

Chapter 8. Rocky Worlds

- RADAR (RAdio Direction And Ranging) can be used to measure the distances to Mercury and Venus. It can also be used to measure their velocities and rotation periods.
- Doppler effect: waves from a source moving toward (away) us would show a shorter (longer) wavelength. Waves from a source moving in a direction across the line of sight will not be Doppler shifted. The wavelength change is $\lambda_{obs} - \lambda_{rest} = \lambda_{rest}(v_r/c)$, where c is the speed of light and v_r is the radial velocity.

Mercury

- Mercury's radius $R_{Mercury} = 0.38 R_{Earth}$, and mass $M_{Mercury} = 0.055 M_{Earth}$. The mean density of Mercury, 5.4 g/cm^3 , is similar to the Earth's, implying that Mercury's core is iron. Mercury has the largest iron core in the Solar System, occupying 60% of its mass and over 70% of its radius.
- Mercury has a weak magnetic field (0.01 of Earth's), implying that part of its core is still liquid. Impurities, such as sulfur, in Mercury's iron core lower the freezing point, much like salt in snow/ice.
- The craters on Mercury appear less rugged, have shorter walls, and smaller ejecta blankets than those we see on the Moon because Mercury has a higher surface gravity than the Moon.
- Scarps are huge cliffs that were produced as Mercury's crust cooled and shrank. Because the scarps cross the craters, the contraction had to occur after the heavy bombardment.
- Mercury has a very thin atmosphere (10^{-12} times the Earth's), consisting of 97% sodium (Na) and potassium (K). The lightest elements have escaped. The heavy elements are liberated from the surface rocks by the solar wind.

Venus

- Venus' radius $R_{Venus} = 0.95 R_{Earth}$, and mass $M_{Venus} = 0.81 M_{Earth}$. The mean density of Venus, 5.3 g/cm^3 , is similar to the Earth's, so it must contain an iron core. Venus does not have an observed magnetic field, implying that its core must be solid.
- Venus has a very thick atmosphere (98 times the Earth's) and is composed of 96% CO_2 and 4% N_2 . The high content of CO_2 in the atmosphere has led to a runaway greenhouse effect. The atmosphere retains heat so well that the surface temperature of Venus does not drop at night.
- The clouds on Venus are ~ 50 km above the ground, and consist of sulfuric acid. There is no "acid rain" because the raindrops evaporate long before they hit the ground.
- Venus has $\sim 100,000$ volcanos (shield volcanos, domes, coronae, and pancakes). Most volcanic activities are mild, as a result of high atmospheric pressure.

- Venus has about 1000 meteor craters. The high temperature of the atmosphere keeps the surface rocks soft, allowing it to melt more easily and flow to large distances from the impact craters, making large ejecta blankets.
- Venus' hot, thick atmosphere is responsible for the solid core! The high temperature weakens the lithosphere, resulting in increased volcanic activity which cools the core rapidly.

Mars

- Mars' radius $R_{Mars} = 0.53 R_{Earth}$, and mass $M_{Mars} = 0.11 M_{Earth}$. The mean density of Mars, 3.9 g/cm^3 , is lower than that of the Earth, suggesting that Mars' core is smaller and less dense.
- The Martian atmosphere is only 0.007 times Earth's. Its composition is 95% CO_2 and 2.8% N_2 . It produces a greenhouse effect, but not very effective, because it is thin.
- The magnetic field of Mars is 10^{-4} times Earth's, indicating a solidified core.
- Mars has an axis tilt of 24° , which leads to an inequality of seasons just like the Earth. Mars has a longer orbital period and a larger orbital eccentricity, hence its southern hemisphere has a significantly colder, longer winter than the northern hemisphere. This causes the southern polar cap of ice to vary widely in size; at maximum, it extends almost halfway to the equator.
- The surface of Mars can be divided into two distinctly dissimilar hemispheres: heavily cratered highlands in the south, and lightly cratered volcanic plains in the north.
- The northern hemisphere of Mars contains Olympus Mons, the largest volcano in the solar system. Olympus Mons is nearly 600 km across and 27 km tall. It can grow to such a size because there is no plate motion on Mars and the gravity is low.
- To the southeast of Olympus Mons is the spectacular fault canyon Valles Marineris. The canyon stretches over 5,000 km, roughly the size of the US.
- There is abundant evidence that the surface of Mars once held vast amounts of water. There are dry riverbeds, erosion marks, etc. The surface temperature of Mars is usually below water's freezing point, so water freezes and gets locked underground.
- Recent analysis of Martian meteorites found at the South Pole (of the Earth) shows possible fossil life. The results are controversial.
- Mars has two satellites: Phobos and Deimos (from the Greek for "fear" and "panic"). These two moons are essentially large rocks. Phobos is 20×28 km in size and Deimos 12×16 km. These moons were probably captured from the asteroid belt.
- The masses of Mars' little moons are small. The precise masses are unknown. [Note: the period and semimajor axis of a satellite's orbit can be used to measure the mass of the planet, not the satellite itself.]