Modern Optics: Homework 11

Due: 25 September 2015

1 Bennett, *Principles of Physical Optics*, 4.1, page 125.

2 Elliptical mirror

An elliptical mirror is oriented with both foci on the x axis.

a) Suppose that the equation for the surface of the mirror is

$$\frac{x^2}{25} + \frac{y^2}{16} = 1.$$

Describe where the source must be placed so that the mirror produces an image of it at one location. Describe the location of the image.

b) Suppose that the foci of the ellipse are at $x = -4\,\mathrm{m}$ and $x = 4\,\mathrm{m}$. The equation for the surface of the mirror is

$$\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1.$$

Use the information about the foci to obtain a relationship between b and a. Is there only one surface which will focus in this way?

3 Parabolic mirrors

Consider parabolic mirrors whose axes are oriented along the x-axis.

a) A satellite dish is an example of a mirror. Suppose that a dish has diameter 0.80 m and that the edge is a height of 0.10 m above the center. At what point must a detector be placed to collect signals from an infinitely distant source?

b) The curvature of a curve described by $y = y(x)$ is defined to be $\frac{d^2y}{dx^2}$. Modify this definition to determine the curvature of a mirror described by $x = y^2/4s$ where s is the location of the focus. To illustrate this construct two parabolic curves, one with a larger and one with a smaller curvature. What happens to the focus as the curvature decreases?