Exam 1 Sept 29, 2017 Astronomy 131

Please answer the questions in your bluebooks. Answer each question as completely as you can. Partial credit will be given for partially correct answers. You must answer at least ***five*** questions. If you answer more than the minimum number, then only your best answers in each section will be counted.

Section 1 (each question worth 20 points, and you must answer at least 5):

1) Congratulations! NASA has appointed you director of the first interstellar robotic exploration mission. You are instructed to plan a mission to visit the nearby star Taylor 359, a star almost identical to the Sun about 10.4 light years away. What type/style of mission would be the best? Explain your reasoning.

   There are many different correct answers to this question, as long as you give a logical explanation for your choices.

2) Consider the solar neutrino problem and its solution. What if scientists using the newest neutrino detectors to observe solar neutrinos noticed a sudden drop off in the numbers of neutrinos coming from the Sun? What would this imply for the Sun? How would you be able to test your explanation?

   According to our understanding of how solar neutrinos are produced, once we are confident that we are accurately counting all three types of neutrinos, any drop in the number of neutrinos being detected suggests that there are fewer being produced. Since they are produced during fusion reactions in the Sun's core, this would tell us that there are fewer fusion reactions occurring in the core. This should eventually lead to a decline in the Sun's brightness, but as it can take almost 1 million years for light to escape from the Sun once it is produced in the core, we would have to wait that long for a change in the brightness. It might be possible to look for changes in the Sun's internal temperature and density that would accompany a sudden change in the heating rate, through helioseismology.

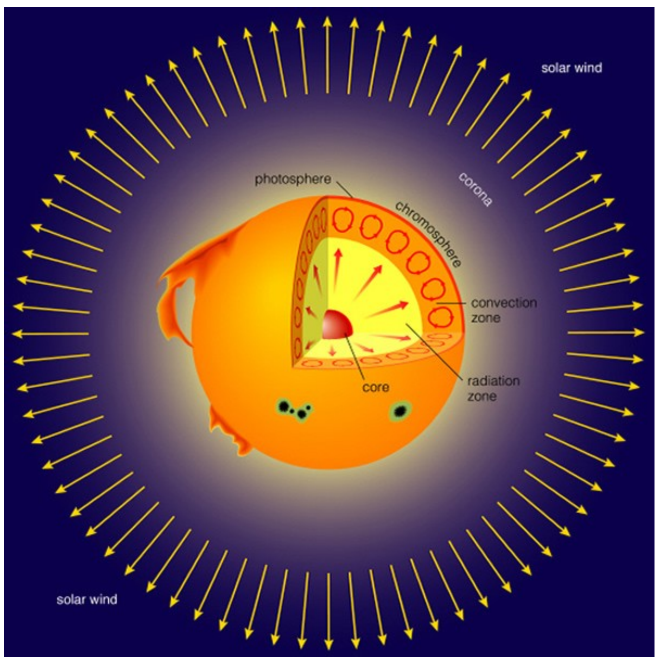
3) What would have been the consequences if the solar nebula had been much ***cooler*** that it really was during the time in which planets were forming? Be as detailed as possible.

   The division between rocky terrestrial planets and gas giants is determined by the temperature in the solar nebula. Had the nebula been cooler, then the location where the temperature transitioned from not allowing low density elements to form solids into where they could form into icy planetesimals would have occurred closer to the Sun. This might have resulted in few terrestrial planets, and more gas giants, and the gas giants could have formed closer in to the Sun than they actually did.

4) Look at Figure 1 and 2 on the screen. What can you tell about the terrain being shown in each figure based on these photographs?

Figure 1 represents and older planetary surface, as demonstrated by the larger number of craters. A relative age difference between craters can be seen by the way that some craters overlay upon othters, and in the case of small craters, how small craters are contained inside bigger ones. The planet in Figure 2 has fewer craters, it has a younger surface, and the pattern coming out of the large crater indicates the presence of wind erosion.

5) Draw and label a sketch of the internal layers of the Sun, and describe how light travels through each layer.



The energy travels though the core and the radiation zone in the form of photons, being continually absorbed, deflected, reflected and bounced around randomly by interactions with atomic nuclei and electrons, resulting in a random walk trajectory. Each interaction can result in lower energy photons being produced from higher energy ones, and after spending about 200,000 years in the radiation zone, the energy passes into the convection zone. Here the properties of the gas allow it to absorb and retain the photons for a longer period of time. As a result, bubbles of hot gas develop at the bottom of the convection zone. These expand and rise up to the photosphere where they sit and radiate their energy into space in the form of visible light.

6) If a planet were identical to Venus in every way, except that it has a core twice as big as Venus's core, how would that extra big core affect what happens on the surface of the planet?

An extra large core would mean the interior would be hotter (due to excess heavy radioactive elements). This would increase the heat available to power volcanic activity, so there could be more volcanoes on the surface, or possibly more frequent volcanic eruptions. The latter would result in an even younger surface on top, with even fewer craters present than we see today, with possibly more of the surface covered in basaltic material than the 85% that Venus actually has.. The extra volcanic activity could cause extra outgassing through the volcanoes, which could increase the CO2 content of the atmosphere, making the greenhouse effect even stronger, causing the atmosphere to be even hotter than it is now.

If the core were still iron/nickel, and extra large core might lead to a stronger magnetic field for Venus, though this isn't certain as it has a very slow rotation.

7) Both Venus and Mercury are deficient in the numbers of small sized craters on their surfaces. Explain how these two very different planets ended up being similar in this particular way.

Venus lacks small craters due to its very thick atmosphere, which causes small meteors to burn up before impacting the surface. Mercury lacks small craters because of low-level volcanic flows in the intercrater plains have filled in the smaller craters, but were not deep enough to fill in larger craters.

8) Describe the ways a planet's surface might look different if that planet had never experienced ***differentiation***.

Without differentiation a planet's interior would not have stratified according to density. Thus we would expect the types of minerals on the surface to have higher average densities. Without the high levels of internal heat due to concentrating radioactive elements in the center, there would be no power source for geological activity like volcanoes, plate motions, vertical crust motions, etc.. Without volcanic activity there would not be two terrain types (highlands and lowlands) as the lowlands are mantle material – there would be no mantle…. Without volcanic outgassing, no atmosphere or water. Without eruptions or erosion, no removal of impact craters.