Lab 1 Report: Speed of Light

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Einstein's special theory of relativity suggests that the speed of light, c, is the speed limit of the universe. Maxwell's equations show that c is a fundamental quantity, and these qualities have given scientists motivation for measuring the speed of light. However, the speed of light inspired curiosity in physicists well before these discoveries, as many scientists attempted to measure the quantity without success before Maxwell or Einstein made their contributions. Fizeau accomplished this feat in the mid-eighteenth century using a rotating gear and mirrors, which allowed him to get circumvent the difficulty in measuring how long it takes light to travel in a linear path. Foucault improved Fizeau's design with a rotating mirror, which has inspired the experimental setup used for the present experiment.

Given that light travels at an incredibly fast speed, we cannot successfully measure the speed of light through timing how long time takes to travel a linear distance. However, we can learn from Foucault and Fizeau and incorporate mirrors and rotations to create our experimental design. As shown in figure 1: we used a polarized laser beam as our light source and reflected this light off of a spinning mirror. When correctly aligned, the laser reflects onto a second mirror that directs the laser into a thin lens to focus the beam. Through the lens the light reflects off of a return mirror back into the lens, and back off of the stationary mirror. Then, in the time that it has taken for the light to travel from the spinning mirror to the return mirror and back, the spinning mirror has rotated θ degrees from the position when it reflected the laser. The light reflects off of the spinning mirror at an angle of 2θ relative to the initial laser, and hits a beam splitter that reflects a fraction of the light through a polarizer and onto a camera sensor. We also placed a photodiode in the plane of the reflection of the laser so that we could measure the frequency of the spinning mirror. This frequency along with the positions captured on the camera allows us to measure the amount of time that has passed between the instants that the light reflected off the spinning mirror. Utilizing the distance that the light travels during this time, we can calculate a value for c.

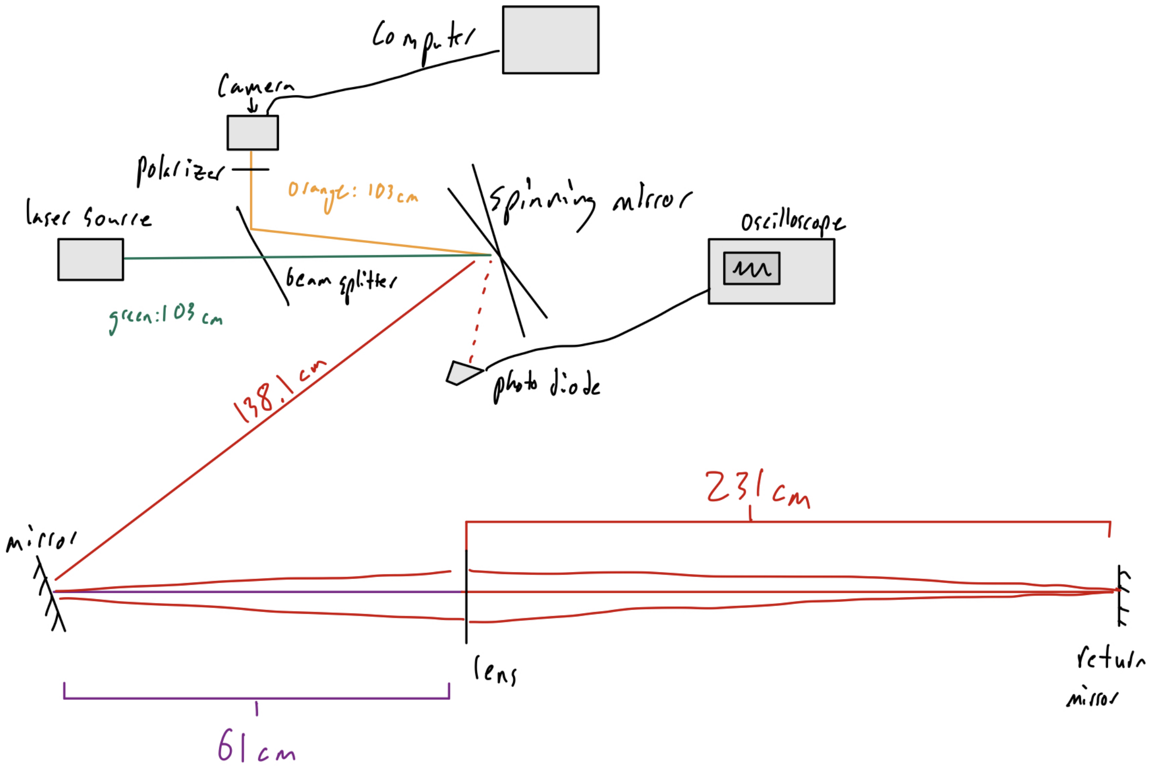

Figure 1: Experimental Setup