg

Eclipses…we have already discussed, look over material on pp 184-191

Read over discussion of tides, the physical nature of them and their effects in the solar system

Features of the lunar surface



With just your eye you can see the Maria and Terrae

The most famous features of the lunar surface…Craters of the Moon

Crater Tycho…lunar orbiter

Crater Copernicus from the Apollo spaceship

Craters are the most distinctive features on the surface of the Moon. At one time they were thought to be unique to the Moon. Now we know them to be widespread and important solar system phenomena. Here are some important aspects.

1. They are large. There are 5 of them with diameters greater than 200 kilometers.
2. The diameters of some of the famous ones are Tycho, 102 km, Ptolemaeus, 164km, Alphonsus, 108 km, Copernicus, 107 km, and Kepler, 31 km. We will see all of these during observing sessions of the Moon.
3. By contrast, the famous Barringer Crater (or "Meteor Crater") in Arizona, which was formed in the same way, has a diameter of 1.1 km.
4. It is now known that the lunar craters are *impact craters*, they were formed by the impact of massive meteors with the Moon. In the next lecture, we'll learn about when this happened.
5. Many craters have central peaks, or mountains in the middle.
6. A few, such as Tycho, Copernicus, and Kepler, have *rays*, or streaks of bright material pointing away from them.

The nature of the lunar craters was considered uncertain until rather late in the history of science. It was not until the early 1960s that it was considered established that they were **impact craters,** holes in the ground made by the explosion of a large object (rock) hitting the surface of the Moon. The diameter of the object is about 1/3 - 1/5 the diameter of the crater

The Apollo program and the exploration of the Moon