Basic Physical Optics

Module 1-5

of

Course 1, *Fundamentals of Light and Lasers*

OP-TEC

National Center for Optics and Photonics Education

This text was developed by the National Center for Optics and Photonics Education (OP-TEC), University of Central Florida, under NSF ATE grant 1303732. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.

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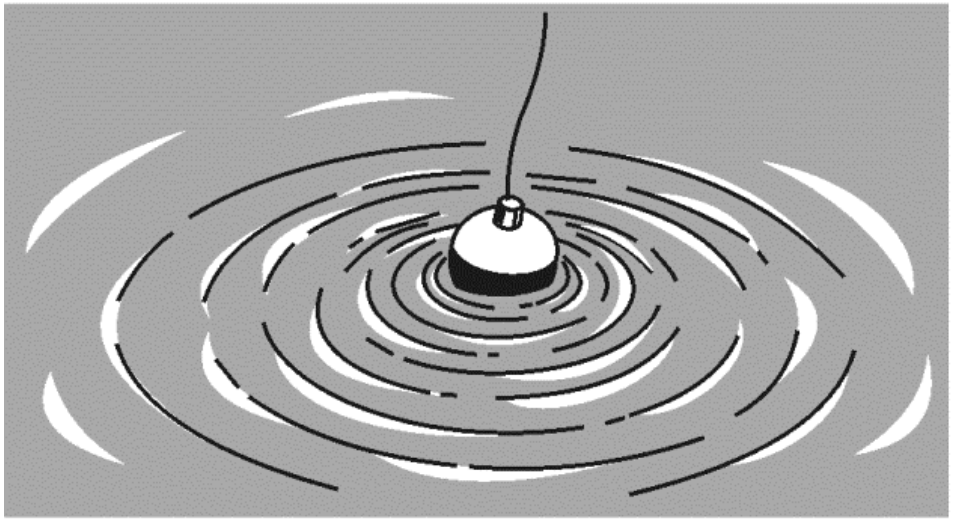
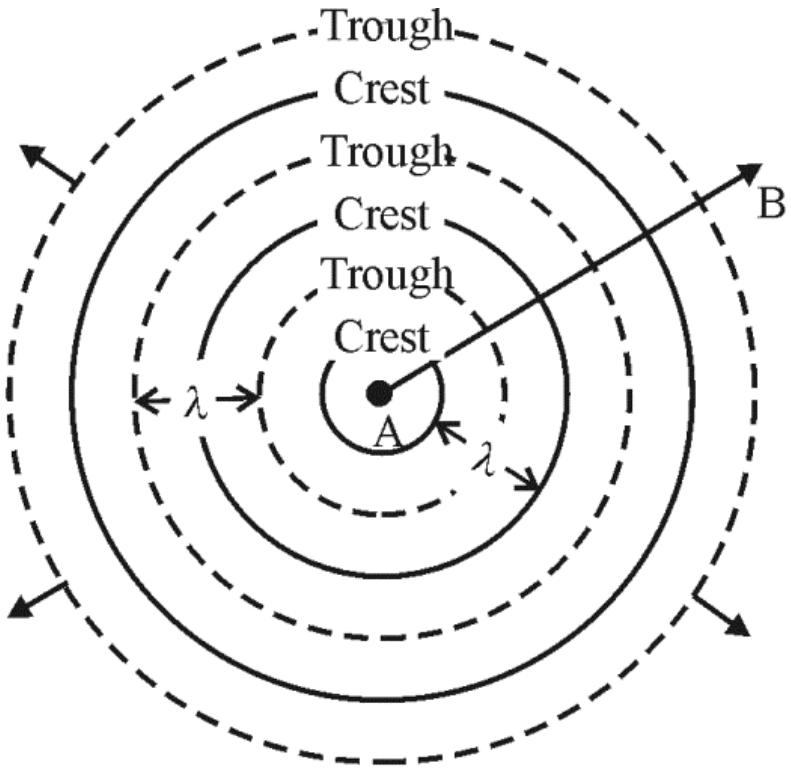
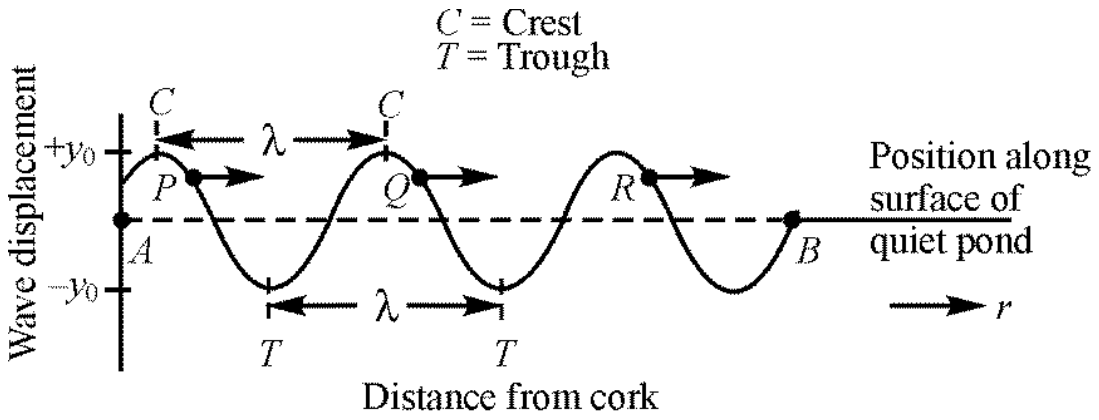


(a) Water waves

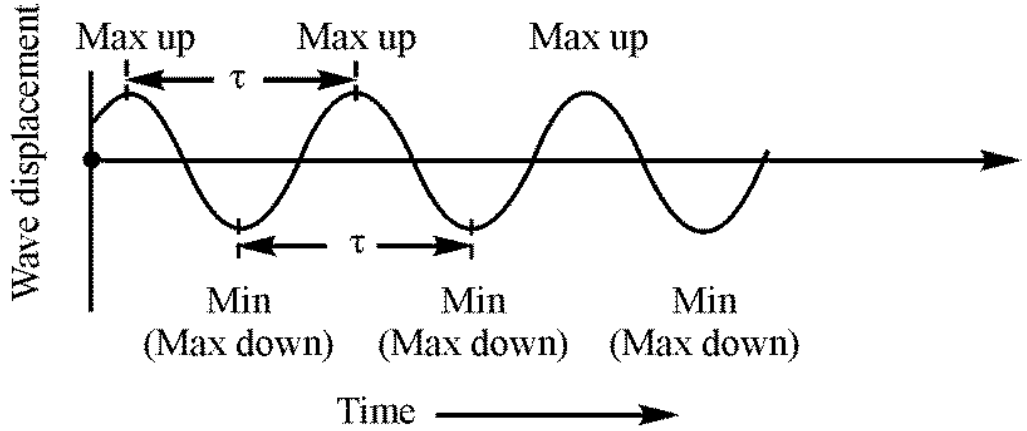


(b) Wave fronts

Figure 5-1 *Water waves and wave fronts*



(a) Wave profile along the pond at a *certain instant of time*



(b) Wave displacement at a fixed position on the pond as a function of time

Figure 5-2 *Two aspects of wave motion for a traveling wave*

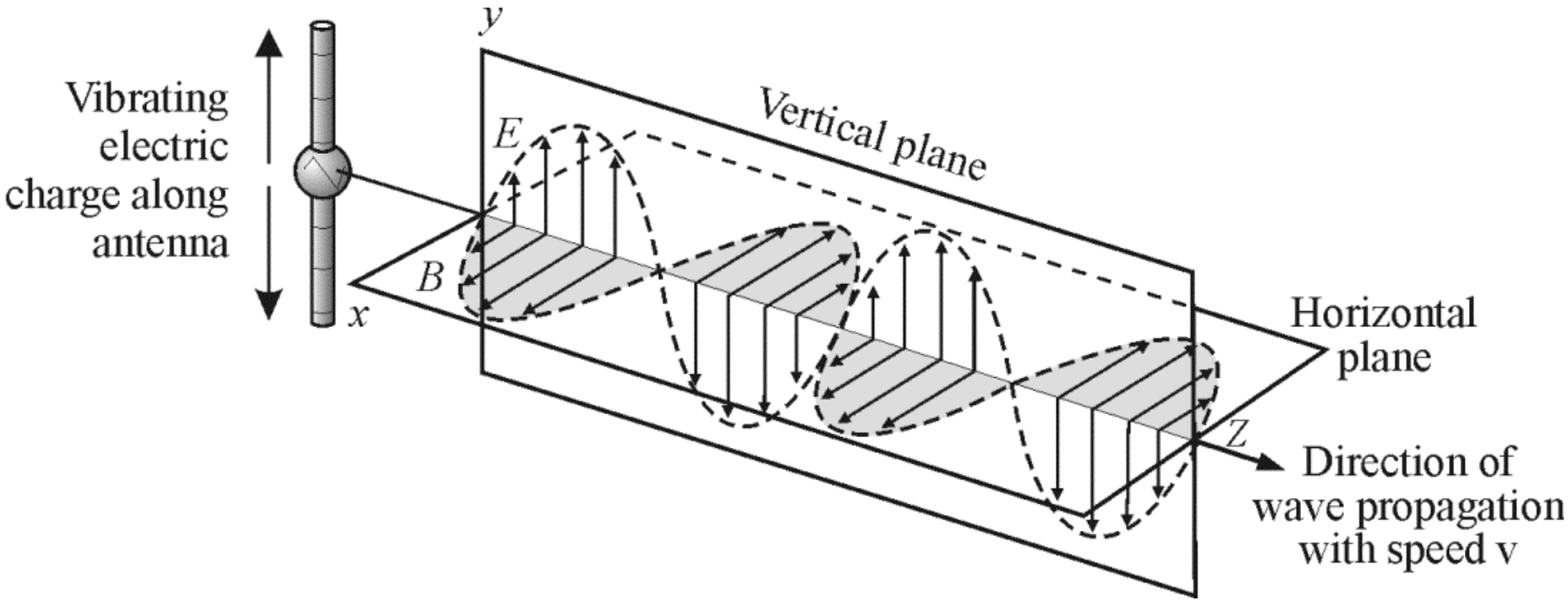


Figure 5-3 *Profiles of the electric (E) and magnetic (B) fields in a light wave at an instant of time, E-field vibrations are in the vertical plane; B-field vibrations are in the horizontal plane. The wave propagates with a speed v in a direction perpendicular to both the E and B vibrations.*

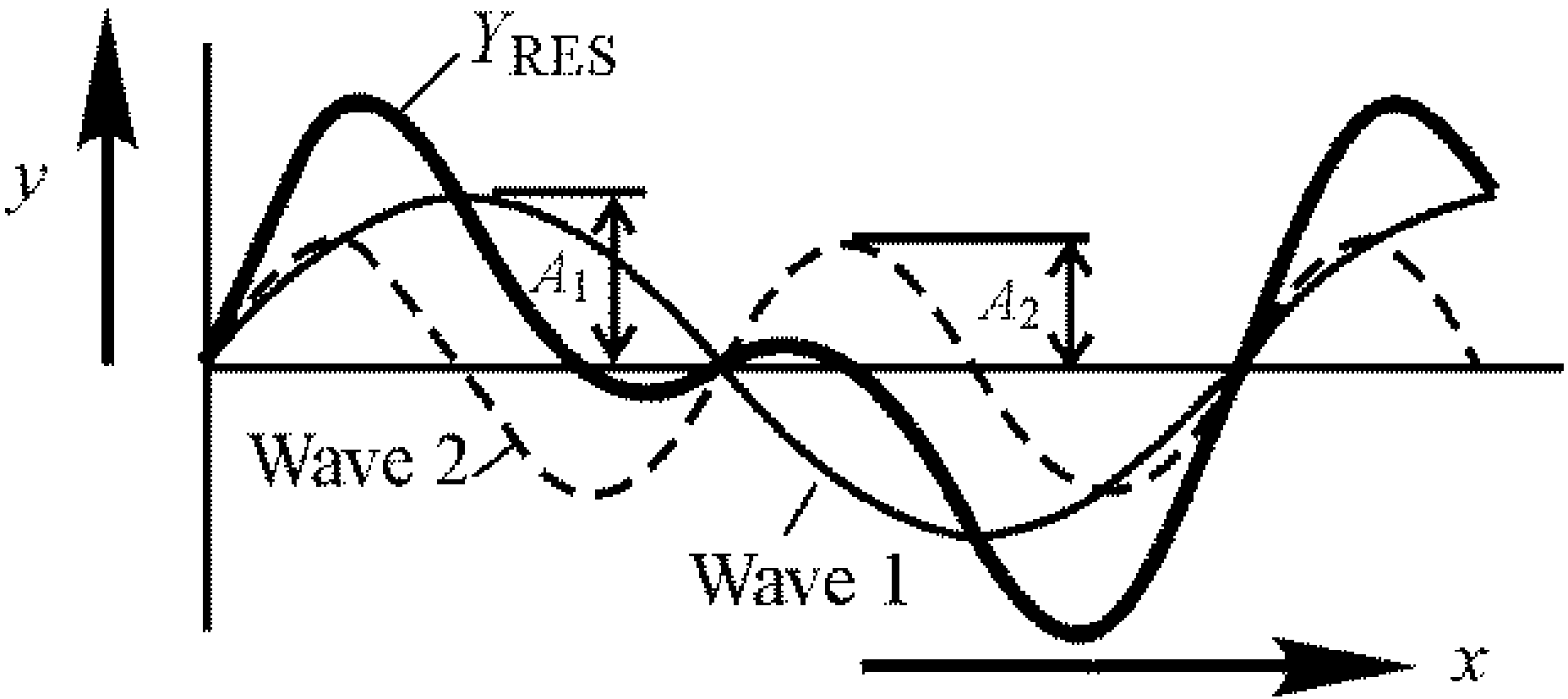


Figure 5-4 *Superposition of two waves moving along the same direction*

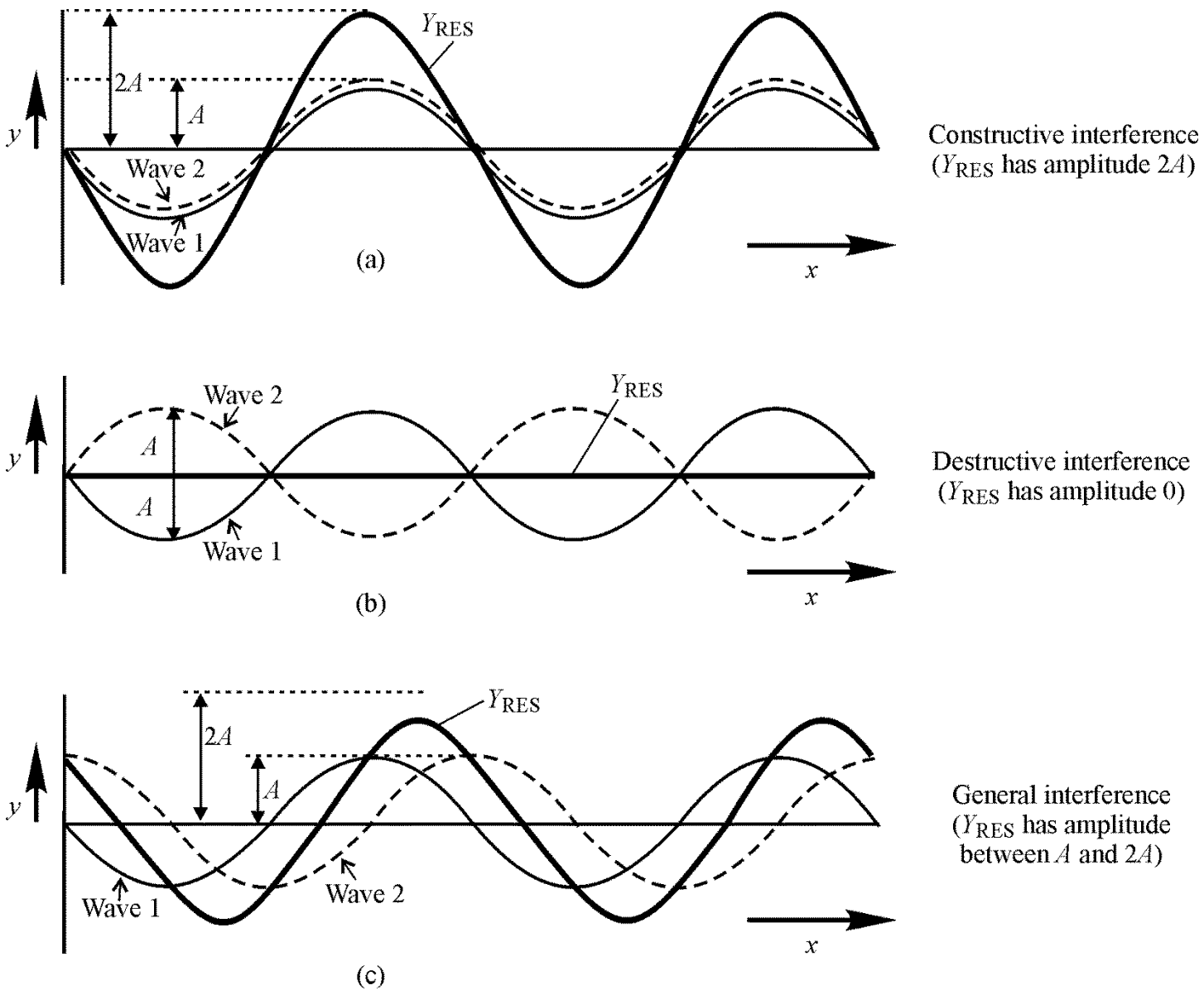


Figure 5-5 *Interference of two identical sinusoidal waves*

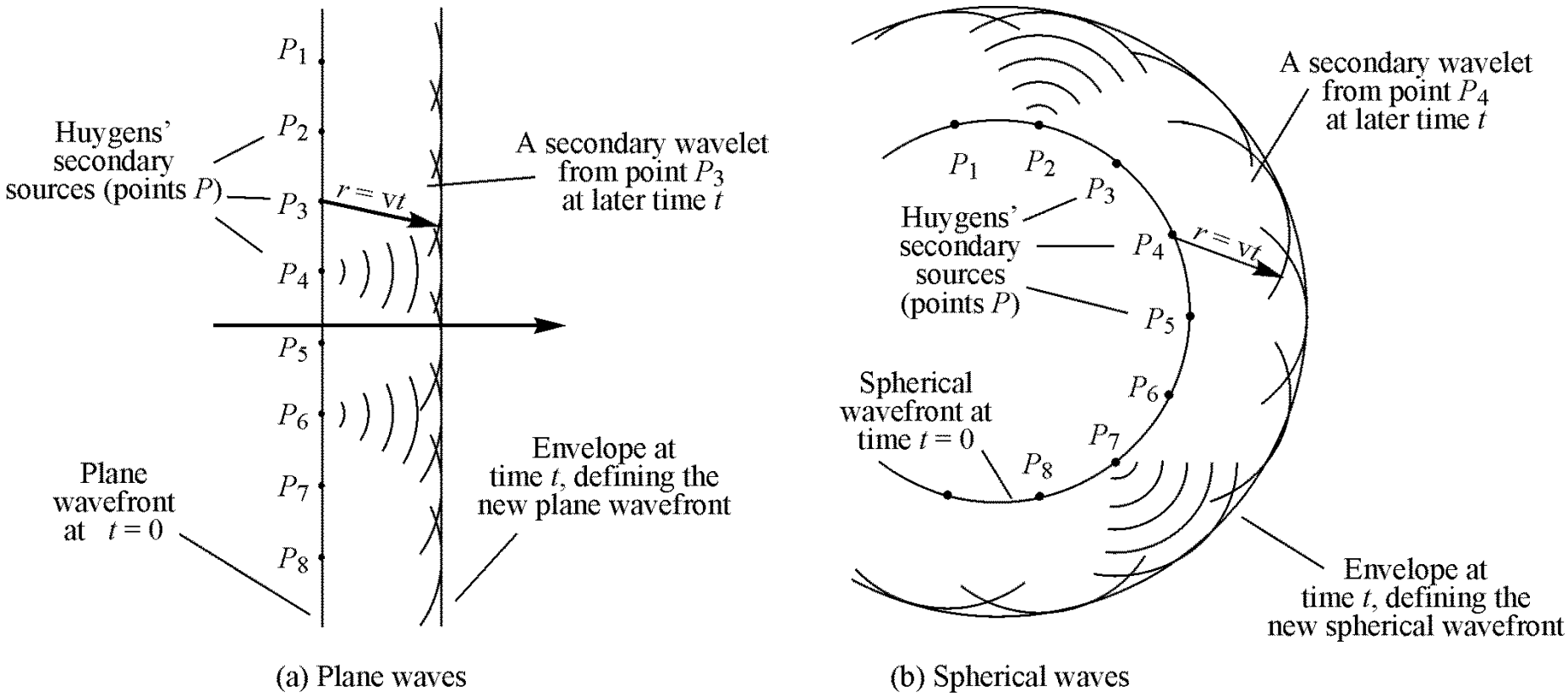


Figure 5-6 *Huygens' principle applied to the propagation of plane and spherical wave fronts*

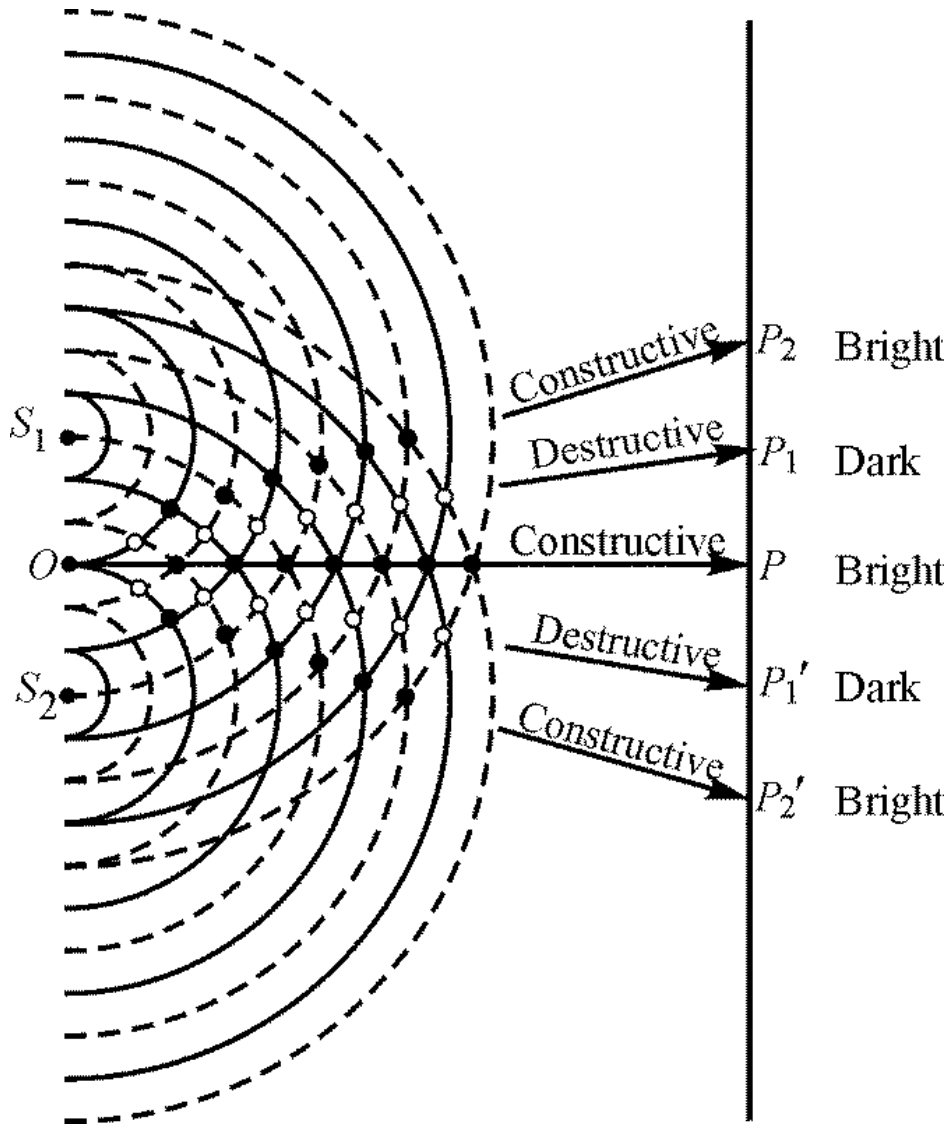


Figure 5-7 *Wave interference created by overlapping waves from coherent sources S and S'*

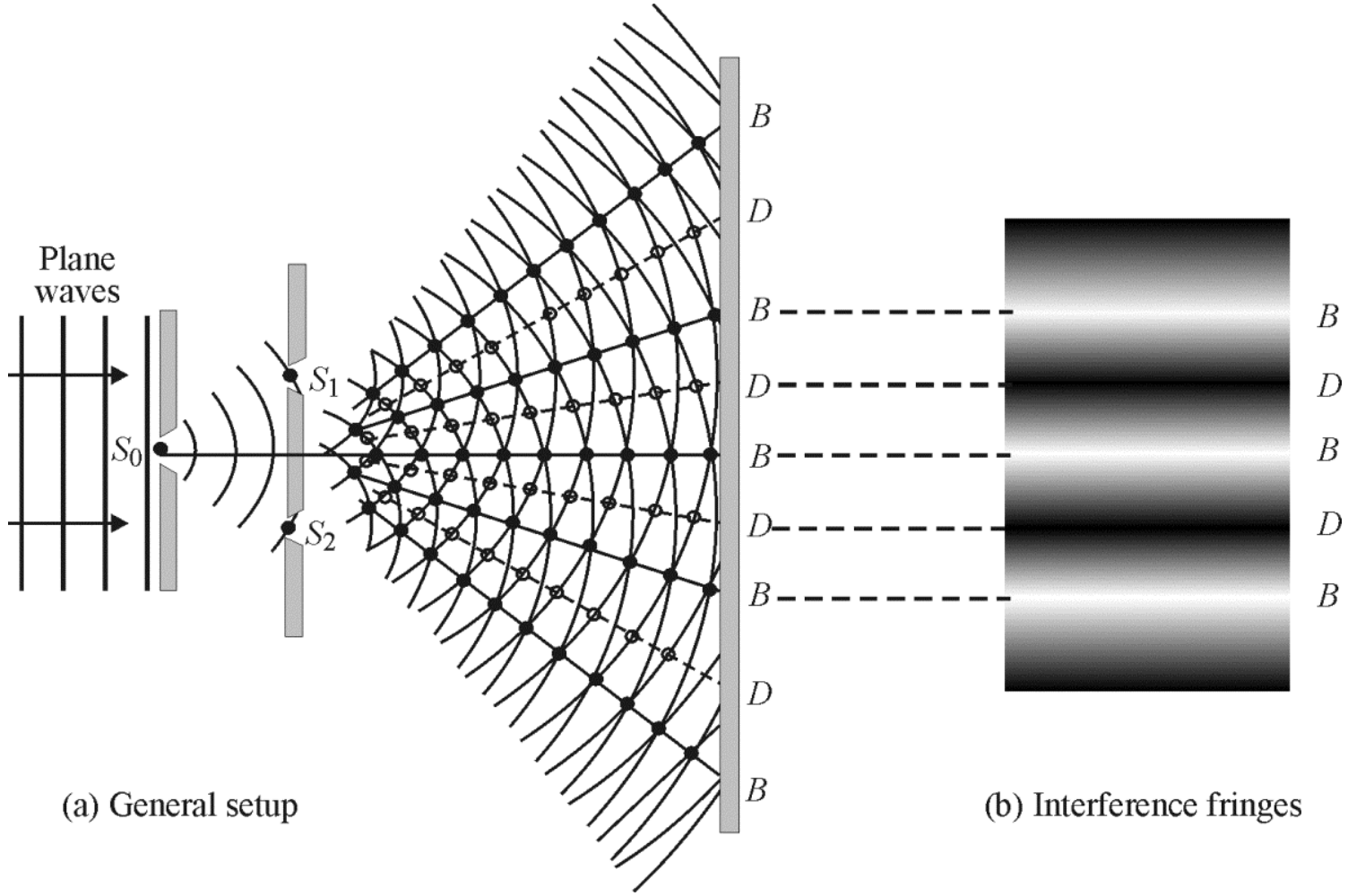


Figure 5-8 *Young's double-slit interference experiment showing (a) general setup and (b) typical interference fringes (artistic reproduction)*

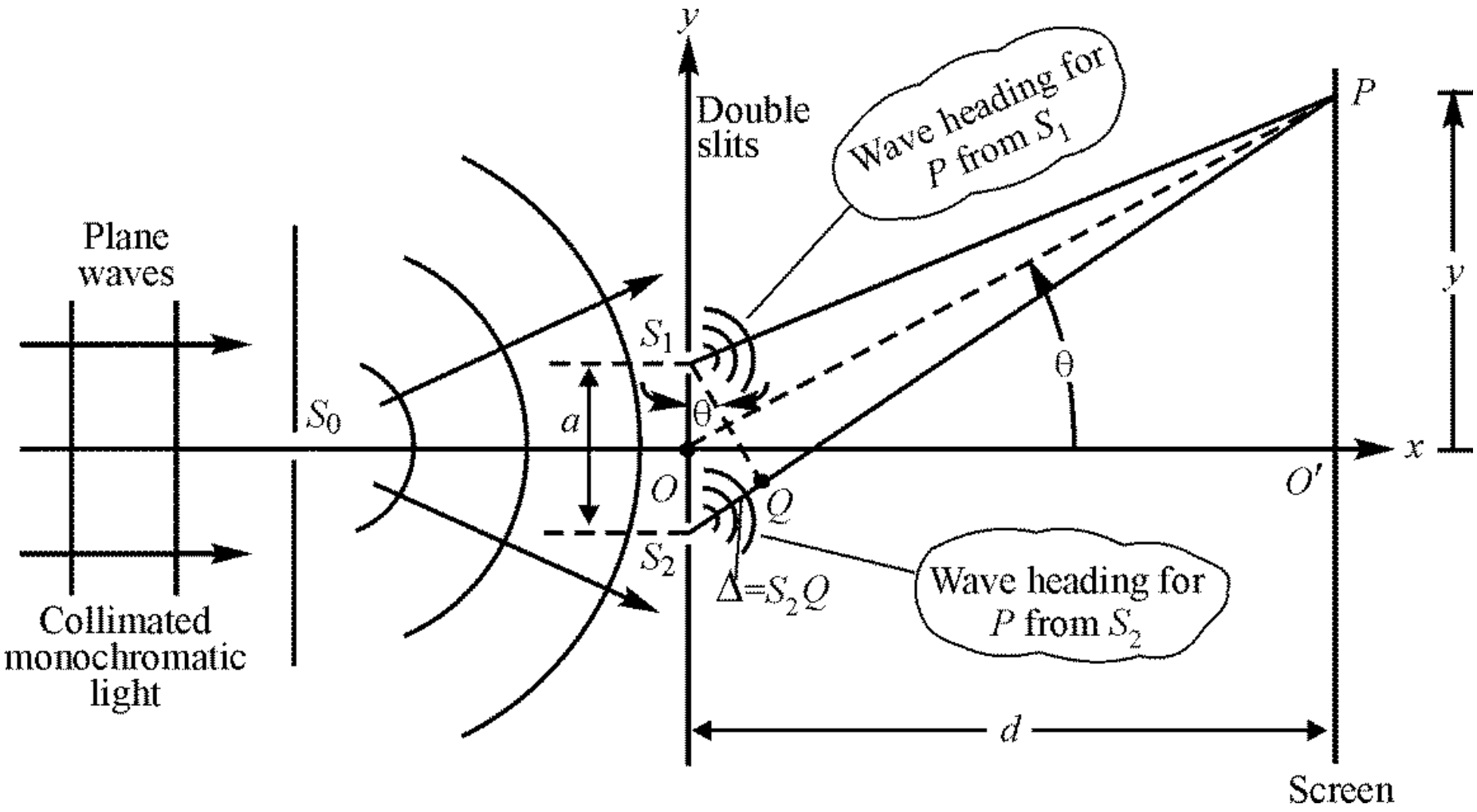


Figure 5-9 *Schematic for Young's double-slit interference experiment. Source S_0 is generally a small hole or narrow slit; sources S_1 and S_2 are generally long, narrow slits perpendicular to the page.*

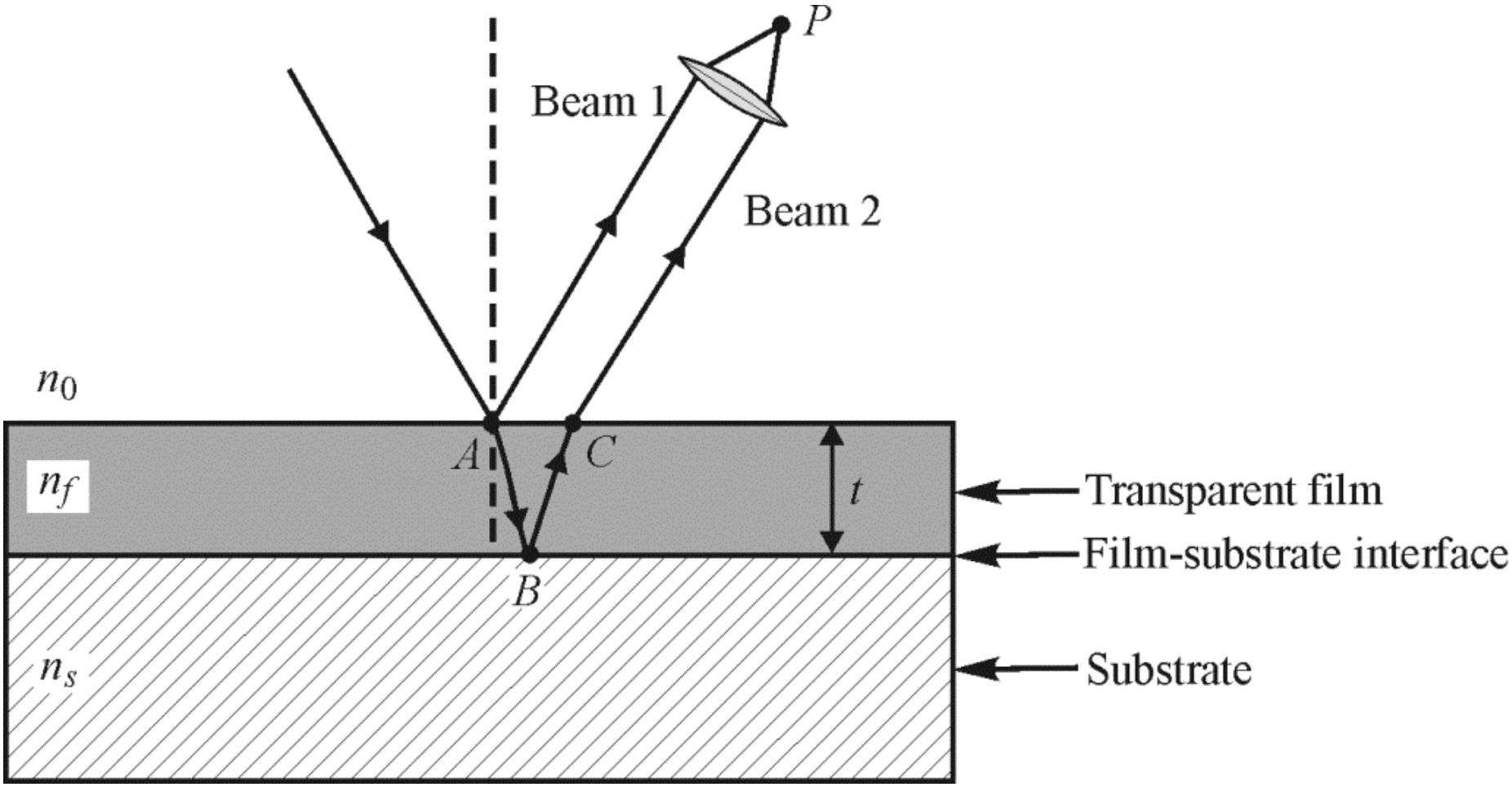


Figure 5-10 *Two-beam interference from a thin film. Rays reflected from the film's top and bottom plane surfaces are brought together at P by a lens.*

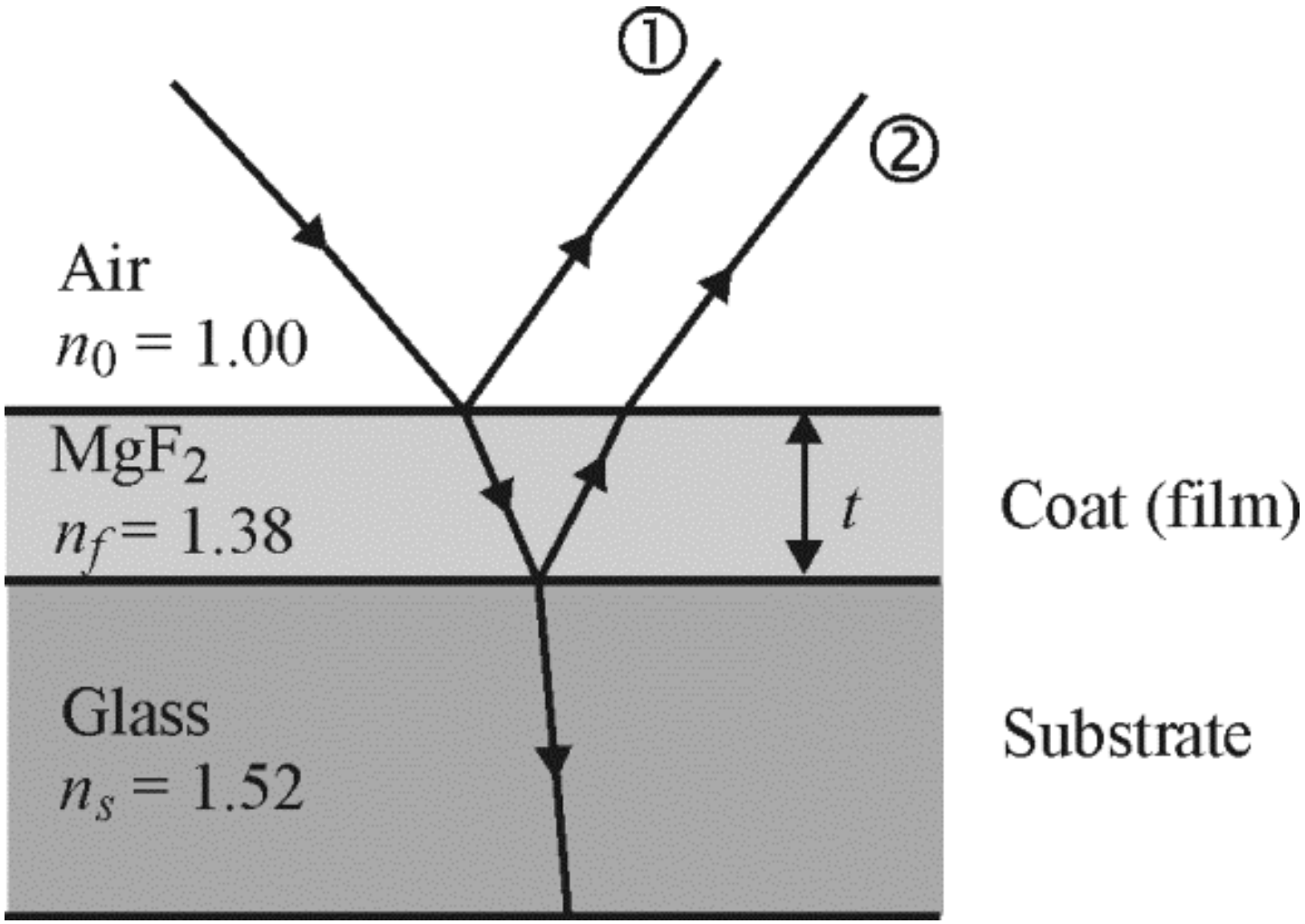


Figure 5-11 *Single-layer AR coat on glass substrate*

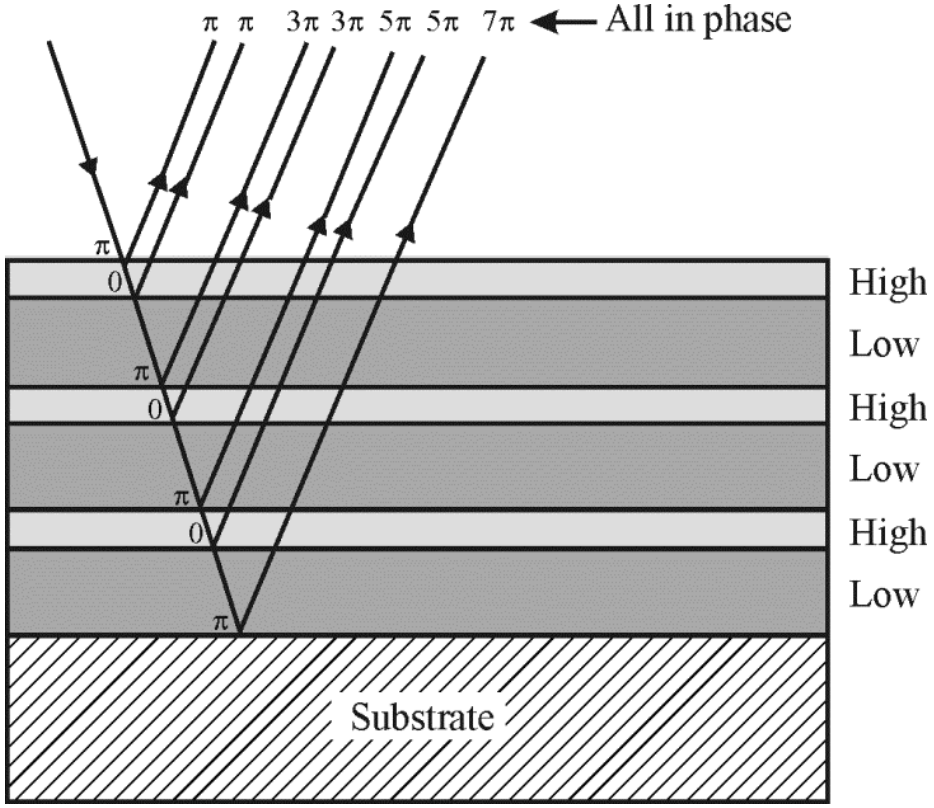
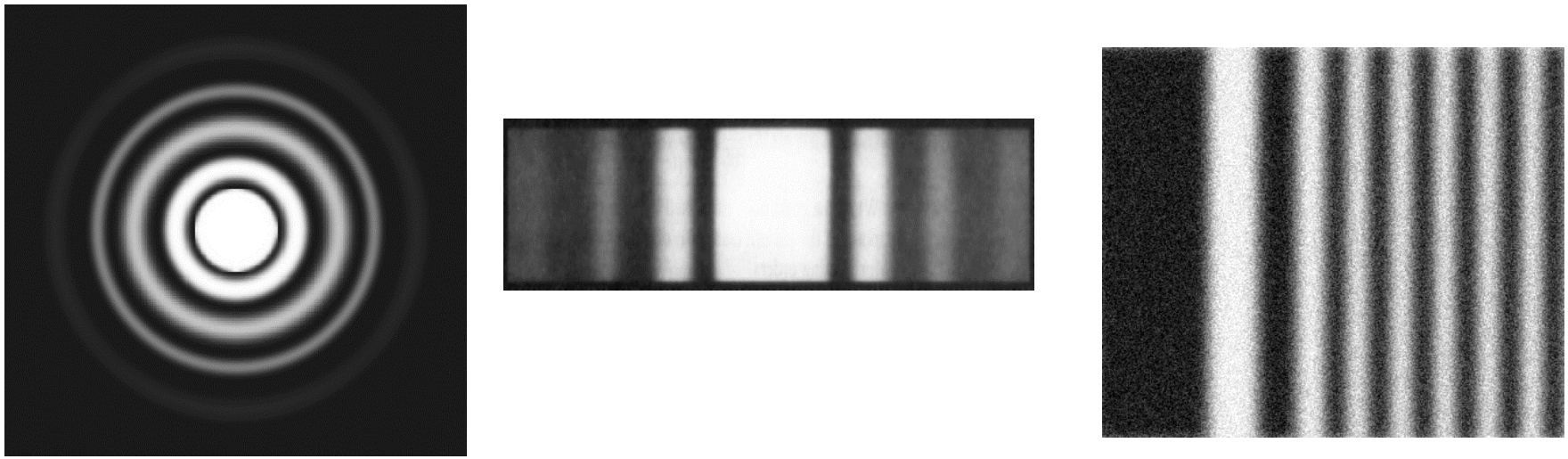


Figure 5-12 *Multilayer stack of quarter-wave thin films of alternating high and low refractive indexes. Each film has an optical thickness of* $\lambda_f/4$. *Automatic phase shifts of* $\delta = \pi$ *or* $\delta = 0$ *are show at each interface. All of the reflected rays exit the stack in phase with one another and interfere constructively.*



(a) Pinhole diffraction (b) Single-slit diffraction (c) Straight-edge diffraction

Figure 5-13 *Sketches of several common diffraction patterns*

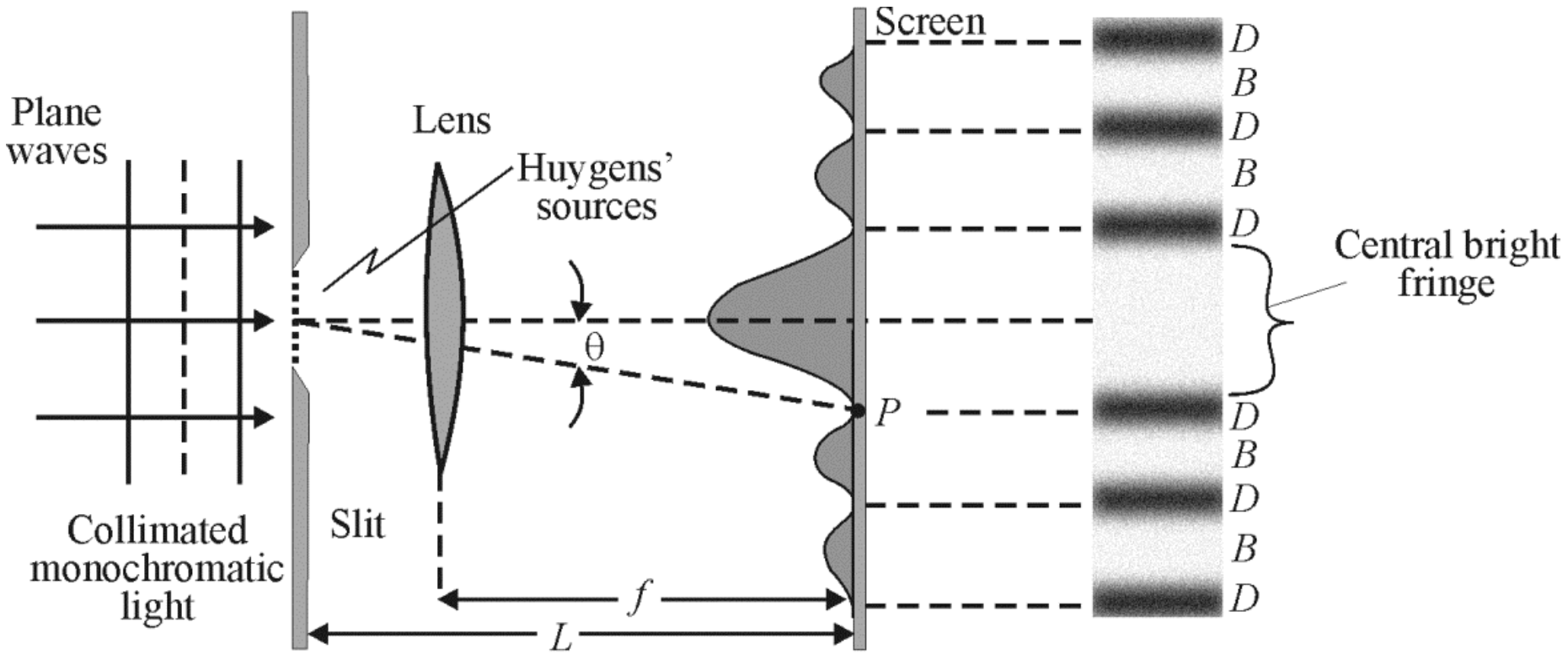


Figure 5-14 *Diffraction pattern from a single slit*

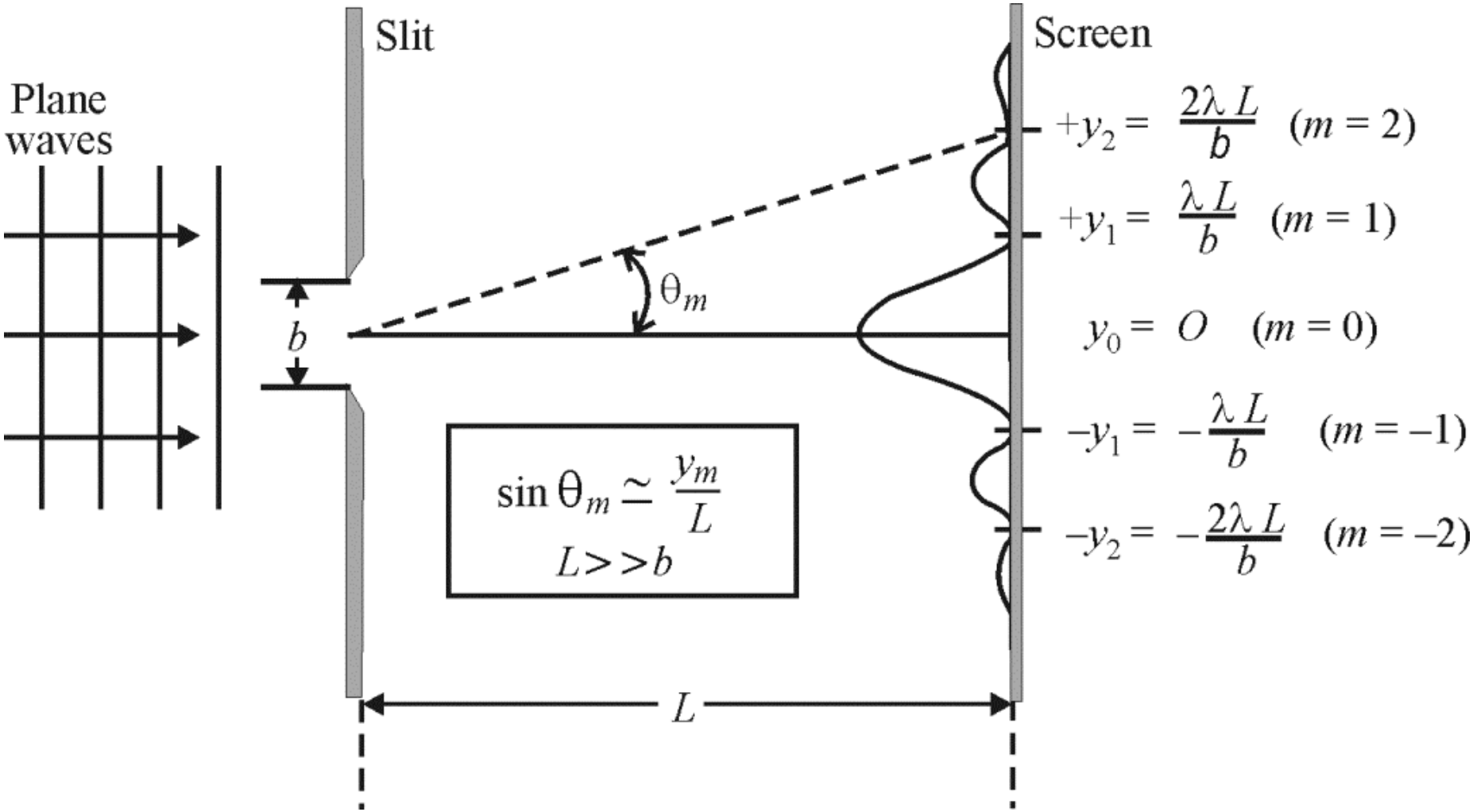


Figure 5-15 *Positions of adjacent minima in the diffraction patterns (Drawing is not to scale.)*

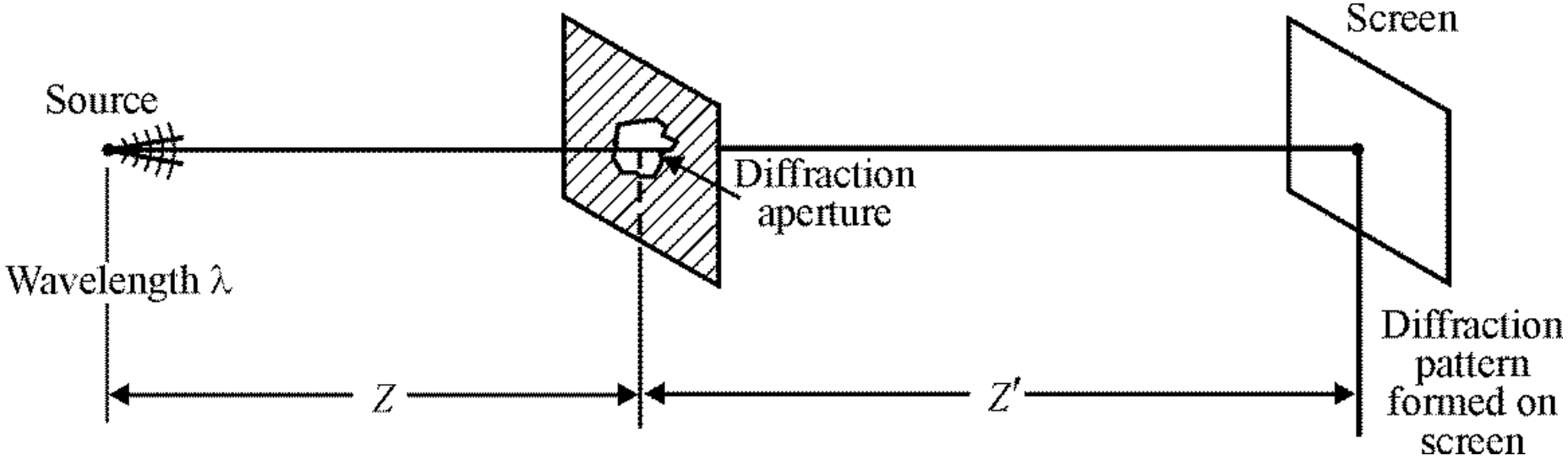


Figure 5-16 *General diffraction geometry involving source, aperture, and screen*

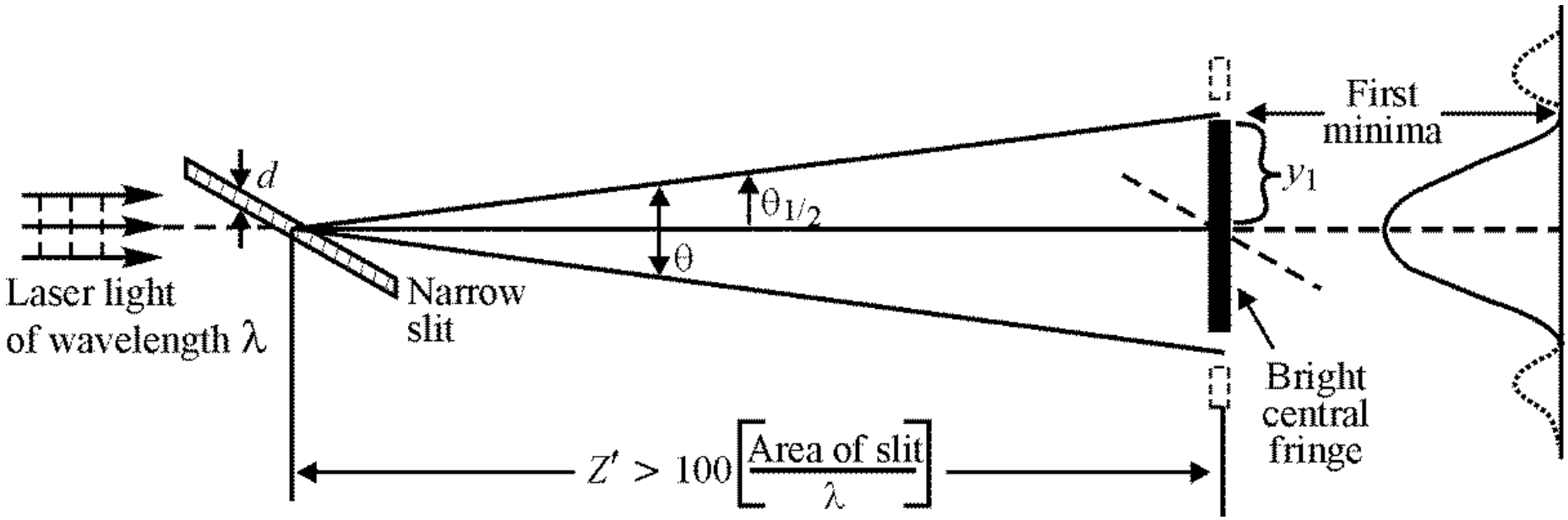


Figure 5-17 *Fraunhofer diffraction pattern for a single slit*

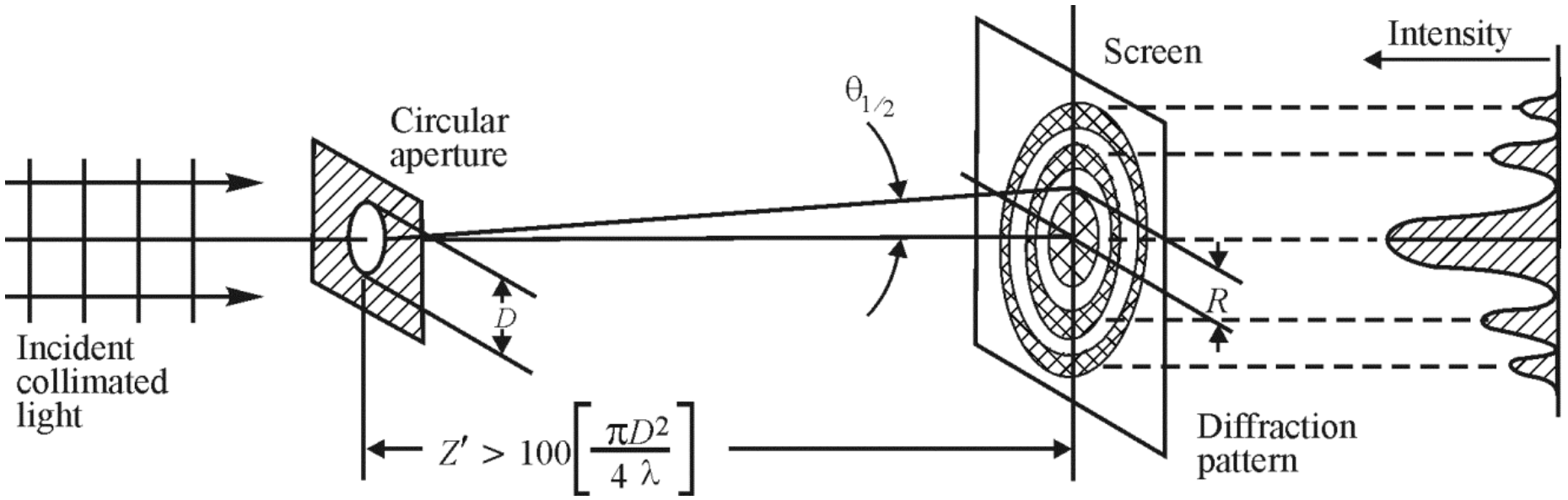


Figure 5-18 *Fraunhofer diffraction pattern for a circular aperture*

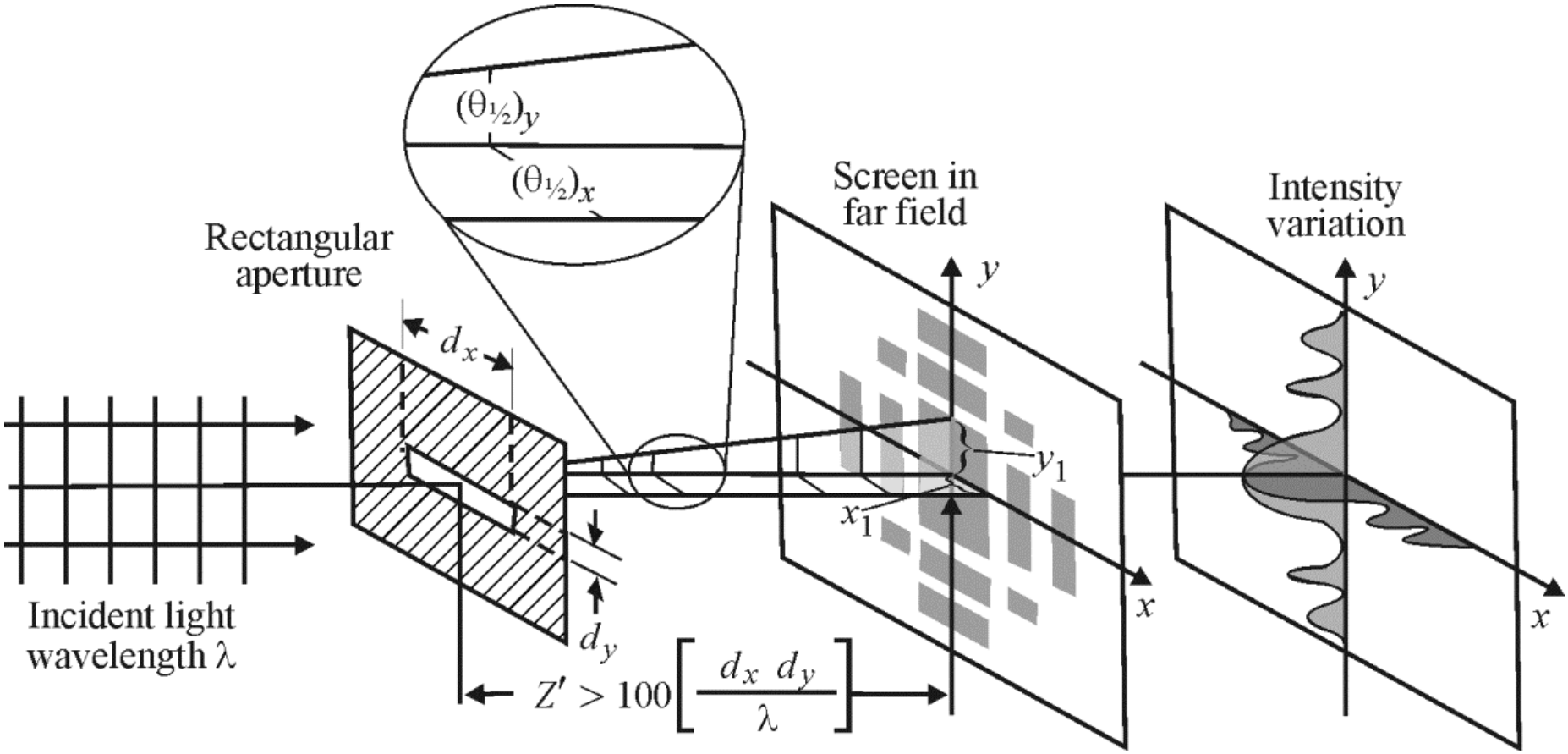


Figure 5-19 *Fraunhofer diffraction pattern for a rectangular aperture*

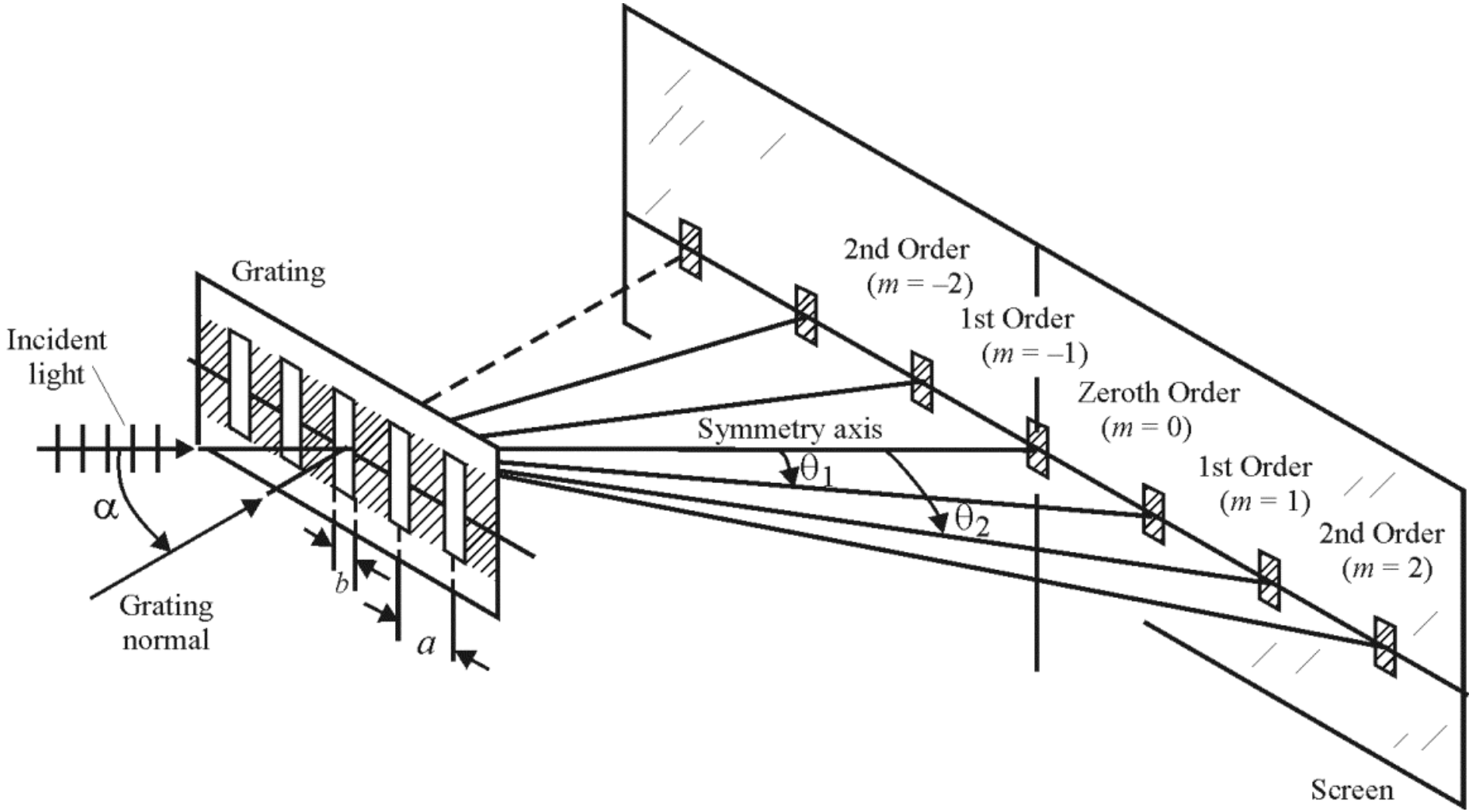


Figure 5-20 *Diffraction of light through a grating under Fraunhofer conditions*

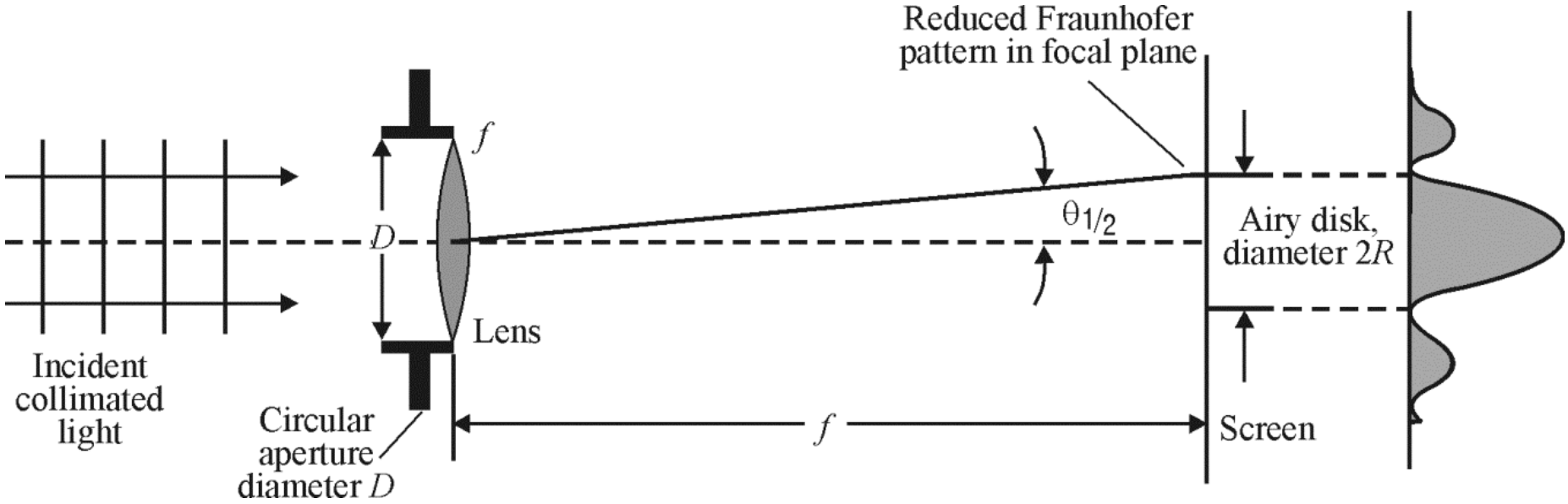


Figure 5-21 *Fraunhofer diffraction pattern formed in the focal plane of a lens of focal length f (Drawing is not to scale.)*

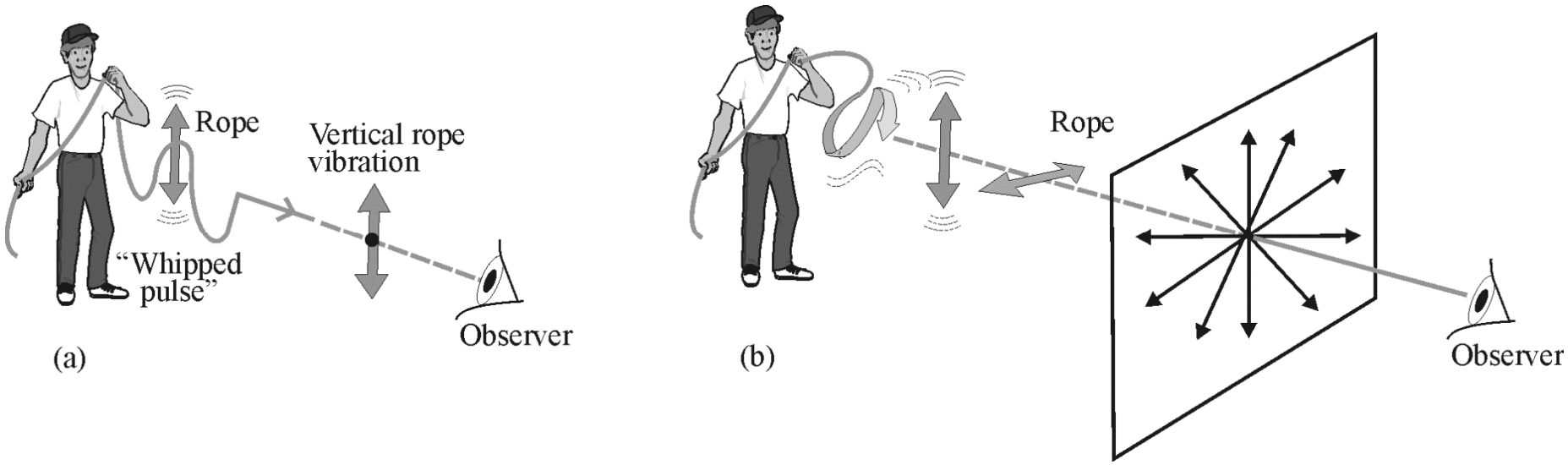


Figure 5-22 *Rope waves and polarization*

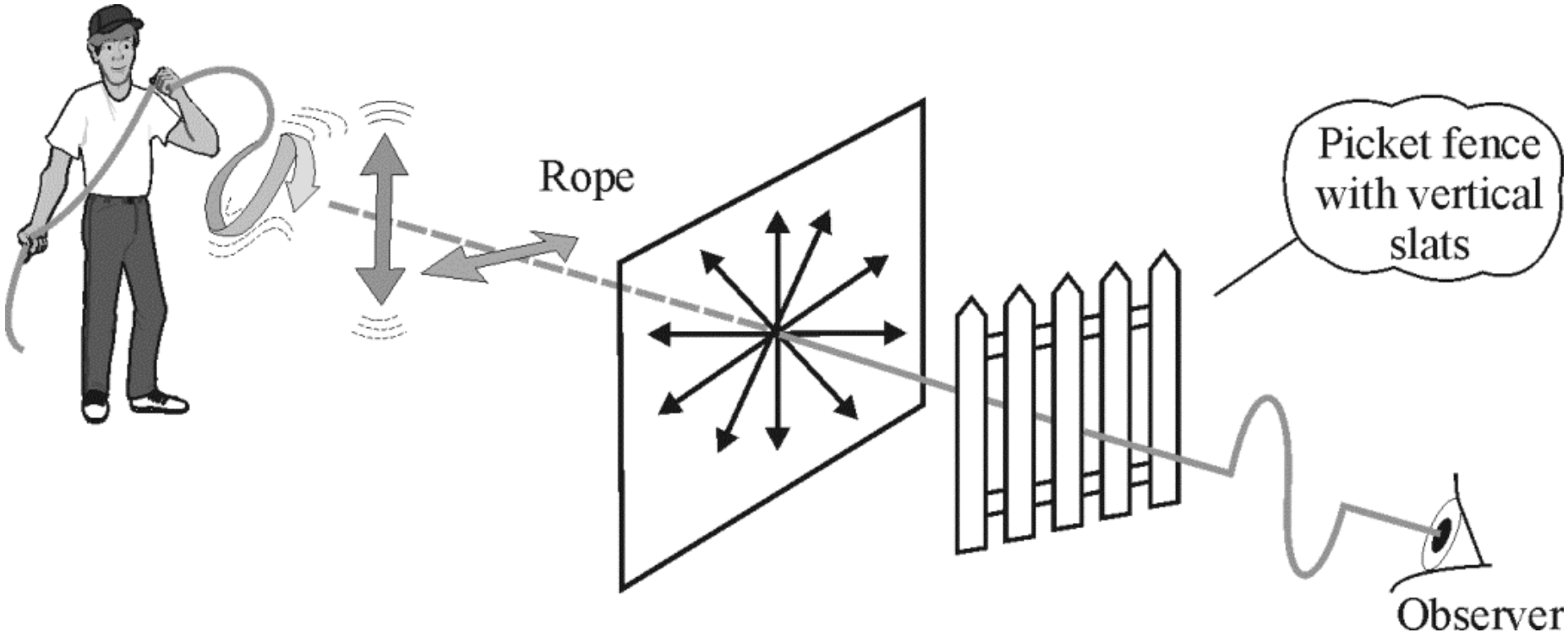


Figure 5-23 *Polarization of rope waves by a picket fence*

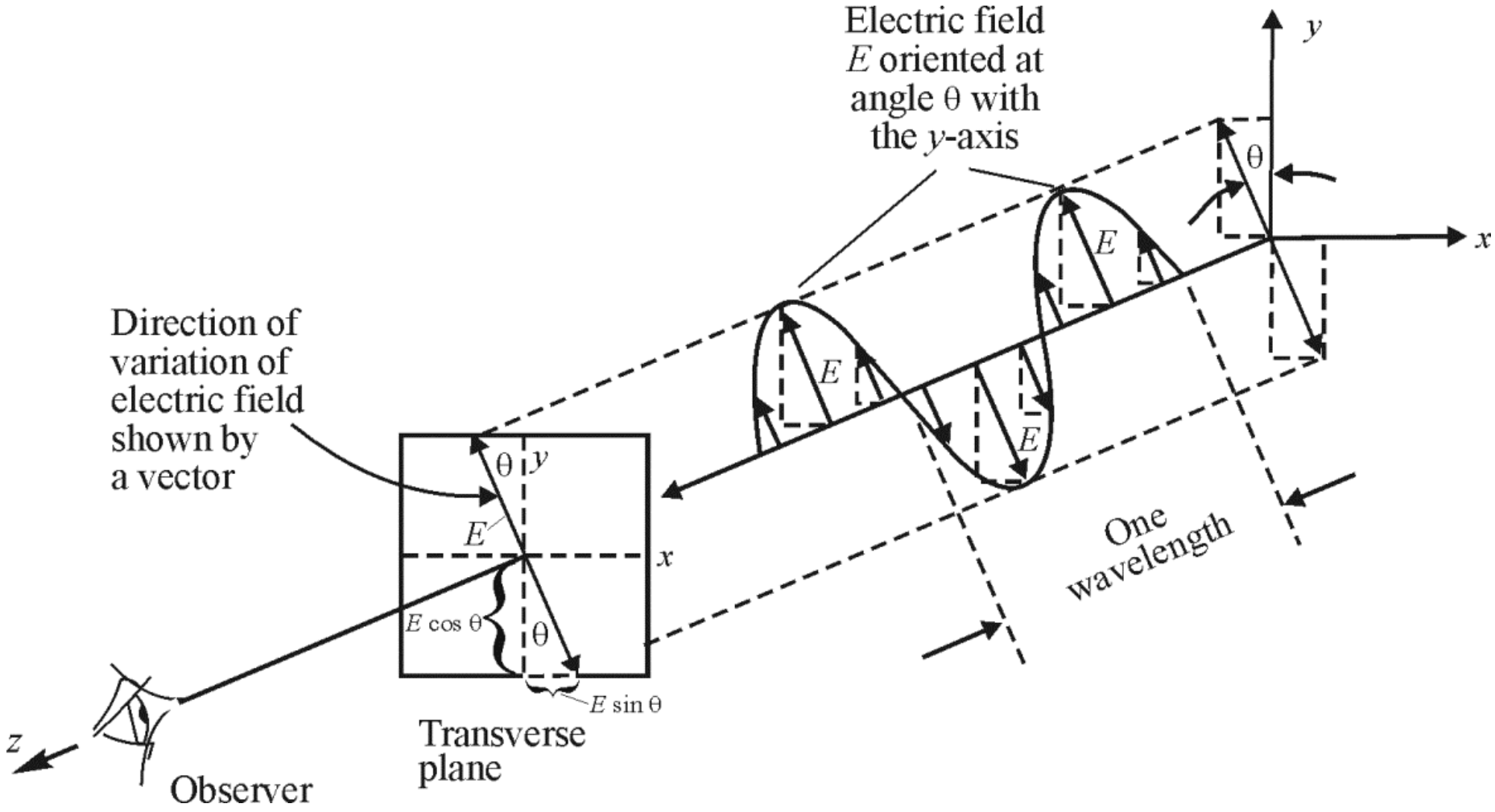


Figure 5-24 *Linearly polarized light with transverse electric field E propagating along the z-axis*

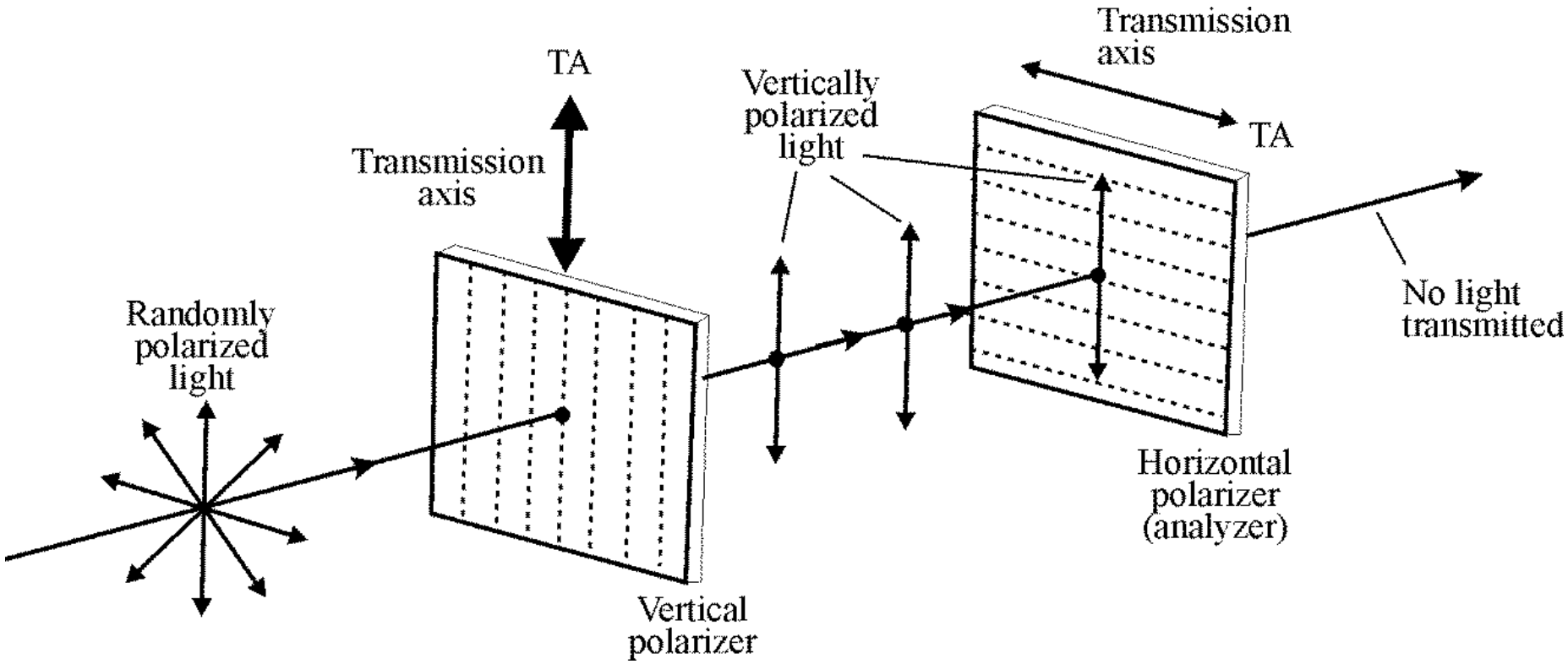


Figure 5-25 *Effect of polarizers on unpolarized light*

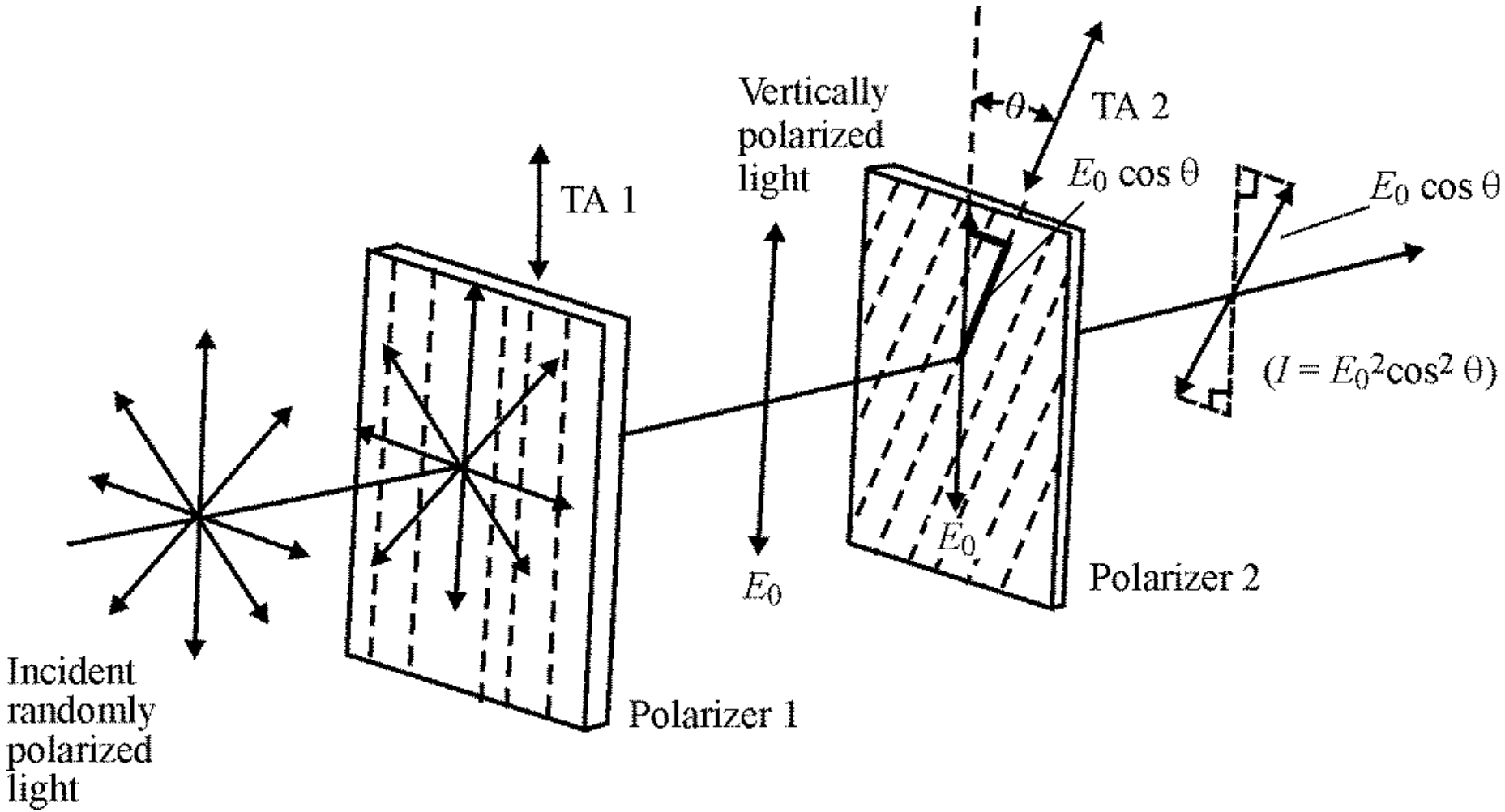


Figure 5-26 *Controlling light intensity with a pair of polarizers*

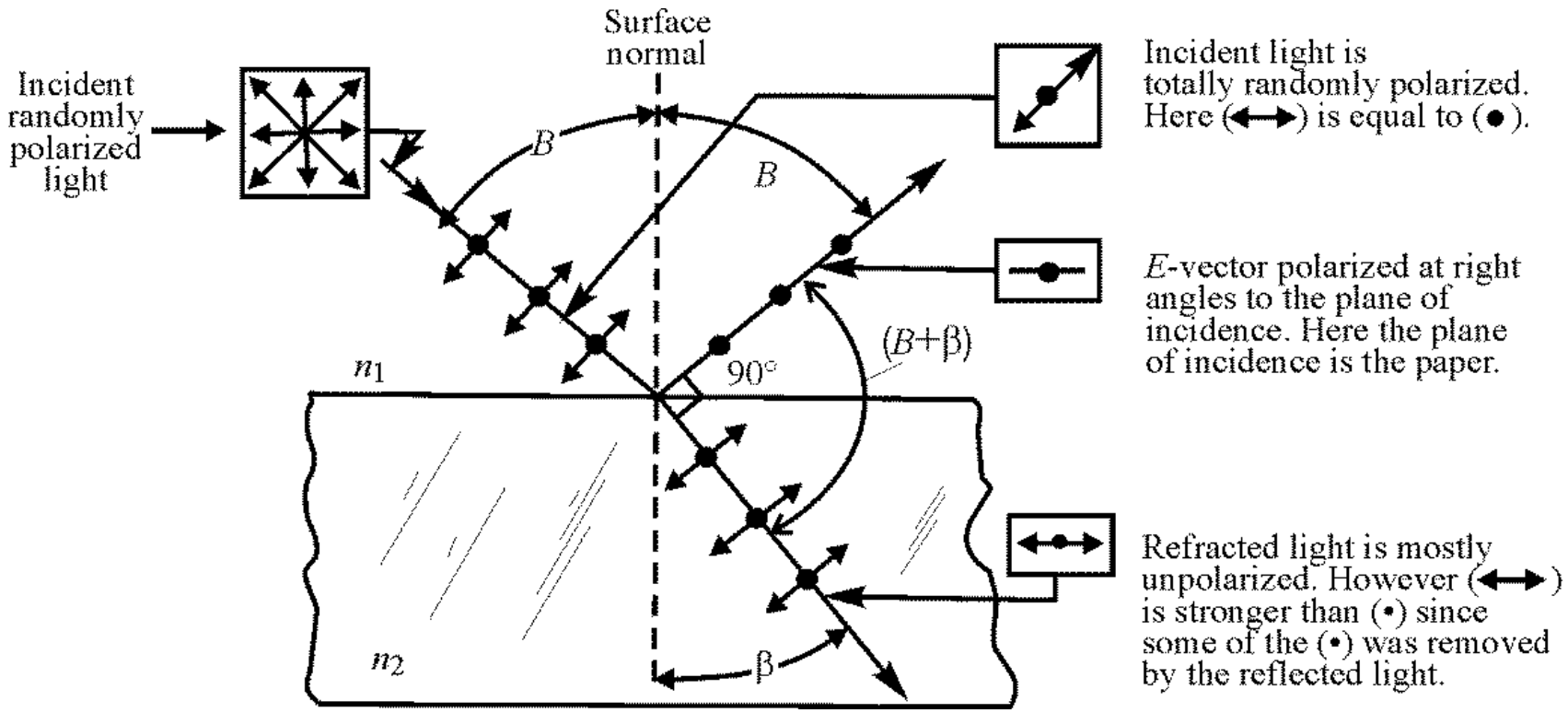


Figure 5-27 *Polarization by reflection at Brewster's angle*

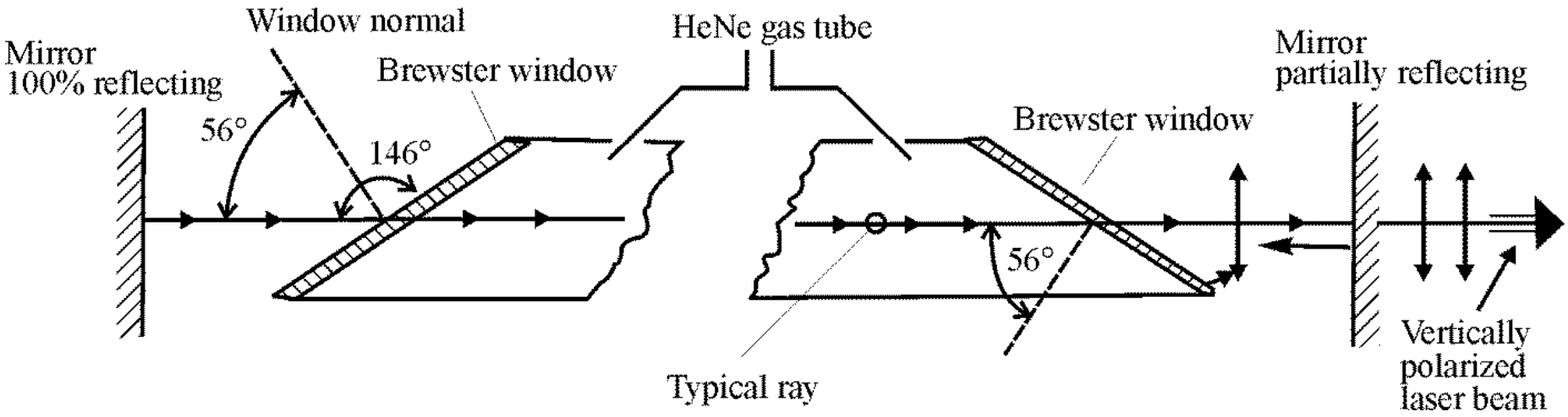


Figure 5-28 *Brewster windows in a HeNe gas laser*

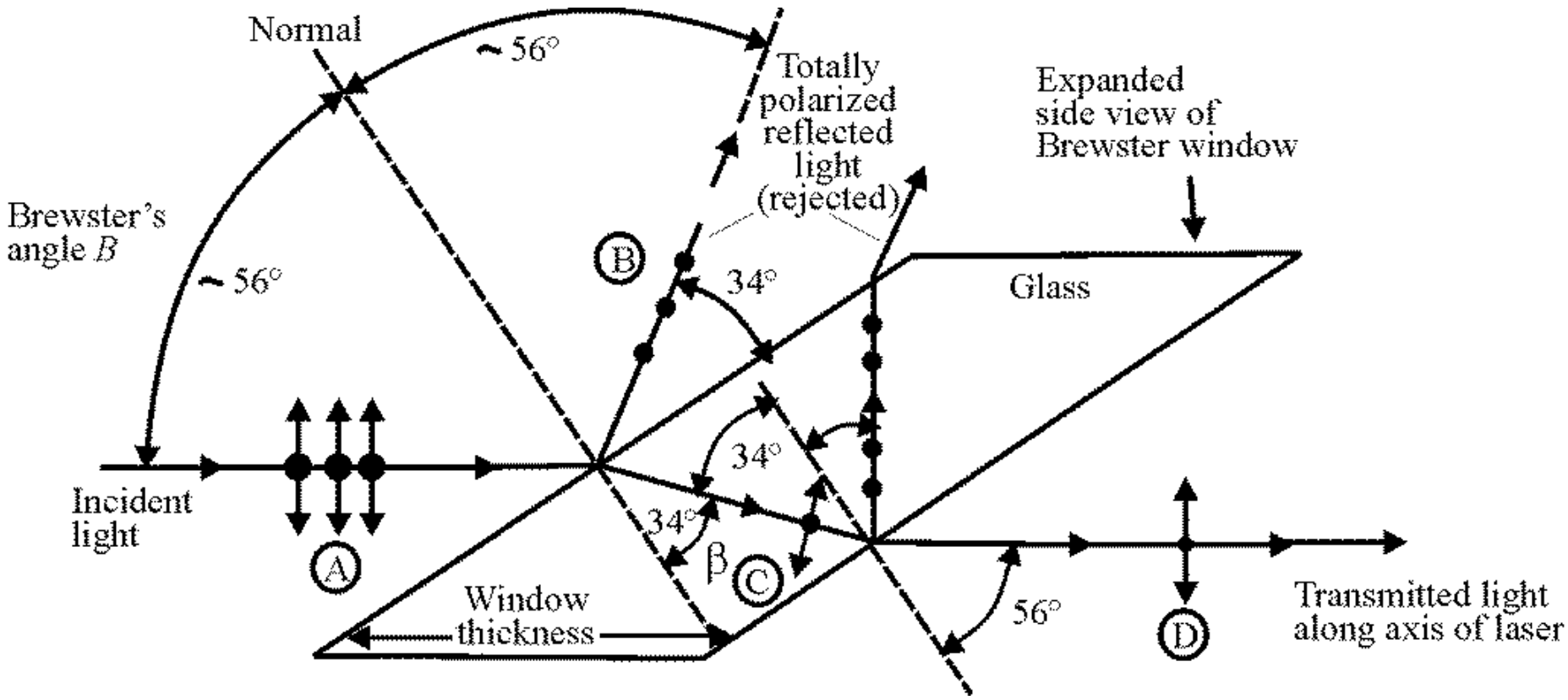


Figure 5-29 *Unpolarized light passing through both faces at a Brewster angle*

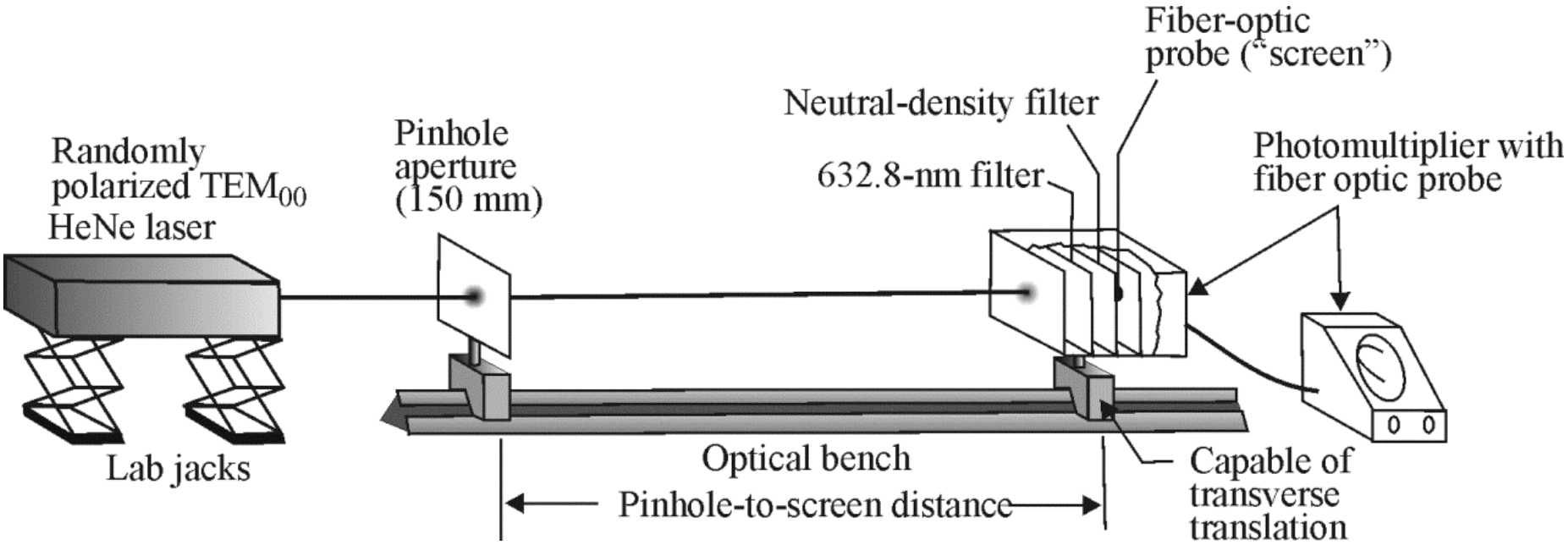


Figure 5-30 *Arrangement of apparatus for recording intensity distribution of Fraunhofer diffraction pattern from a circular pinhole.*

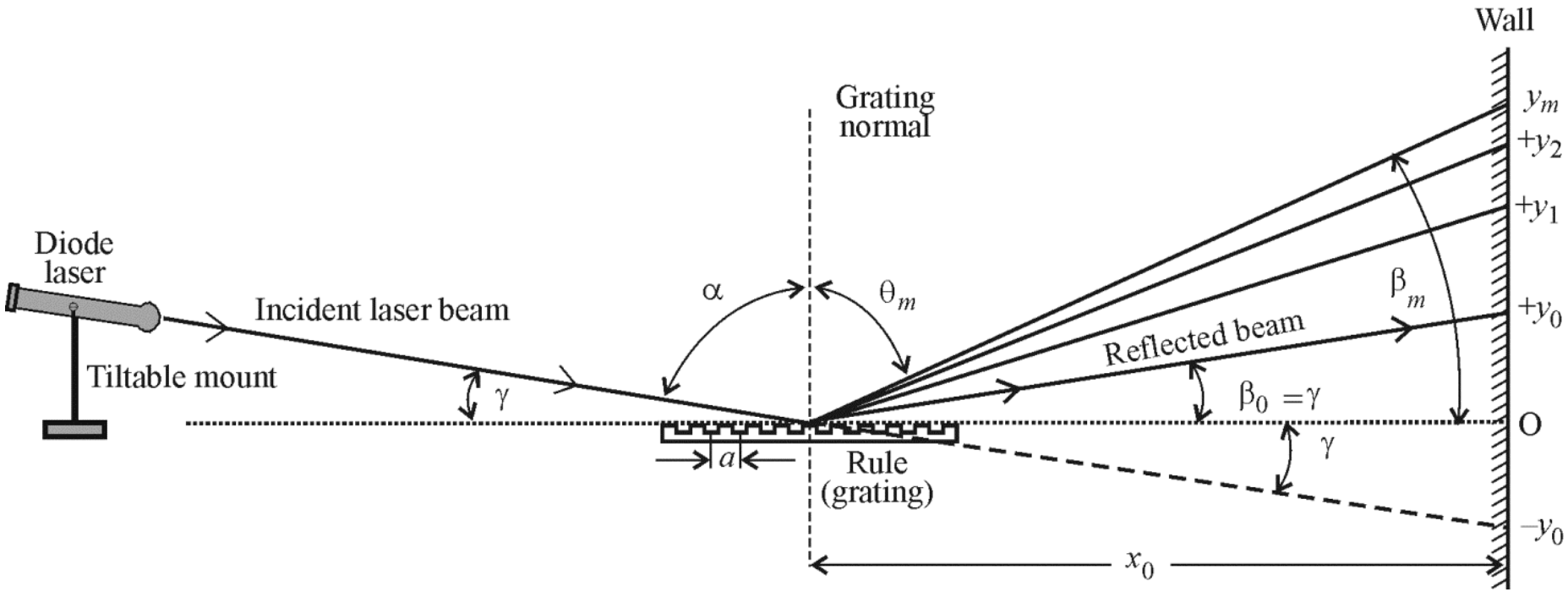


Figure 5-31 *Using the grooves on a machinist's rule as a reflection grating*

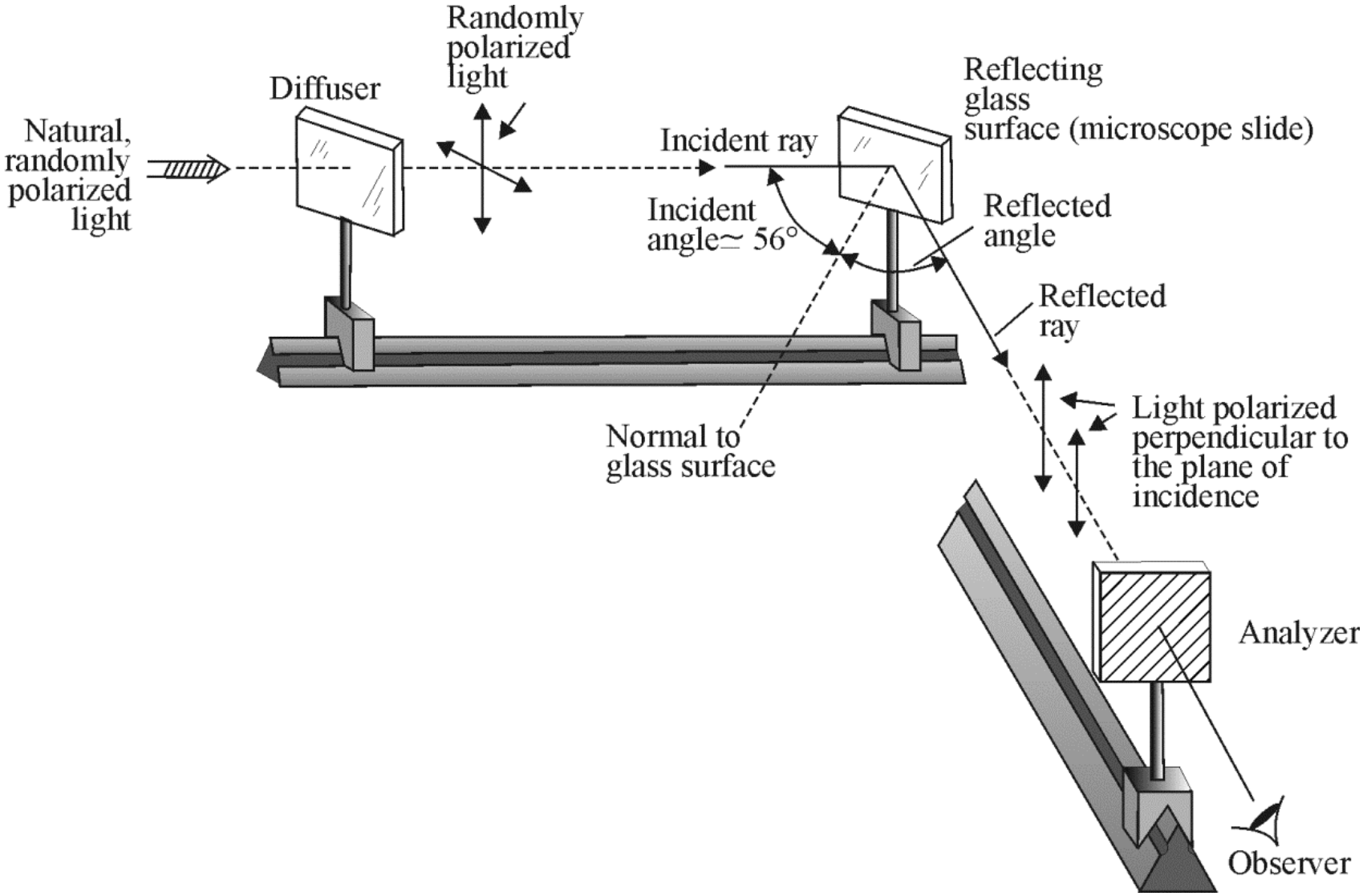


Figure 5-32 *Polarization by reflection at Brewster's angle*

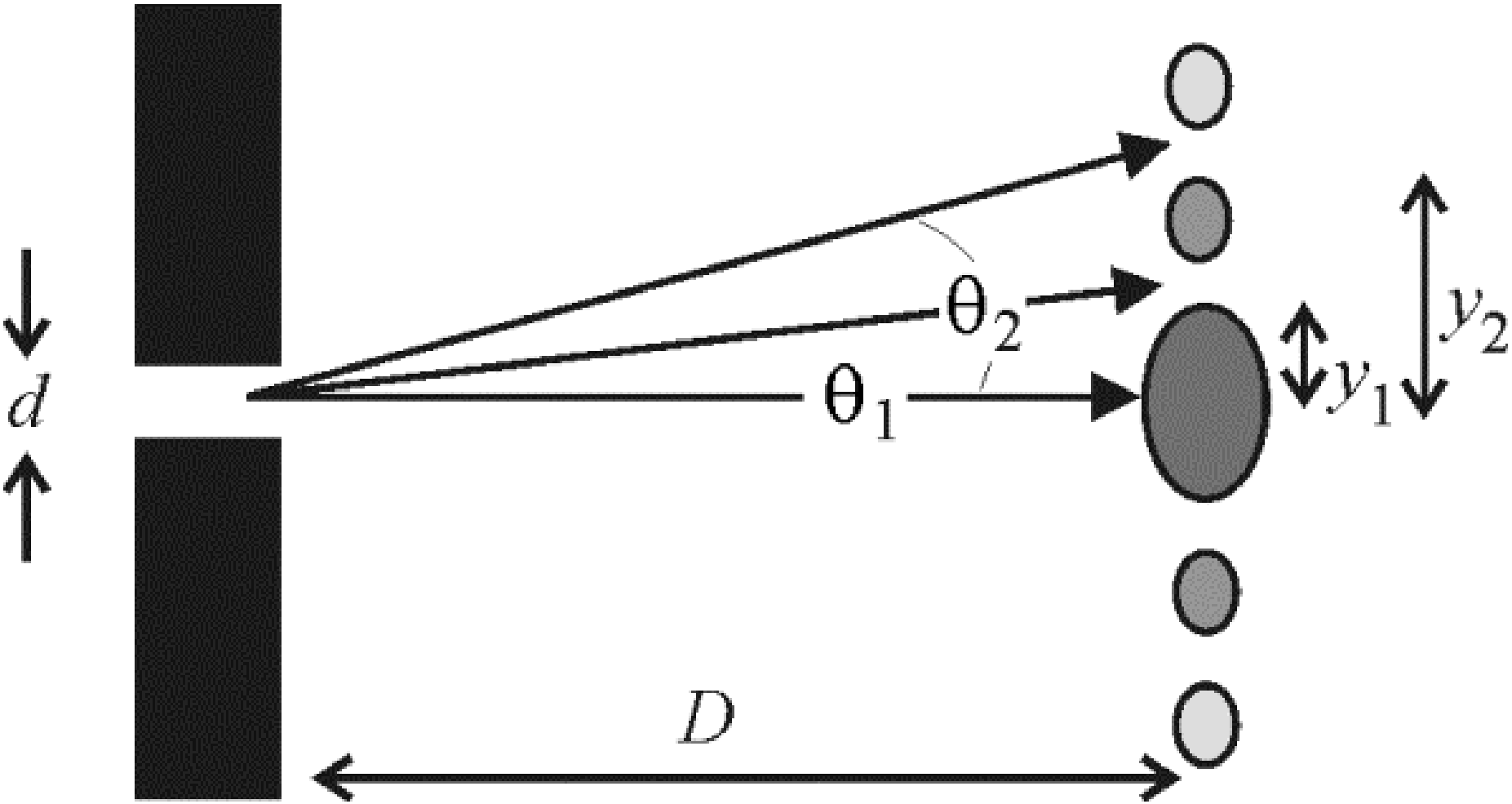


Figure 5-33
(Laboratory 1-5B: Interference and Diffraction)

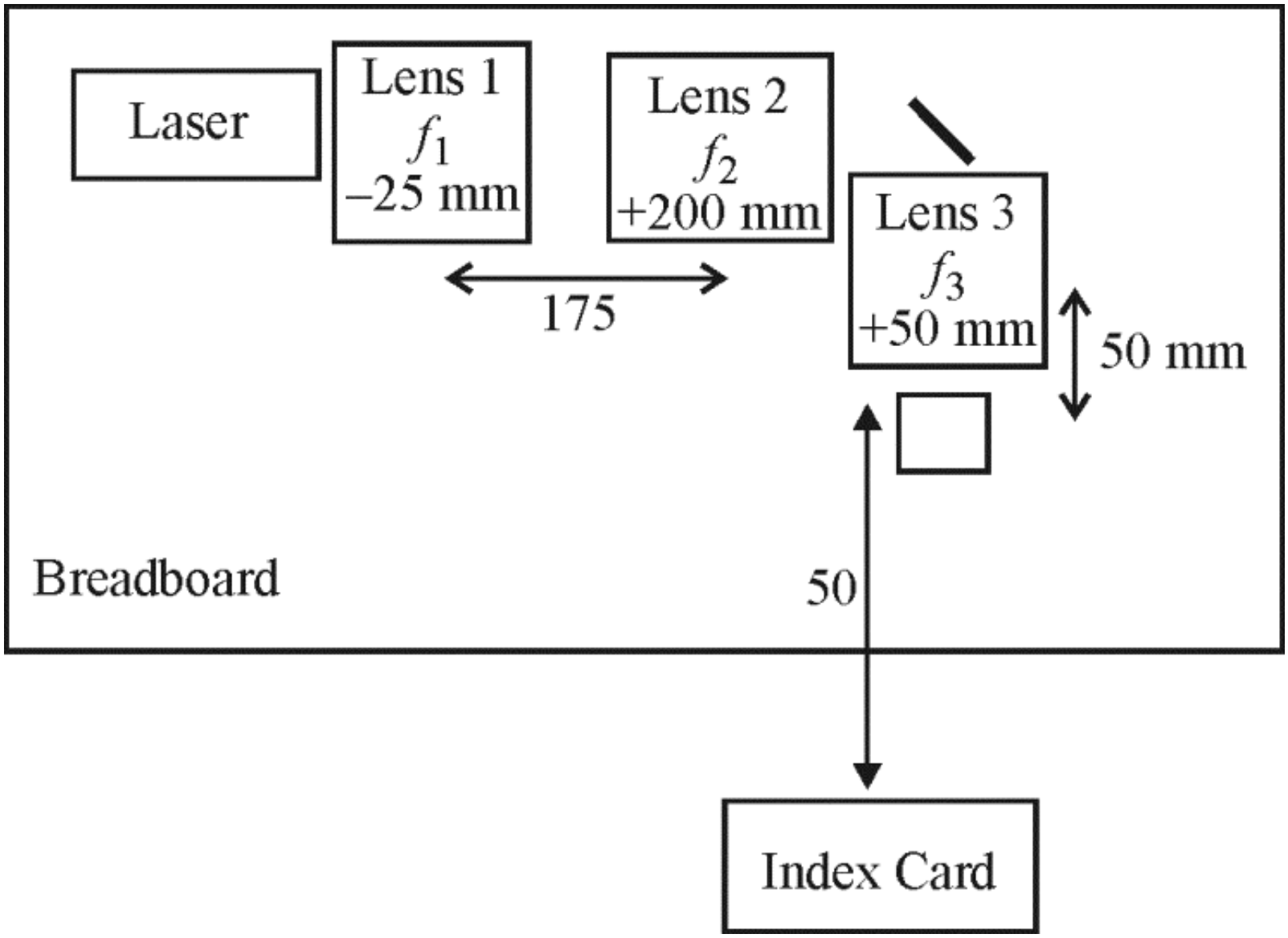


Figure 5-34

(Laboratory 1-5B: Interference and Diffraction)

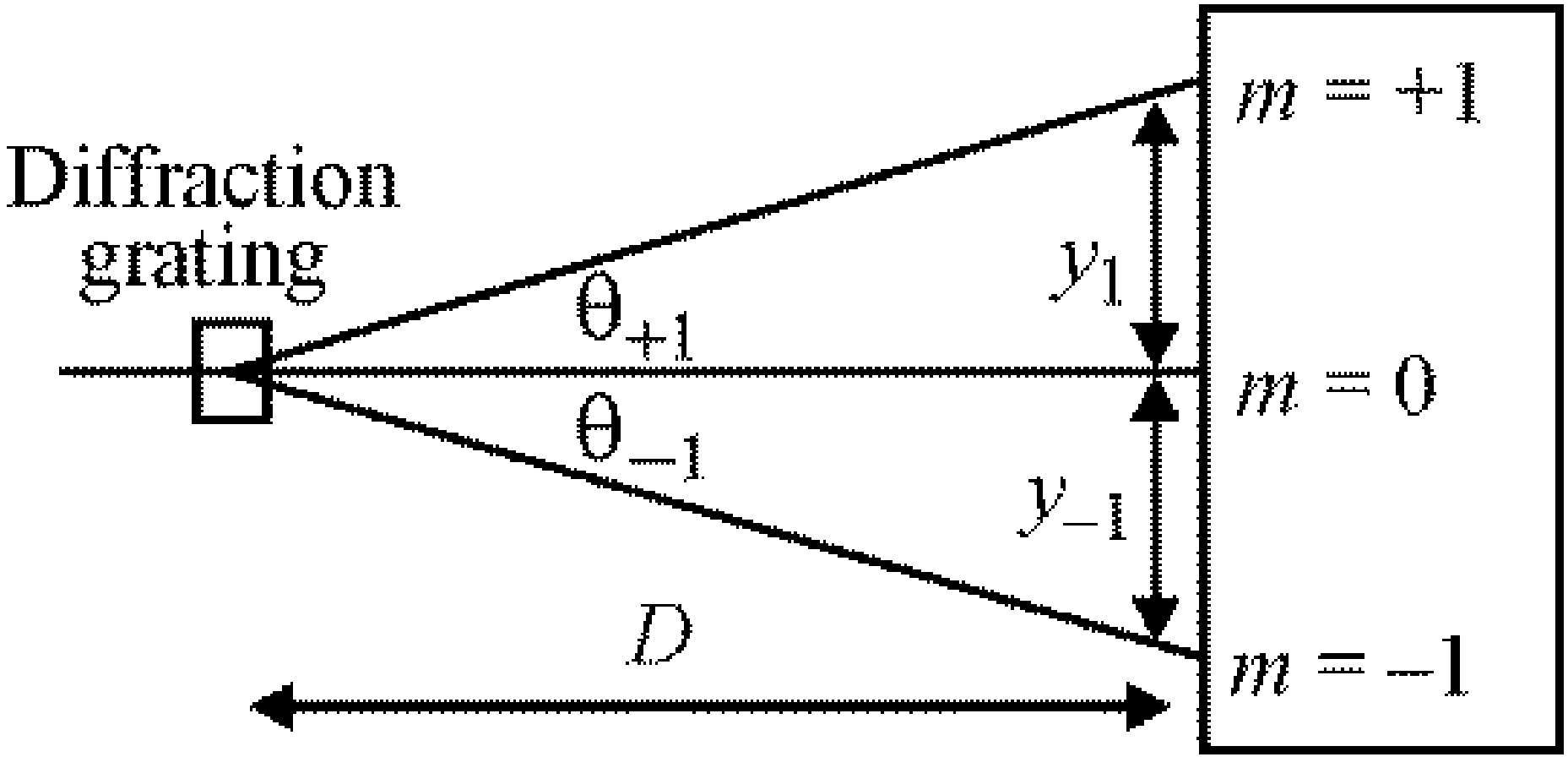


Figure 5-35
(Laboratory 1-5B: Interference and Diffraction)

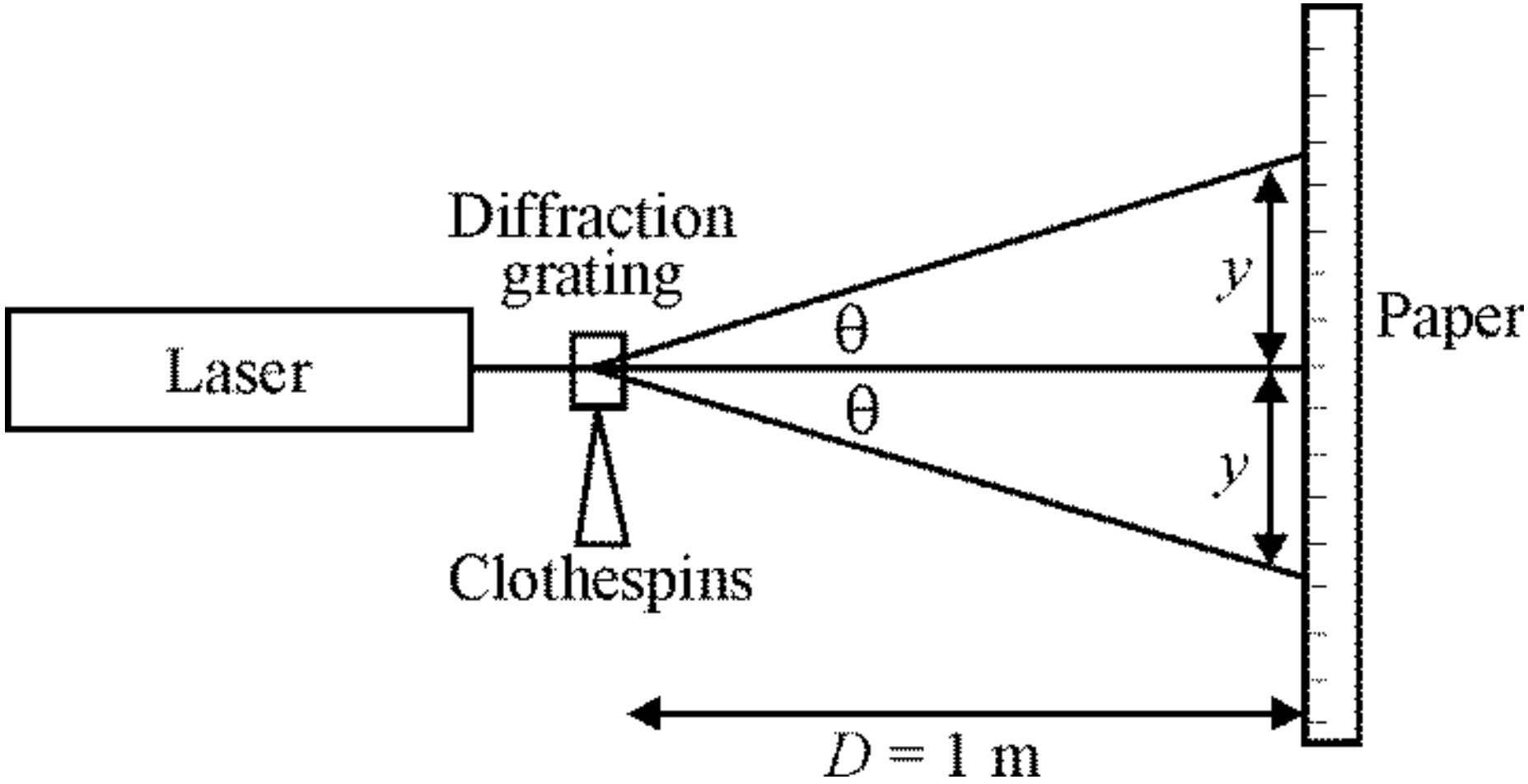


Figure 5-36 *Experimental Setup for Procedure A*
(Laboratory 1-5B: Interference and Diffraction)

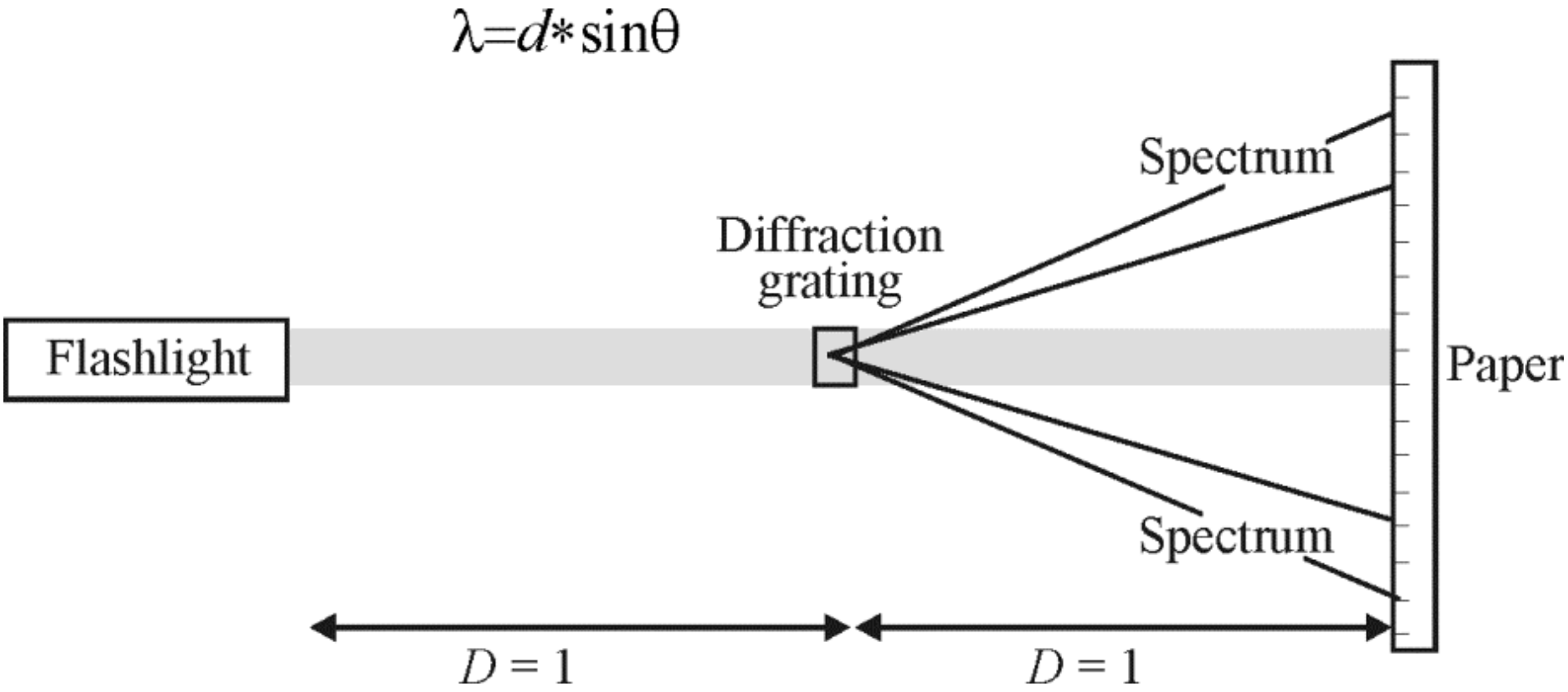


Figure 5-37 *Experimental Setup for Procedure B*
(Laboratory 1-5B: Interference and Diffraction)

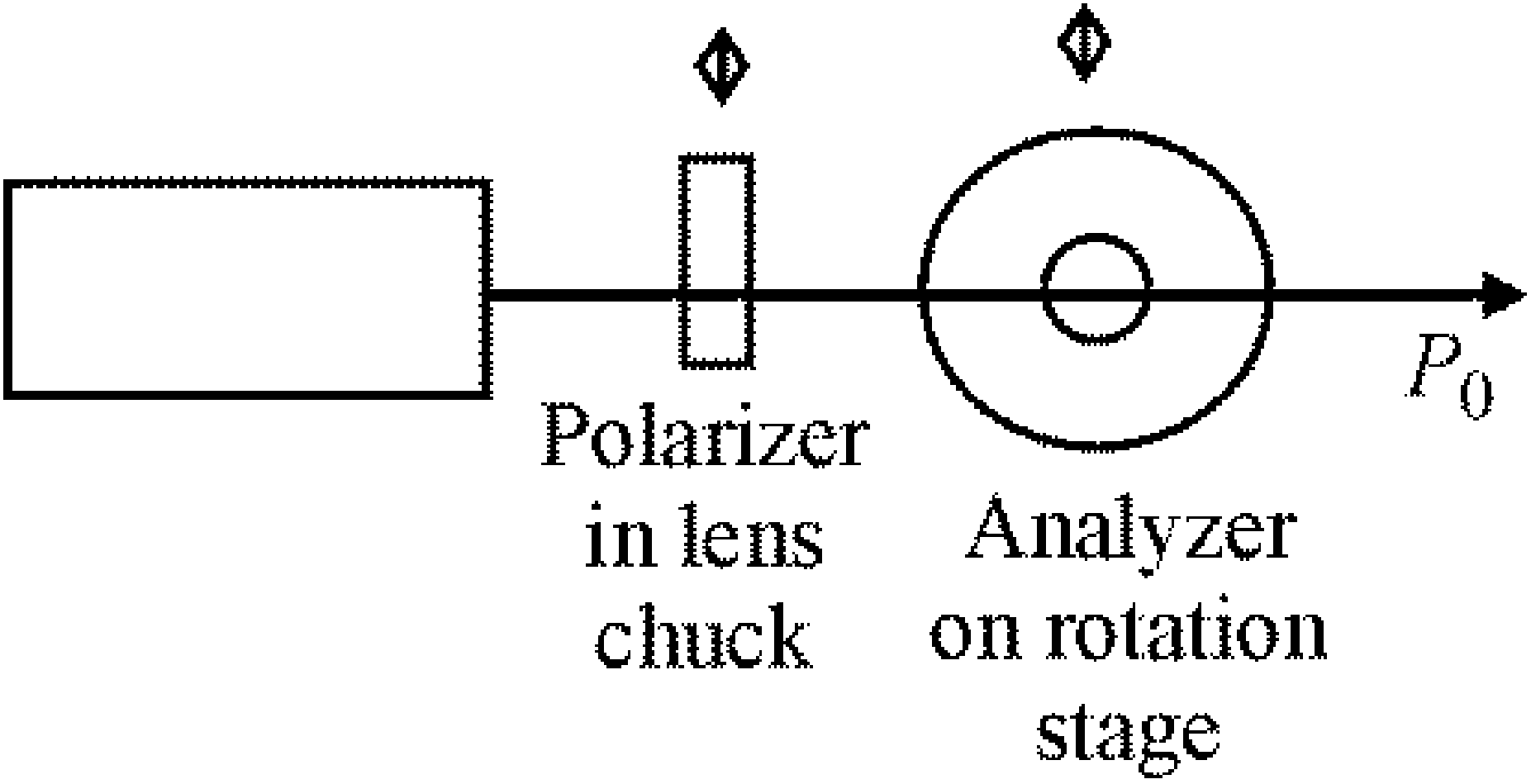


Figure 5-38
(Laboratory 1-5C: Polarization)

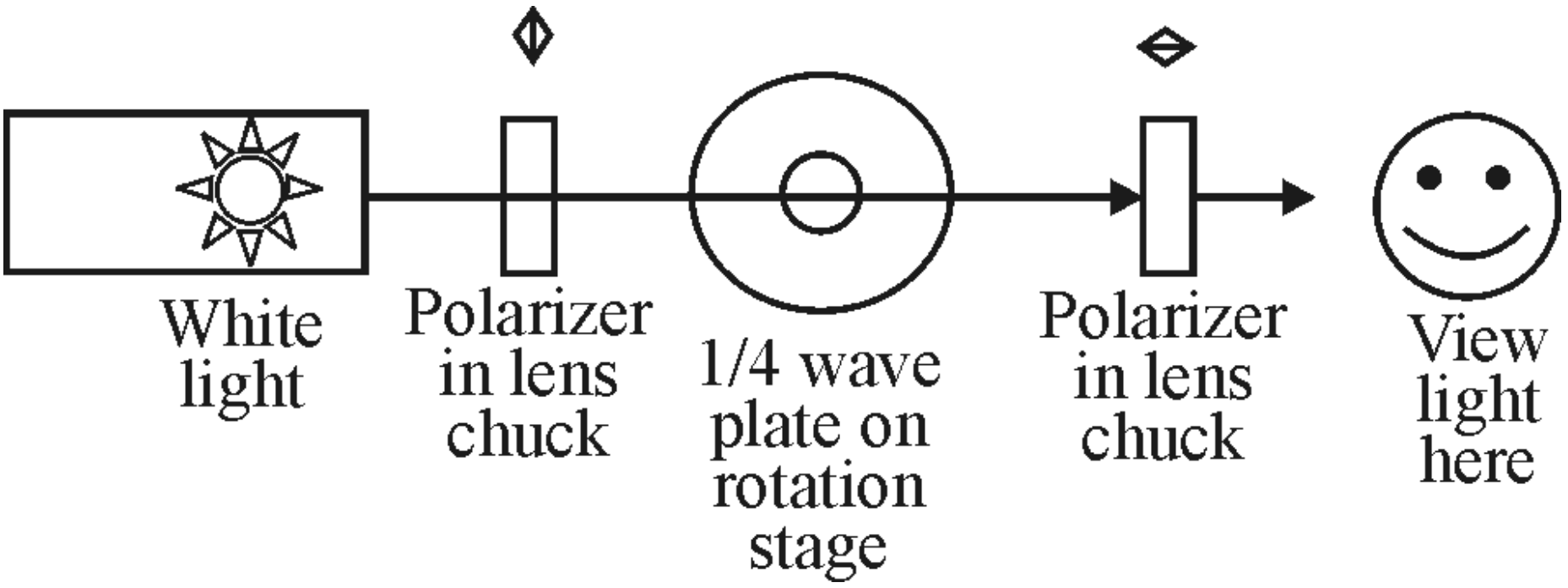


Figure 5-39
(Laboratory 1-5C: Polarization)

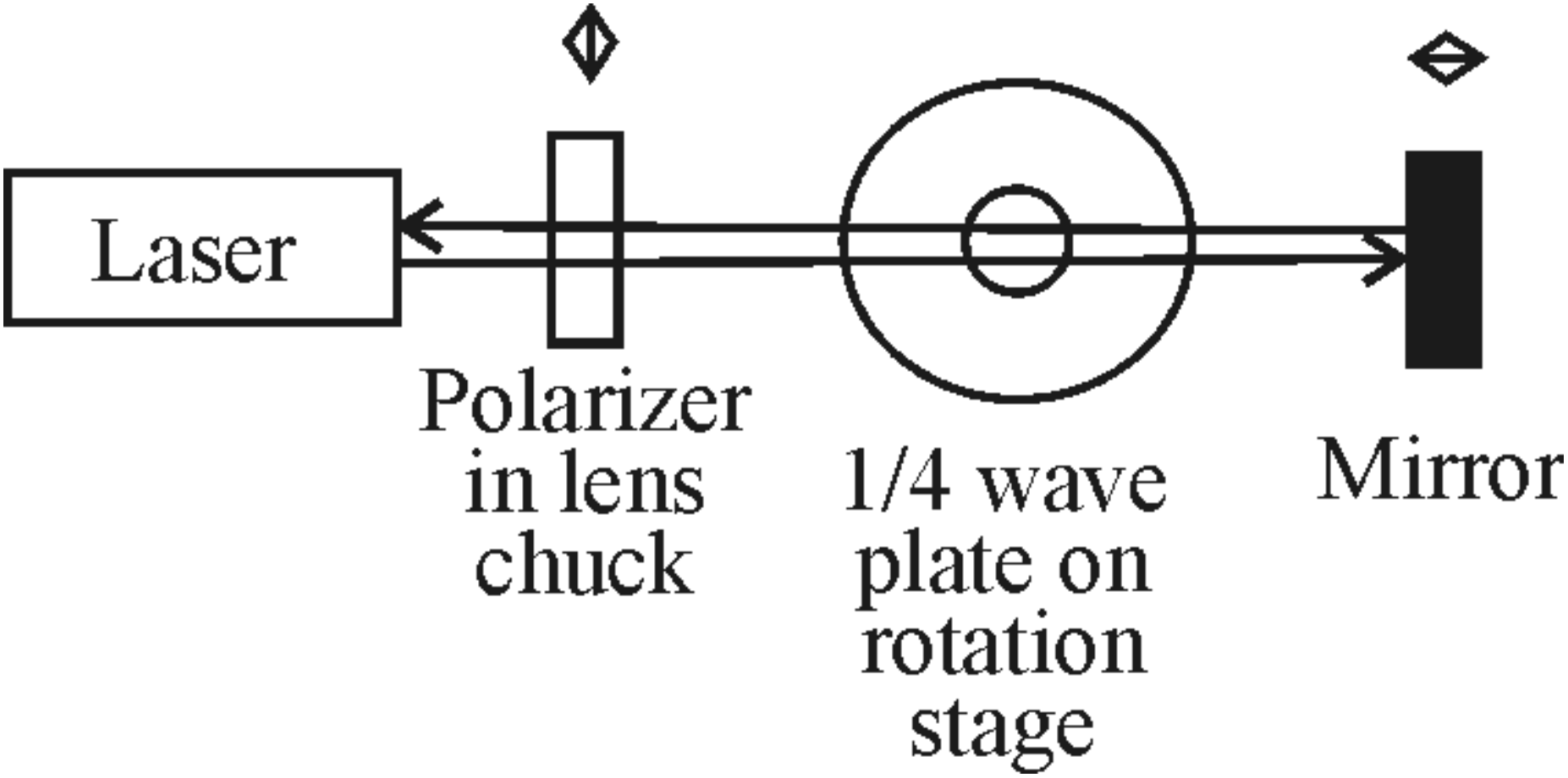


Figure 5-40
(Laboratory 1-5C: Polarization)