

1. READING:

Ellis and Williams, *Flat and Curved Space-times*

Chapter 3. So far we have discussed sections 3.1 - 3.4 (we skipped pages 58-9). Looking ahead section 3.5 (length contraction) will be derived on Thursday (October 2). We'll start on section 3.6 (the whole kit and kaboodle) on the 7th.

Towards the end of next week we'll discuss the material in section 3.7, although I will post some alternate reading on this topic (" $E = mc^2$ "). After that I will ask for your input on where to go from there. We will have finished with special relativity. I'd like to touch on general relativity, black holes, etc - perhaps one lecture. (For a taste of this "curved space-times" see Ellis and Williams sections 5.1-5.3.) But there is interesting stuff in the quantum section as well...

2. QUESTIONS: DUE WEDNESDAY, OCTOBER 8 BY 5 PM

A calculator will be handy for questions 2, 5, and 7. If not stated explicitly, each question is worth 1pt.

- (1) (Short answer) (0.5 pt.) If you would like, please offer suggestions for more observer-pair names, like "Alice-Bob". If the pronunciation is not straightforward please offer a suggestion on how to pronounce the names.
- (2) (Short answer) Have a look at the spectrum "example 2" in the Links section of the course webpage. What is the redshift z for this galaxy?
- (3) (Short answer) In your own words and diagrams explain why two events simultaneous in one frame will occur at different times in any other frame.
- (4) (Short answer) If

$$v = \frac{15}{17}c$$

then what are K and γ equal to? Hint: It is easiest to work this out in terms of fractions

- (5) You buy a *really* fast car. After trying out the car on a stretch of straight and empty road you are stopped for running a red light ($\lambda \approx 650$ nm) in a 45 mph zone. You decide to contest the ticket in court. In your defense you simply state that the light appeared to be green ($\lambda \approx 530$ nm). The judge agrees! But then changes the charge to speeding. You are charged 0.001 dollar for every mile per hour over 45 mph. What is the fine (approximately)? You can use the conversion $2.2 \text{ mph} = 1.0 \text{ ms}^{-1}$.
- (6) (2 pts.) A Federation cruiser is at rest relative to the border of Klingon Space and is in Federation Space. The border is 6 light-hours away. A Klingon battleship zips by the cruiser moving at $\frac{3}{5}c$ towards the border. Let's call this event A and have it designate noon for both frames. A little while later the Klingon battle ship fires a parting shot in the form of a laser beam ("phasor") at the Federation cruiser. The phasor impacts the cruiser at 8 PM, according to the Federation clocks, severely damaging the spaceship.
 - (a) Sketch a space-time diagram of the history in the cruiser's frame, including the spaceships, border, and phasor.
 - (b) When did the Klingon battleship fire the phasor, according to the Federation clocks? When does the Klingon ship pass into Klingon Space?

- (c) Many months later the case comes to Intergalactic Court. The Klingon-Federation Space-time Treaty states that it is illegal for a Klingon (Federation) ship in Federation (Klingon) territory to damage Federation (Klingon) property. The lawyer representing the Klingon ship's captain argues that they are within the letter of the law, since in the ship's frame the damage to the cruiser occurred after the Klingon ship crossed back into Klingon territory. Hence they were not in Federation territory at the time the damage occurred. Did the event of the phasor impacting the cruiser really occur after the Klingon ship crossed into Klingon territory, in their frame?
 - (d) On the basis of this case, would you recommend that the Intergalactic Congress re-negotiate the treaty to clarify this law? If so, how would you recommend wording the treaty?
- (7) Ellis and Williams 3.14
 - (8) (3 pts.) Ellis and Williams 3.18
 - (9) Apropos our discussion in class September 25 - Ellis and Williams 3.21. Draw a careful space-time diagram in A's frame, including the surfaces of simultaneity, to answer this one.