Homework

1. Describe qualitatively what is the precession of perhelion. What is its dominant cause of this precession?

2. In quantifying the precession of the perihelion of mercury, we could use in degrees/year. Usually we use a different unit arcseconds/century to describe the precession.

   (a) What is 300 arcseconds/century in degrees/year?

   (b) Estimate the smallest angle visible with the naked eye in degrees?

   (c) How long would I have to wait (in years) before the shift in the perihelion would be visible with the naked eye?

3. Why did Le Verrier believe (until it was refuted) in a planet named Vulcan.

4. (**Michelson Morely**) Consider a (fast) river shown below moving with the speed of the earth in space $v = 30,000\,\mathrm{m/s}$ (about mach 100), and a (very small and fast) boat moving with the speed of light $c = 3 \times 10^8 \mathrm{m/s}$. We will analyze the time to go from A to B and back using classical physics. Take $L = 1.5\,\mathrm{m}$ (that's a short river)

   (a) Show, using classical physics that the time to go from A to C and back to A is

   $$\Delta t_{ACA} = \frac{2L}{c} \tag{1}$$

   (b) Show that the time to go from A to B and back is

   $$\Delta t_{ABA} = \frac{L}{c+v} + \frac{L}{c-v} \tag{2}$$

   (c) Determine the fractional difference between these times.

   $$\frac{\Delta t_{ACA} - \Delta t_{ABA}}{\Delta t_{ACA}} \tag{3}$$

   When you calculate these numbers you will need to use at least 10 digits, otherwise you will get zero.

   Go to www.wolframalpha.com for a free calculator up to the task. (type in $3.0 * 10^5/1.51 * 10^3$)

   (d) In class we estimated that this difference is of

   $$\frac{\Delta t_{ACA} - \Delta t_{ABA}}{\Delta t_{ACA}} \sim \frac{v^2}{c^2}$$

   In this case our estimate is almost exactly equal to the full result. This is accidental. Explain.

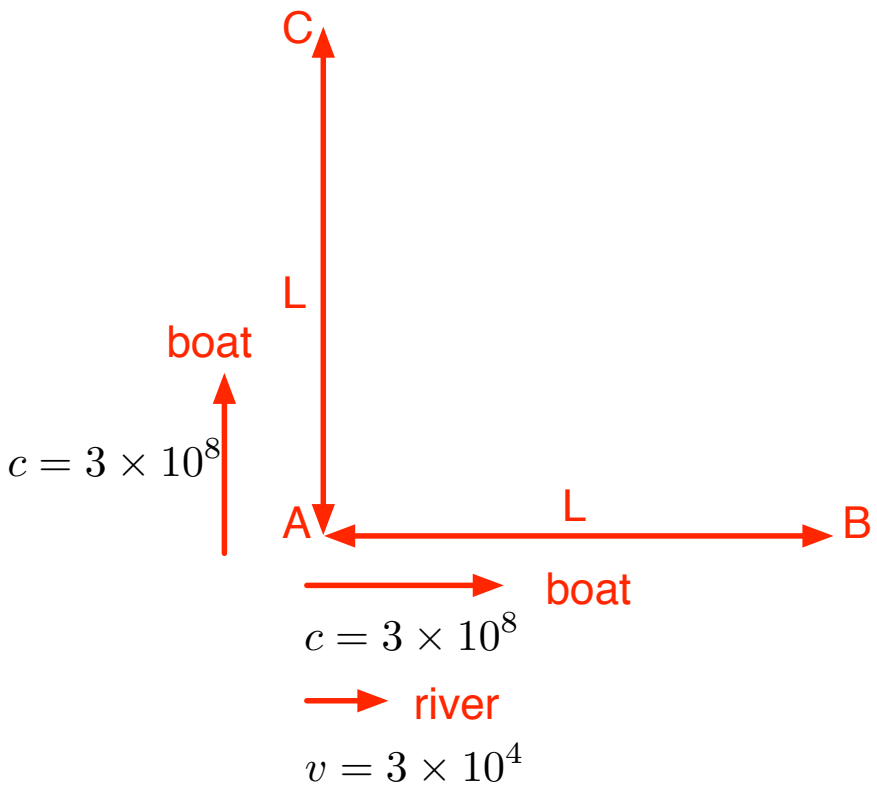

Figure 1: Set up of Michelson Morley Experiment.

5. The mysterious planet vulcan is observed at a radius of $r_V = 0.1\,AU$. (What about $0.1\,AU$ makes it a special special planet?)

   (a) Determine the orbital period of the planet.

   (b) The sun spontaneously (and quickly) ejects 1/2 of its mass into outer space, so that the planet Vulcan remains at its same orbital radius. After things settle down, what would the orbital period of the planet Vulcan be?