PHYSICS 125 EXPERIMENT NO. 9
YOUNG'S MODULUS

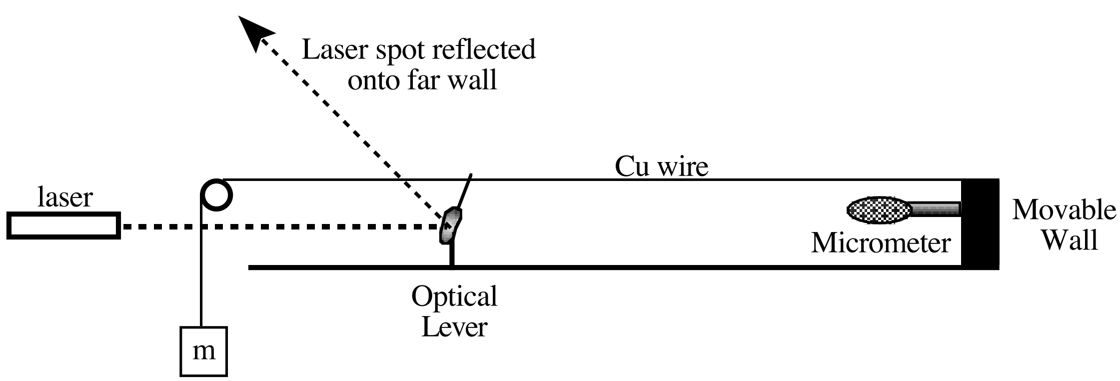
In this experiment we test the linear relationship between stress and strain and determine the Young's Modulus of copper. The experiment is performed by placing a copper wire of known diameter under varying degrees of tension and measuring the resulting small length change using an optical lever.

A. Equipment

1 Meter stick, 1 Laser, 1 Optical Lever, 1 Cu wire attached to micro-meter pivot, hanging masses.

B. Method

The linear stress/strain relationship is expected to hold only for cases of small strain (and consequently small stress). Thus we must be able to measure extremely small deflections with high precision (well beyond the capabilities of a simple meter stick. To accomplish this task we use an "optical lever" (a mirror mounted on a small pivot). In the figure below the mass *m* can be varied by stacking additional weights onto the hanger. As one adds these weights the Cu wire will stretch and the laser spot strike at a lower position on the far wall.



The micrometer is used to move the wire a known distance while observing the laser spot. This allows for a calibration of the laser spot position in terms of the actual deflection of the wire.

C. Procedure

1. Set up the system as shown in the diagram with the 50 gram "hanger" as your only weight.

CAUTION #1: NEVER stare directly into the laser beam.

CAUTION #2: NEVER place more than 300 g on the wire!

2. By turning the micrometer and/or moving the base of the optical lever, position the reflected beam spot on the far wall at a convenient height.

3. By turning the micrometer (don't change anything else), make the beam spot move vertically. Make a graph of micrometer reading (your TA will teach you to read the micrometer) vs. reflected beam spot position. Take at least 5 points and make the beam spot position vary by roughly one meter.

4. Find the slope, *m*, of the best straight line fit to your graph. From this point on, you can use the relation $\Delta l = m\ \Delta_{spot}$, where Δl is the change in position of the top of the optical lever, and Δ_{spot} is the change in vertical position of the reflected spot.

   Q1. Justify the relation given above: $\Delta l = m\ \Delta_{spot}$.

5. Measure using the meter stick l_0, the distance from the "fixed" end of the copper wire to the point of contact with the optical lever. Be careful not to "bump" the apparatus.

   Q2. Why is the precision of this experiment not ruined by a measurement using a meter stick?

6. Using the diameter of the wire (provided by the TA), calculate the stress of the wire in proper MKS units.

7. Vary the stress in the wire by adding weights to the hanging mass. At each point record the total weight and the spot location. Compute for each point the stress you applied and the strain you observed.

8. Make a plot of stress vs. strain.

   Q3. Does your measurement support a linear stress strain relationship?

   Q4. Calculate from your graph the Young's Modulus of copper.