Introduction to Astronomy
Summary Questions Week 3

21 October 2019

1. Based on the standard formation scenario of the Solar System, what do you expect about the chemical composition of the planets?

Solution:
All planets are essentially formed from the same primordial cloud, implying that *their initial chemical composition must have been quite similar to that of the Sun*. However, after the Sun ignited, the heat generated by the *Solar radiation heated up the atmospheres of the nearest planets and evaporated some of the more volatile gasses*. Subsequently, these were *blown out of the inner Solar System by the Solar wind and radiation pressure*. As a consequence, we expect:

- *Giant planets* (in the outer Solar System) have a *chemical composition close to that of the Sun*: mostly H, some He and trace amounts of heavier elements.
- *Terrestrial planets* (in the inner Solar System) have a *chemical composition that is mostly dominated by heavier elements*, with far less H and He, except in molecular states (like H_2O, for example).

2. What does the presence or absence of a magnetic field tell us about the interior of a planet?

Solution:
If a planet has a magnetic field, then the dynamo mechanism is active inside the planet. This implies that:

- there is *a conducting liquid*, probably in the outer core
- there is some *convection*, probably caused by a temperature gradient
- there is a *metallic inner core*.

3. What do craters on a planet's surface tell us about the planet's interior?

Solution: Craters can only remain visible is they are not eroded away by the atmosphere (or liquids) and if they are not filled by volcanic eruptions. So the presence of craters can *tell us something about the presence of volcanism on a planet*. Volcanism, in turn, can only exist if there is a layer of *molten or partly molten material not far below the crust*.

Furthermore, the sharpness of craters; and potential overlap between different craters, can give us an estimate of the crater's age, because every crater – and especially crater walls – eventually erode under gravity, even in the absence of a dense atmosphere. Therefore, in the case of cooling planets with no more active volcanism, craters can give an estimate of *how long ago a planet's volcanism ended (i.e. when the upper mantle solidified)*.

4. Tides can play an important role in the evolution of a planetary system. Explain the effects tides have (had) on the evolution of the spin of Venus and the Earth and on the orbit of the Moon.

Solution:

The tidal forces of the Sun on the dense atmosphere of Venus has caused friction which *stopped (and even reversed) the direction of Venus' spin.* A similar effect is seen in the Earth-Moon system, where the tidal effect of the Moon *is slowing down the rotation of Earth.* Simultaneously, the tidal interaction between the Earth and the Moon is *accellerating the Moon in its orbit* around Earth, thereby *pushing the Moon to a higher (more distant) orbit* around Earth.