OpenStax Astronomy, Ch.20: WS Problems (Apr-2021)

Review Questions

1. Why do nebulae near hot stars look red? Why do dust clouds near stars usually look blue?

2. Describe how the 21-cm line of hydrogen is formed. Why is this line such an important tool for understanding the interstellar medium?

3. Describe the properties of the dust grains found in the space between stars.

4. Why is it difficult to determine where cosmic rays come from?

5. What causes reddening of starlight? Explain how the reddish color of the Sun's disk at sunset is caused by the same process.

6. Why do molecules, including H_2 and more complex organic molecules, only form inside dark clouds? Why don't they fill all interstellar space?

7. Why can't we use visible light telescopes to study molecular clouds where stars and planets form? Why do infrared or radio telescopes work better?

8. The mass of the interstellar medium is determined by a balance between sources (which add mass) and sinks (which remove it). Make a table listing the major sources and sinks, and briefly explain each one.

9. Where does interstellar dust come from? How does it form?

10. The terms H II and H_2 are both pronounced "H two." What is the difference in meaning of those two terms? Can there be such a thing as H III?

11. Describe the spectrum of each of the following:

    A starlight reflected by dust,

    B a star behind invisible interstellar gas, and

    C an emission nebula.

12. New stars form in regions where the density of gas and dust is relatively high. Suppose you wanted to search for some recently formed stars. Would you more likely be successful if you observed at visible wavelengths or at infrared wavelengths? Why?

13. We can detect 21-cm emission from other galaxies as well as from our own Galaxy. However, 21-cm emission from our own Galaxy fills most of the sky, so we usually see both at once. How can we distinguish the extragalactic 21-cm emission from that arising in our own Galaxy? (Hint: Other galaxies are generally moving relative to the Milky Way.)

14. Suppose that you gathered a ball of interstellar gas that was equal to the size of Earth (a radius of about 6000 km). If this gas has a density of 1 hydrogen atom per cm^3, typical of the interstellar medium, how would its mass compare to the mass of a bowling ball (5 or 6 kg)? How about if it had the typical density of the Local Bubble, about 0.01 atoms per cm^3? The volume of a sphere is $V = (4/3)\pi R^3$.

15. H II regions can exist only if there is a nearby star hot enough to ionize hydrogen. Hydrogen is ionized only by radiation with wavelengths shorter than 91.2 nm. What is the temperature of a star that emits its maximum energy at 91.2 nm? (Use Wien's law from Radiation and Spectra.) Based on this result, what are the spectral types of those stars likely to provide enough energy to produce H II regions?

16. Dust was originally discovered because the stars in certain clusters seemed to be fainter than expected. Suppose a star is behind a cloud of dust that dims its brightness by a factor of 100. Suppose you do not realize the dust is there. How much in error will your distance estimate be? Can you think of any measurement you might make to detect the dust?