

29:52 Exploration of the Solar System
Class Notes for March 24, 2008
Exploration of Mars I

We now come to Mars, fourth planet from the Sun. As we will see, there have been numerous spacecraft flights to Mars, and will be more in the future. The reason for this is that arguably of all topics in the field of astronomy, the study of Mars is the most closely associated with the question of life elsewhere in the universe.

Properties of the Orbit of Mars

Mars has a semimajor axis of 1.523 au. Kepler's 3rd Law then tells us that the orbital period is 1.88 years (687 days). The eccentricity of the orbit is 0.093. This high eccentricity indicates that Mars is much closer to the Sun at perihelion than at aphelion.

The greater distance of Mars means that it is a colder object than Earth. The value of the *solar constant*, or heating power of sunlight, falls off as the square of the distance from the Sun. So the value of the solar constant at Mars is only $\frac{1}{1.523^2} = 0.43$ that at Earth.

Physical Characteristics of Mars

The physical characteristics of Mars are given in Table 11.1 of the textbook. The diameter of Mars is 6794km, or 0.53 times the diameter of Earth. The mass is 6.42×10^{23} kg, = 0.11 Earth masses. So Mars is about half the diameter of Earth, and has only 11 % its mass.

The density of Mars is 3.94 gm/cc, which is significantly less than that of Earth, and more like the density of the Moon.

Some Interesting Points

- You can see the surface of Mars from the Earth. It is not obscured by a layer of clouds as is the case for Venus.
- Next to Venus, Mars comes closest to the Earth (at times of opposition) of any of the planets.
- High eccentricity means the Earth-Mars distance at times of opposition varies a lot. In the opposition of August, 2003, Mars was 0.373 au from the Earth. This was the closest opposition since 1924. In 2007 December, right before the start of the semester, the distance was 0.589 au. The next opposition, in January, 2010 will have Mars at 0.664 au, almost twice as far as in 2003.

Some Interesting History About Mars

The varying opposition distances plays a role in the history of Mars. In 1877, there was an especially close opposition (like in 2003), and astronomers throughout the world observed it closely. An Italian astronomer named Giovanni Schiaparelli thought he saw linelike markings on the surface, which he called “canali”. This was translated into English as “canals”, and many people thought they were evidence for canals built by intelligent Martians. A wealthy amateur astronomer named Percival Lowell used his money to build a world-class observatory in an excellent site (Flagstaff, Arizona) for the next close opposition. He made extensive maps of Mars which seemed to show a network of canals. This idea that there were canals on Mars, apparently built by intelligent creatures, dominated popular thinking on Mars until the middle of the 20th century.

The Straight Story on Mars

We now know none of the above is true. There are no canals on Mars. The surface conditions there are impossible for higher life forms. The present-day search for life on Mars is exploring two possibilities.

1. That microbial life exists there now.
2. That microbial life, or even somewhat more complicated life, could have existed there early in the history of the solar system.

The Atmosphere of Mars

The reason we have “descoped” Mars as an abode of life is that we learned more about its atmosphere. The atmospheric pressure at the surface of Mars is 650 Newtons/m², or 0.0064 atmospheres. Water cannot exist in the liquid state at this low pressure. It would evaporate. In addition, the atmospheric content of Mars is 95 % CO₂, with the rest being nitrogen and argon. The atmosphere of Mars resembles that of Venus rather than that of the Earth.