IX Iberoamerican Physics Olympiad

Salvador, September 2004

2 Experiment II: Interferometry and polarisation

2.1 Historical introduction

Albert Abraham Michelson and Edward Williams Morley performed the Michelson-Morley experiment in 1887. The experiment detected no motion of Earth relative to the ether, the hypothetical medium once thought to carry light waves, although the apparatus was sensitive enough to observe the expected effect. This result became a major foundation of the theory of relativity of Einstein. Michelson built an interferometer for this experiment.

2.2 Aim

Use an interferometer similar to Michelson-Morley to study light interference and its dependence on polarisation.

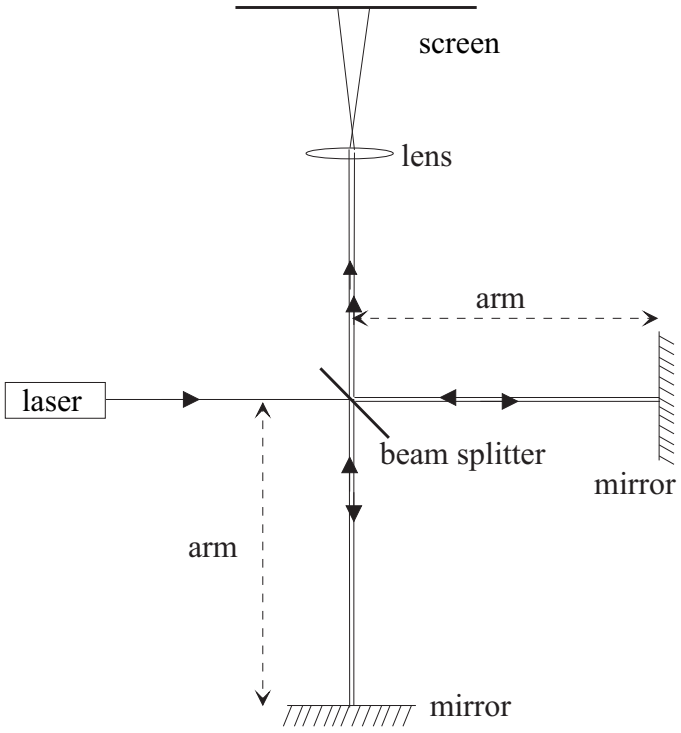


Figure 1: Light-ray paths in the interferometer

2.3 Experiment

Norms of safety and care

1. **Never gaze directly into a laser beam, as it can cause permanent retina injuries.**
2. **Never manually contact any interferometer mirror, beam splitter or lens, since irreversible damage can result.**

2.3.1 Material

A Michelson-Morley interferometer: a laser pointer on a base, two plane mirrors, one plane half-mirror and a biconvex lens. Two polarisers on bases, a loose polariser without a base, a screen and paper (figure). Each polariser transmission axis is parallel to one edge.

2.3.2 Procedure

1. Adjust the mirrors to obtain interference fringes on the screen.
2. Sketch what appears on the screen.
3. Which parts of the pattern correspond to:
   (a) interference?
   (b) possible imperfections in the laser beam?
4. How can you distinguish these two contributions?
5. Can the laser beam polarisation direction be determined uniquely with the equipment provided? Explain.
6. Place a mounted polariser in each arm, between the half-mirror and the plane mirror, so light from both arms reaches the screen.

   Ensure that light from the two arms is polarised in perpendicular directions. How did you check this?

   What is the relative orientation of the mounted polarisers?

   Describe your procedure clearly and in order.
7. Explain in detail why interference fringes disappear, or their contrast becomes very small, in the previous arrangement.
8. Restore the fringes with the loose polariser, without touching the arms or their mounted polarisers. Explain the procedure and result using polarisation.