ASTR340 (Fall 2018) Homework 2

The expanding Universe and Special Relativity

(Due at the start of class on 25 Sept 2018)

1. FMC, Q6.4

2. FMC, Q6.9

3. FMC, Q6.10

4. FMC, Q7.3

5. FMC, Q7.9

6. Describe the Michaelson-Morley experiment, explaining its goal and how the apparatus was set up to make the needed measurements. Explain in what sense the original experiment was a "failure" and how this "failure" was important to the development of new hypotheses concerning light and motion.

7. Answer concisely the following questions: (a) what are the two postulates of special relativity? (b) What are the basic consequences of special relativity regarding space and time? (c) Why the speed of light is regarded as the maximum speed that any object can reach?

8. Gamma-Ray Bursts (GRBs) are extremely violent explosions in space that probably arise from a particularly catastrophic collapse of a massive star. When a GRB detonates, it sends a powerful blast wave through space that travels at almost the speed of light. Suppose a particular GRB produces a blast wave with a velocity of v=0.9995c, where c is the speed of light. What is the Lorentz factor corresponding to this velocity? Suppose you were in a spacecraft riding along with this wave as it was engulfing a planet with a diameter of R=10,000km. What shape and size would the planet appear to have (just prior to being engulfed – it would probably be destroyed rapidly once it has been engulf!)?

9. Two spaceships (A and B) approach your spacecraft at 9/10 the speed of light (0.9c) from opposite directions. They send out radio messages. What is the speed you measure for the radio waves from A and B? What is the speed of the radio waves from A as measured by B. What speed does B measure for your motion? How fast does spaceship B observe spaceship A to be moving?