11-11 Suppose that a CO_2 gas laser emits a diffraction-limited beam at wavelength 10.6 μm, power 2 kW, and diameter 1 mm. Assume that, by multimoding, the laser beam has an essentially uniform irradiance over its cross section. Approximately how large a spot would be produced on the surface of the moon, a distance of 376,000 km away from such a device, neglecting any scattering by the earth's atmosphere? What will be the irradiance at the lunar surface?

11-12 Assume that a 2-mm-diameter laser beam (632.8 nm) is diffraction limited and has a constant irradiance over its cross section. On the basis of spreading due to diffraction alone, how far must it travel to double its diameter?

11-13 Two headlights on an automobile are 45 in. apart. How far away will the lights appear to be if they are just resolvable to a person whose nocturnal pupils are just 5 mm in diameter? Assume an average wavelength of 550 nm.

11-14 Assume that the pupil diameter of a normal eye typically can vary from 2 to 7 mm in response to ambient light variations.

a. What is the corresponding range of distances over which such an eye can detect the separation of objects 1 mm apart?

b. Experiment to find the range of distances over which you can detect the separation of lines placed 1 mm. apart. Use the results of your experiment to estimate the diameter range of your own pupils.

11-15 A double-slit diffraction pattern is formed using mercury green light at 546.1 nm. Each slit has a width of 0.100 mm. The pattern reveals that the fourth-order interference maxima are missing from the pattern.

a. What is the slit separation?

b. What is the irradiance of the first three orders of interference fringes, relative to the zeroth-order maximum?