ISP 205
Review Answers, Week 9

1. What technique has been used to find most of the planets discovered so far? What is the basic idea behind that technique? *It is the "Wobble" technique (called the "Doppler technique" in the textbook). The planet and star both move in orbits around the center of mass of the system. The star has a lot of mass, so its orbit is much smaller in radius than the planet's. If we see such an orbit edge-on, then sometimes the star is moving away from us and sometimes it is moving towards us. We can measure the line-of-sight component of the motion (the "radial velocity") by measuring the way in which the wavelengths of absorption lines in the star's spectrum change due to the Doppler effect. The fact that the star moves shows that the planet is pulling on it (through gravity), and from the star's orbital velocity and orbital period we can figure out the mass of the planet and the size of its orbit.*

2. Why can't the above technique find terrestrial planets in the habitable zone? *The velocity of the star in its orbit becomes larger when the planet is more massive and/or when the planet is closer to the star. There is a minimum velocity that can actually be measured using current techniques. Small planets far from the star (such as would be the case for an Earth-sized planet 1 AU out) don't cause the star to move fast enough for it to be measurable.*

3. What technique is being used by the Kepler spacecraft in its search for terrestrial planets? *It is looking for planets in orbits seen edge-on, so that when the planet crosses between us and the star, some of the star's light is blocked. Kepler monitors the brightness of 100,000 stars, looking for ones with periodic dips in brightness.*

4. Why are we so especially interested in finding terrestrial planets in the habitable zone? *They would be enough like Earth that they would be capable of supporting life. Finding out what fraction of such planets actually do have life on them would tell us how hard it was for life to have formed here on Earth.*

5. Regarding the Sun: What is the photosphere? The chromosphere? The corona?

   Photosphere = deepest layer in the Sun from which light can freely escape into outer space. This is the depth down to which we can see.

   Chromosphere = the gas between the photosphere and the place where the gas density in the Sun drops to a very low value. It is about 1000 miles deep, and is the gas that forms the absorption lines seen in the Sun's spectrum.

   Corona = very hot (over 1 million degrees), very low density outer envelope of gas surrounding the main body of the Sun. It has a ragged, constantly varying shape that extends out about twice as far as the main body of the Sun.

6. What causes sunspots? *Sunspots are places where magnetic fields either loop up out of the surface of the Sun or where the same magnetic field lines then dive back down into the Sun, so sunspots always come in pairs. They are darker than the rest of the photosphere because they are slightly cooler. They are cooler because the intense magnetic fields that pass through the sunspots are able to help support the gas against the pressure of the surrounding gas that is not part of the sunspot. A lower gas pressure (meaning a lower temperature) is then needed inside the sunspot so that the total pressures inside and outside the sunspot are in balance with each other.*

7. What is the “sunspot cycle”? *The number of sunspots seen over the whole surface of the Sun at any one time is sometimes quite large, and other times almost zero. This number goes through a cycle that repeats itself every 11 years. We are approaching a “sunspot maximum” now, meaning that we see lots of sunspots on average. But the 11 year cycles come in pairs… with a flip in the magnetic polarity pattern of the Sun between the two successive 11-year cycles. So it is really a 22 year cycle. This is all thought to be due to the general magnetic field of the Sun (which is generated in the outer third of the Sun) getting gradually twisted up and disordered by the Sun’s differential rotation, until at some point the magnetic field has a massive short circuit and then regenerates itself as a nicely order pattern again. “Differential rotation” refers to the fact that the gas at the Sun’s equator rotates around in less time than does gas near the Sun’s poles.*