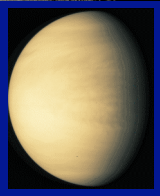
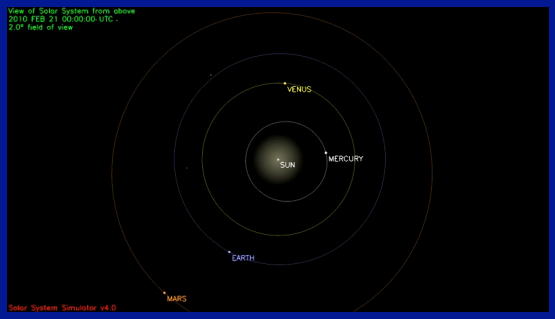
The planets Mercury and Venus



Where are Mercury and Venus in the Solar System?



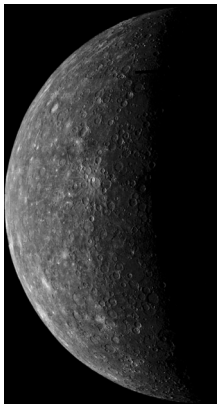
Mercury and Venus in the night sky

- Mercury is always very close to the Sun in the sky, is small in diameter, and is farther away than Venus. This makes it a difficult object to see. The legend is that Copernicus never saw it.
- Venus at times is the brightest object in the sky after the Moon; you can't miss it.

It is difficult to find an example of a pre-space age illustration of Mercury

- The best telescopic observations were probably about like seeing the Moon with the naked eye.
- First good look at planet was in 1974, with Mariner 10 spacecraft flyby. Pictures in textbook come from that spacecraft

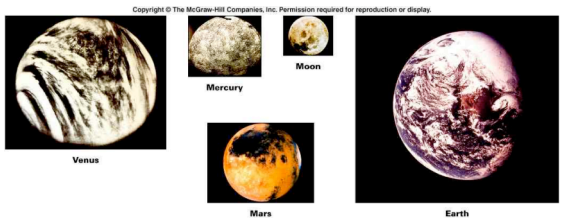
Based on this picture of Mercury, what could you say about it, its geology, and geological history?



Basic facts of Mercury

- Semimajor axis of orbit: 0.3871 au
- Eccentricity of orbit: 0.206 (large for major planet)
- Inclination of orbit: 7.00 degrees
- Diameter: 4878 km (0.38 Earth diameters
- Mass: 0.055 Earth masses
- No atmosphere, surface heavily cratered

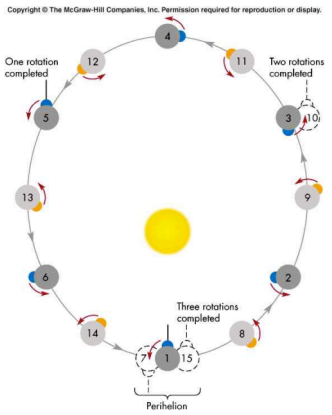
Relative sizes of Mercury and Venus



Interesting aspect of Mercury: the length of the day

Mercury is closest major planet to Sun, so tides are significant. For long time, it was believed to be synchronously rotating (like the Moon), with a rotation period equal to the revolution period of 88 days. In 1967 this was found not to be true. Mercury is in “2/3 resonance”, meaning it undergoes 3 rotations for 2 revolutions

3/2 synchronous rotation and the weird day of Mercury



The weird day on Mercury

- Weirdness is due to the fact that the rotation period is comparable to period of revolution, and that they are related by the ratio of 2/3 (see figure 10.3)
- An apparent solar day lasts 2 years!
- Only 2 longitudes have the noon when the planet is at *perihelion* ("hot poles")
- Only 2 other longitudes have noon at *aphelion* ("warm poles")
- From one of the hot poles, the Sun would rise quickly, linger around noon, then set fast

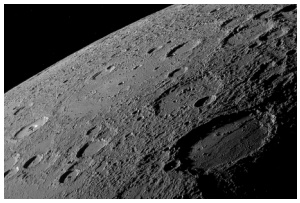
Surface temperature on Mercury

Mercury is much closer to the Sun than the Earth, so the amount of solar heating is much larger (technically, the flux of solar radiation is larger by the square of the distances of the planets, which is $\frac{1.00}{0.387}^2 = 6.7$ times higher. In addition, daytime (when the Sun is above the horizon) lasts 88 days. As a result, the daytime temperature of Mercury is unbelievably hot. Surface temperatures can reach 700 K (700 degrees Kelvin), which is about 770 degrees Fahrenheit. Read the textbook about the Kelvin temperature scale. We will be using it the rest of the course.

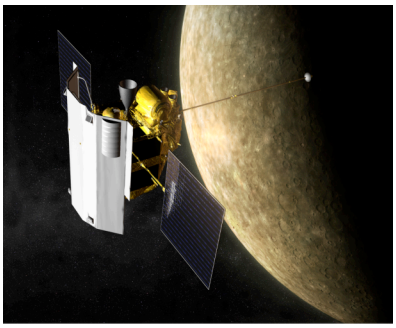
At nighttime, the Sun is absent from the sky for a revolution period of 88 degrees, so there is plenty of time for the surface of Mercury to cool off. Furthermore, *Mercury has no atmosphere to help retain the heat.* On the nighttime side, the temperature drops to 100 K, which is similar to temperatures in the outer solar system far from the Sun. The Kelvin temperature scale is described on p134 of your textbook. Read it.

The geology of Mercury

What we can learn from its high mean density, magnetic field, and surface photography from Mariner 10 and the Messenger spacecraft. (look at pages 214 and 215)



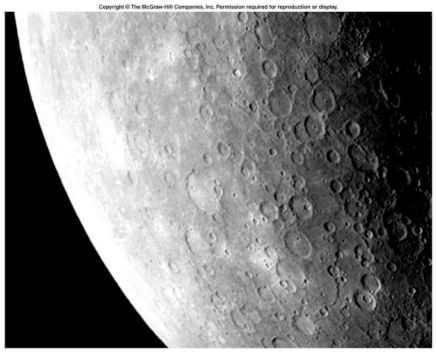
The Messenger spacecraft and the study of the planet Mercury…we are about to learn much more about Mercury



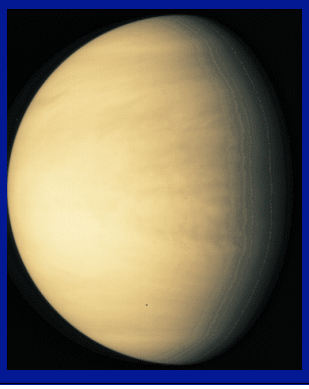
The Messenger Spacecraft: launch and arrival

http://messenger.jhuapl.edu/the_mission/movies.html

The surface of Mercury

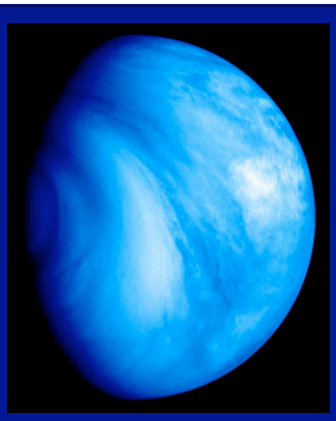


Venus…Earth's twin

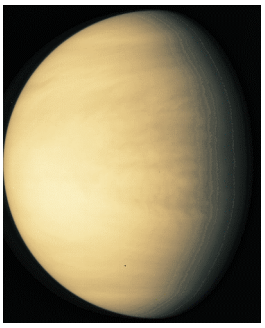


Venus in ultraviolet light

What is under The clouds?



The planet Venus: the Earth's twin (in a limited sense)



A comparison of Earth and Venus

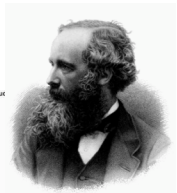
- Semimajor axis of orbit: 0.7233 (V) 1.000 (E)
- Orbital eccentricity: 0.007 (V), 0.017 (E)
- Diameter: 12104 km (V) 12756 (E) !
- Mass: 0.815 Earth masses (V) 1.00 Earth masses (E) !!
- As spheres, Venus and Earth are very similar

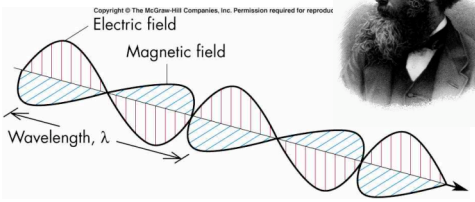
Seeing through the clouds of Venus with **Radio Astronomy!**

The Goldstone (California) tracking station and planetary radar

So what does radio astronomy or radar astronomy do for you?

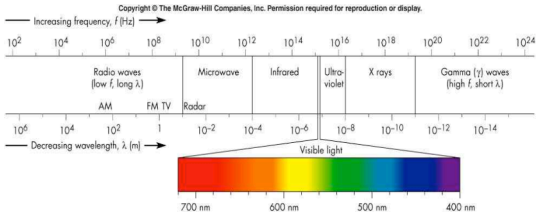
First result: light is a wave (electromagnetic wave)





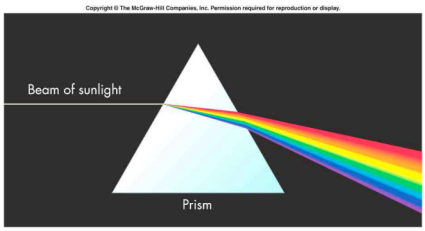
Wave characterized by wavelength, amplitude
DEMO

Amazing fact of nature: wide range of wavelengths of electromagnetic waves



EM radiation includes gamma rays, x-rays, ultraviolet, Light, infrared, microwave, radio

Concept from physics crucial for astronomy: the spectrum of light

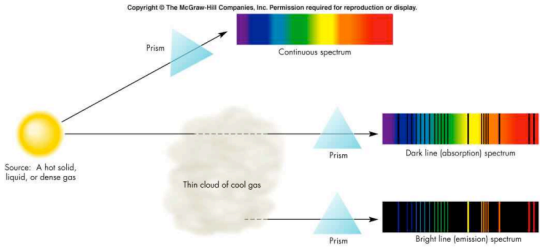


DEMO

The Physics of Spectrum Formation, Kirchoff's Laws and Wien's Law

- Hot opaque solid or liquid produces a continuous spectrum
- Hot, tenuous gas observed against dark background produces emission line spectrum
- Cold, tenuous gas observed against bright background produces absorption spectrum
- See Figure 16.6

Kirchoff's Laws of Radiation



Kirchoff's First Law + Wien's Law

- Hot, opaque objects produce *continuous spectrum*
- The hotter the object, the bluer it is
- Wien's Law w_{max} = 2.9E-03/T
- The hotter an object, the brighter it is