Donald P. Shiley School of Engineering
EGR 491 Telescope Design, Fall 2019
Assignment 8

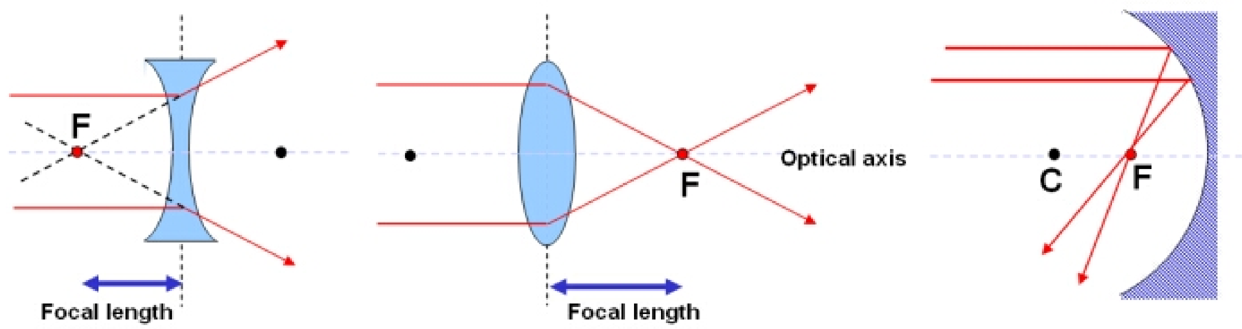
For this assignment, feel free to use books, journals, even web pages to look up anything you want. Do try to be careful to make sure the information is from a reputable trustworthy source (you can assume my posted class notes are trustworthy – if they're not, it's my fault).

1) Write a short biography of William Herschel and Charles Messier (about ¼ to ½ page for each). Discuss such things as when and where they lived, their contribution to astronomy (including approximately how many objects they discovered), describe the telescope(s) they used (refractor/reflector/catadioptric, size of primary optics), etc. For Charles Messier, include some discussion of the Messier list and why it is popular with amateur astronomers.

2) What is the "New General Catalog" (NGC), when was it compiled, approximately how many objects does it include?

3) In the 18th century, how were comets distinguished from other objects of similar appearance?

4) For reflecting telescopes, the mirror ideally should be a paraboloid. However, for long focal length mirrors, the paraboloid is nearly spherical. Let's assume we have a spherical mirror for this homework question. The focal length (point F) for lenses and mirrors are shown here:



For mirrors, the center of curvature is at the point where the "object distance" equals the "image distance". This is point "C" in the image at the above right. If your eye is at point C, you would see your eye's image reflected at all points of the mirror. As you move your eye closer to the mirror, the image distance would move further out (beyond point C). If you placed your eye at the focal length (point F), the image distance is infinity. From the figure above, we know that the focal length is less than the radius of curvature. If the focal length of a spherical mirror is 1000mm, what is the radius of curvature? Use the law of reflection to help you think through this.

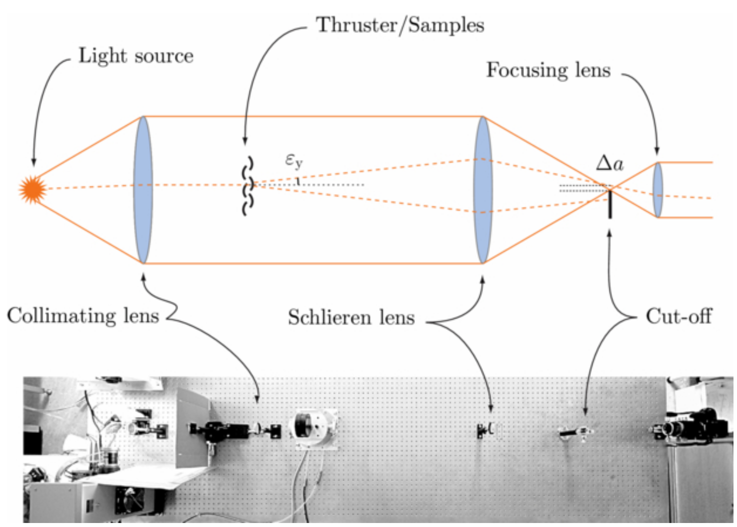
5) Determine critical angle of glass-to-air. The critical angle is the minimum angle for total internal reflection. Assume the index of refraction is 1.5.

6) For optics, a converging lens has convex curvature (the middle image in the above sketch). Sketch a converging lens for ultrasound (is in convex or concave?) Hint, so posted "optics notes" for speed of waves in various media.

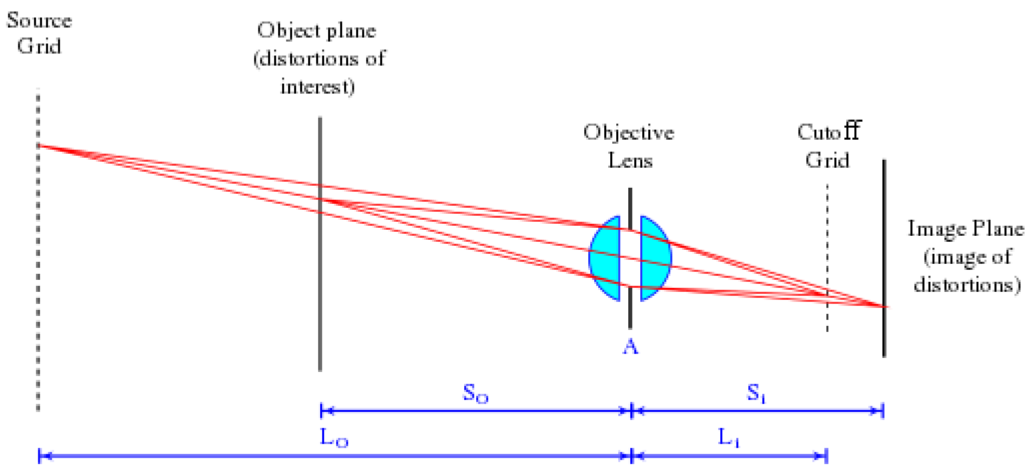
7) The speed of light in air is slightly slower than in a vacuum; and the “more air” there is, the slower it goes. In other words, the speed of light is a function of the air’s density. The air density in the room you are currently sitting in while reading this is not precisely uniform – it varies from point to point. Why? Air density is a function of air temperature – and the temperature is not uniform at all points. So what? If speed of light varies as it travels through air, it will be refracted. This causes mirages over hot landscapes and causes stars to twinkle. Wikipedia describes this:

Convection causes the temperature of the air to vary, and the variation between the hot air at the surface of the road and the denser cool air above it creates a gradient in the refractive index of the air. This produces a blurred shimmering effect, which affects the ability to resolve objects, the effect being increased when the image is magnified through a telescope or telephoto lens.

If the stars are not twinkling, astronomers refer to this as “good seeing”. If the stars are very twinkly, then the seeing is poor, and magnified views through a telescope are very blurred. Schlieren systems are laboratory devices that demonstrate this. Read about Schlieren systems and how they work. Also, look up a video (youtube, etc.) that demonstrates this and include the URL as the “solution” to this hw question.



http://iopscience.iop.org/article/10.1088/0957-0233/23/8/085403



https://en.wikipedia.org/wiki/Schlieren_photography