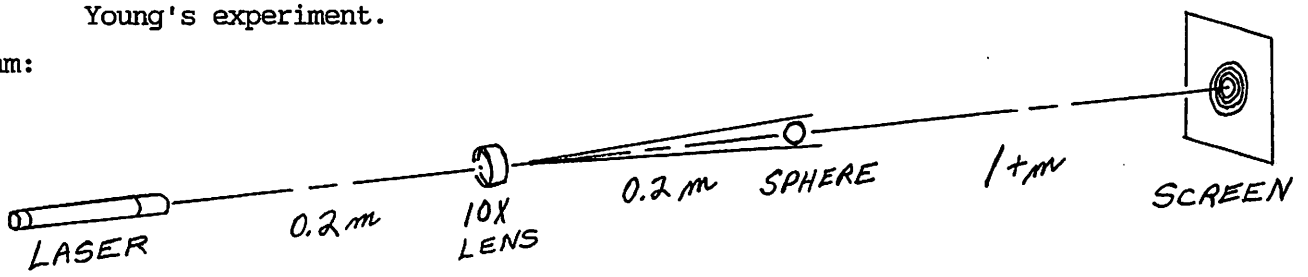
John B. Johnston, The Faraday Center, 103 Creamery Road, Livingston Manor, NY 12758
(845) 439 - 4706

Poisson's spot - long considered one of the great experiments (demonstrations) on the topic of light. It is easily performed today via the use of the laser and some simple materials. But first, a little history to illuminate its importance in the development of our knowledge about the nature of light.

1672 - Newton's corpuscular (particles of matter) theory of light.
1678 - Huygens' wave theory of light (principle).
1803 - Young's double slit experiment (interference pattern) predicted by Huygens' principle.
1819 - Poisson (particle supporter) vs Fresnel (wave supporter). Fresnel's wave (diffraction) equations were solved by Poisson who considered the result reached absurd. It predicted that a bright spot due to diffraction (and interference) would occur behind the center of a small, round, solid object (sphere?) instead of a shadow. Arago (particle supporter) set up the experiment and discovered the spot. Fresnel's reputation and the wave theory were secure. Rarely mentioned is the beautiful interference pattern of concentric circles which adds further credence to the wave nature of light. The pattern is simply an extension of Young's experiment.

Diagram:

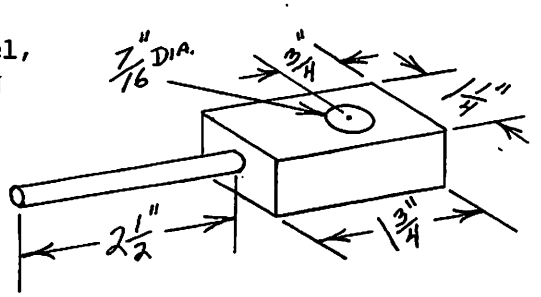


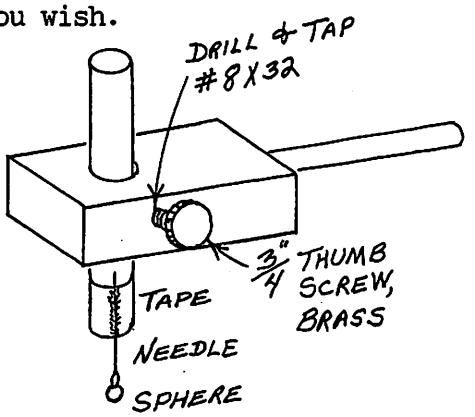
Materials: laser pointer (red or green), 10 x lens (microscope ocular, simple magnifier), ball bearing, steel (3/32"), screen, white (posterboard, classroom wall), ring stands, right-angle clamps, meter stick

A simple way to "suspend" a small, steel ball bearing is on the tip of a steel needle taped onto the end of a small bar magnet; the needle is mostly unobstrusive. Below is my design for a simple, wooden ball bearing holder; you may alter as you wish.

Plan for ball bearing holder:

3/4" pine
3/8" dia. dowel,
3 1/8" long



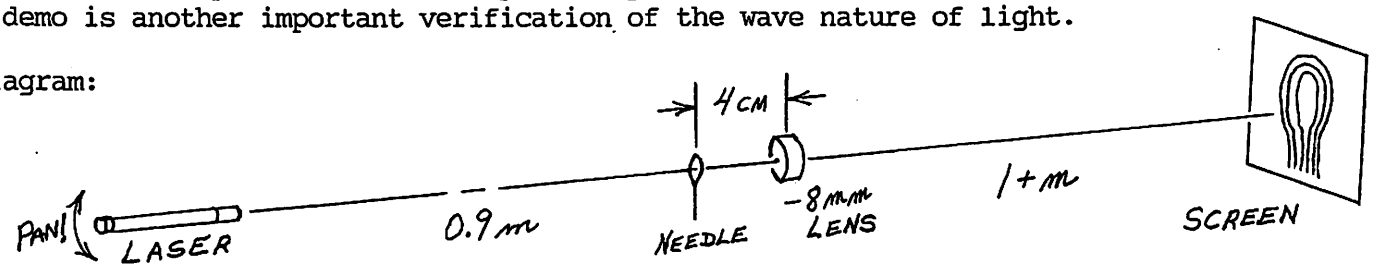


Assembly of bearing holder: (a) Cut out pine block and drill the three necessary holes: 3/8" dia., 5/8" deep for dowel; 7/16" dia. through for 3/8" dia. magnet; and #29 drill bit through for #8 brass thumb screw. (b) Cut the dowel, sand ends, add glue, and tap it into the block with a hammer. (c) Carefully tap the #8 thumb screw hole; add wax or soap to the thumb screw and carefully twist it into the block. (d) Tape a small needle to the end of the magnet with the eye extended about ½". Insert the magnet into the wooden holder and tighten the thumb screw until snug. Don't over-tighten and strip the wooden threads. Fasten the holder to a ring stand with a right-angle clamp. Add the bearing. A small, steel bearing of a different size may be used; experiment. The 10 x lens acts as a beam spreader.

Procedure: (a) Align the laser, lens, bearing, and screen as illustrated in the diagram; adjust the spacing (0.2 m) if necessary. (b) The spot and pattern will show best in a darkened room. Have the students get up close for a better look; they can now see what Arago saw for the first time in 1819. Neat!

Addendum: The eye of a needle - another classic demonstration, closely related to Poisson's spot, is one that can be projected in a large pattern on a classroom wall. The laser's light diffracts around the needle's eye, inside and out, and establishes a tiny interference pattern that is expanded by the diverging lens onto a large screen or wall. The demo is another important verification of the wave nature of light.

Diagram:



Materials: laser pointer, very small needle, -8 mm concave lens, screen, white (wall?), ring stands, right-angle clamps, meter stick

Procedure: (a) Align the laser, eye of the needle, the lens, and the screen as illustrated; adjust the spacing if necessary. (b) The interference pattern will show best in a darkened room. (c) Pan the "eye" so the entire pattern can be observed. Could a camel pass through the center of the pattern on the wall? Kind of amazing to learn what light is and how we can manipulate (control) it.

Addendum: An alternative screen for both demos. If a darkened room is not possible, try a pane of frosted window glass as a screen and view it from behind. It is safe, and the patterns are clearly visible. I mounted the glass (9½" x 11") in a simple frame so I could easily attach it to a ring stand.

Diagram: