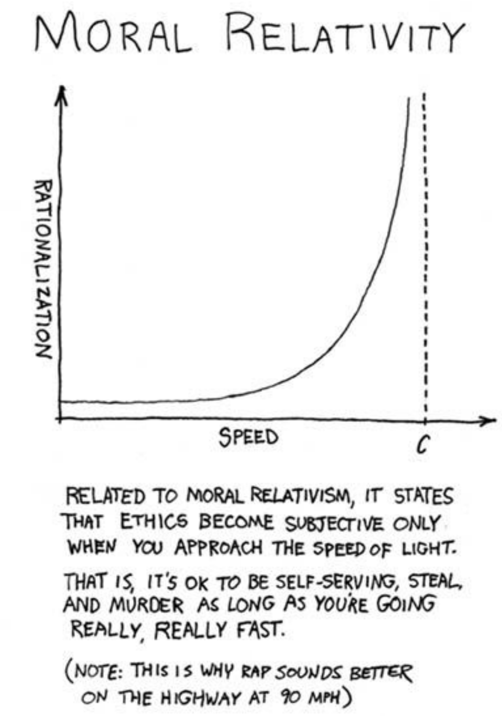
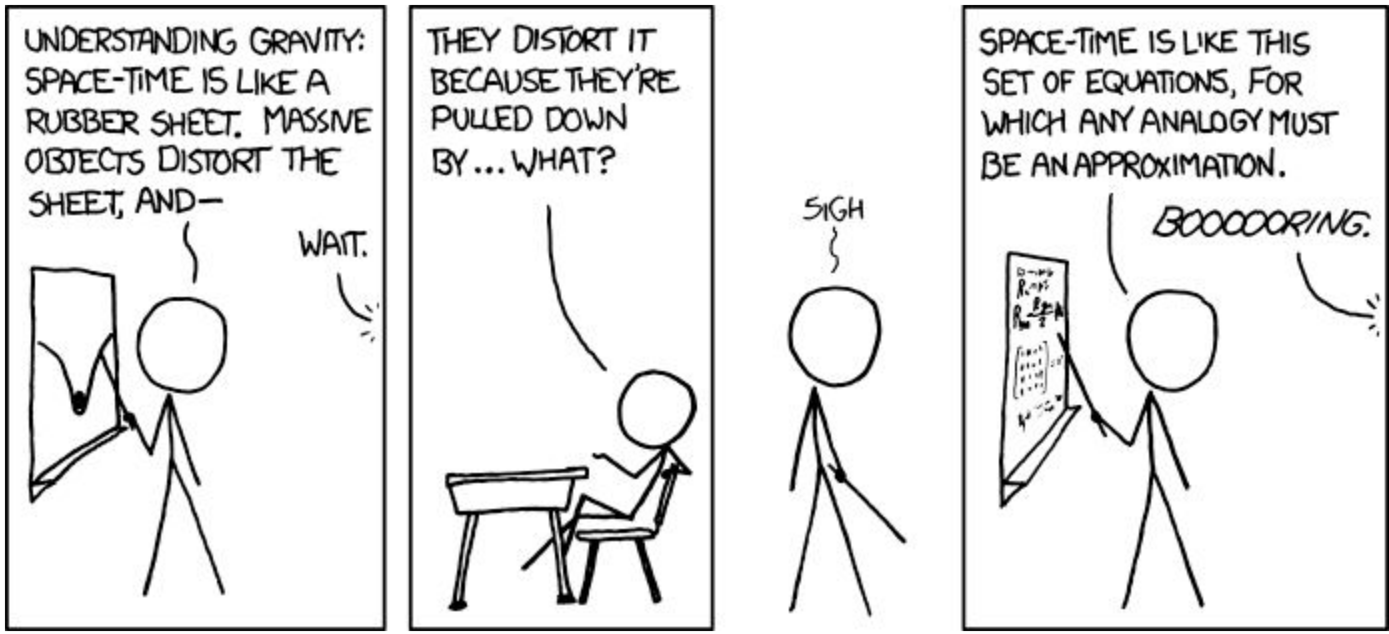
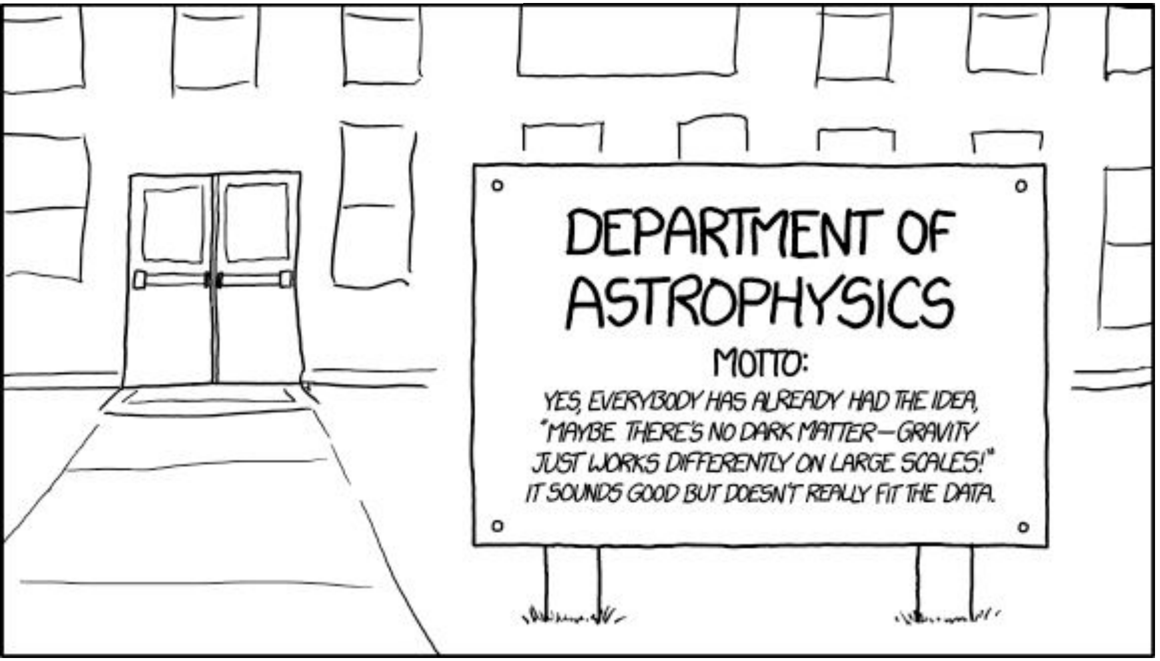
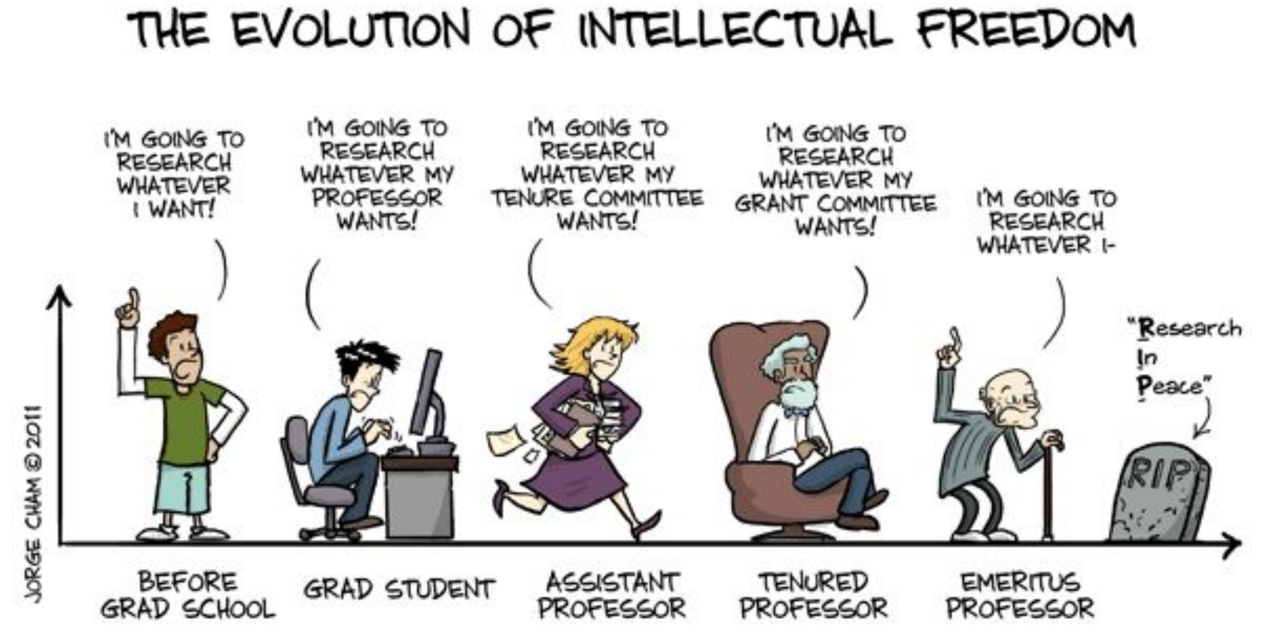


PHY151 Practical 10

November 30







Today’s Schedule

- **6:10** Tutorial Problems
- **6:50** Evaluation of Practicals and TAs
- **7:00 Practical** Relativity Module, Activities 1, 2, 3, 4 (and 5 for bonus)
- **9:00** we must clear this room – all TERM booklets must be collected by this time.

Tutorial Problems

1. This problem is just about light travel time, you shouldn't need to use the length contraction equation, just a Galilean transformation.
2. Think about when and where the light that entered your camera in problem 1 was emitted. Remember that the speed of light is always the same, no matter your reference frame.
3. Remember that the length of the rocket that you measure is not it's rest-frame length
   a. This is just about light travel times again
   b. Use your result from (a) and the time dilation equation

Answers:

1. You observe the rear of the rocket was 1200 m away from you 4 μs in the past, and was moving at 240 m/μs away from you. You thus measure that at the moment you took the photograph, it would be at position

$$x = x_0 + vt = 1200 + (240)(4) = 2160 \text{ m}.$$

   You similarly find that the front of the rocket would be at position

$$x = 1800 + (240)(6) = 3240 \text{ m}$$

   at the moment you took the photograph. The length of the rocket is thus measured to be 1080 m.

2. The proper way to measure the length of a moving object is to measure the location at the two end points of the object at the same time. This means you are simultaneously measuring the location of the two ends of the object.

   Since different observers disagree on simultaneity, the other observer believes you took the wrong data. They think you measured the location of the front at one time, then waited for the back to move some distance before measuring its location. They thus believe you measured a shorter length than its true length.

   Which agrees with the notion of length contraction.

3. (a) $t = d/v = 1080/(0.2c) = 18$ μs is the time you measure for the light to reach the front. $t = d/v = 1080/(1.8c) = 2$ μs is how long you measure the return trip should take. Total time: 20 μs.

   (b) $\gamma = 1/\sqrt{1-(0.8)^2} \simeq 1.67$ so your clock registering 20 μs means the proper time should be 12 μs.

   (c) They measure the one-way trip was 6 μs, so they should measure the length of their rocket to be 1800 m.

TA Evaluations + Nathan's help centre hours

The TAs are going to leave the room for 10 minutes while you fill out your TA evaluations. We'll pick one of you to be in charge, they will collect evaluations in envelopes and slip them under April's door when the 10 minutes is up.

If you finish early, pull up your exam schedule. When we get back, Nathan will hold a poll to decide when his 3 Help Centre Hours will be:

- Monday, December 12 – 11:30-13:00 or 13:00-14:30
- Tuesday, December 13 – **13:00-14:30**
- Wednesday, December 14 – 13:30-15:00 or **15:00-16:30**
- Thursday, December 15 – 11:30-13:00 or 13:00-14:30

Note that your exam is at 19:00 on December 15.

Important equations

Nathan is walking along Yonge Street (Yonge Street is frame *S*) at a speed *u*. Prof. Wilson is on a bus on Yonge Street moving at speed *v* relative to *S*. Prof. Wilson's rest frame is *S'*. Nathan's speed in Prof. Wilson's rest frame *u'* is given by

$$u' = \frac{u - v}{1 - \frac{uv}{c^2}}$$