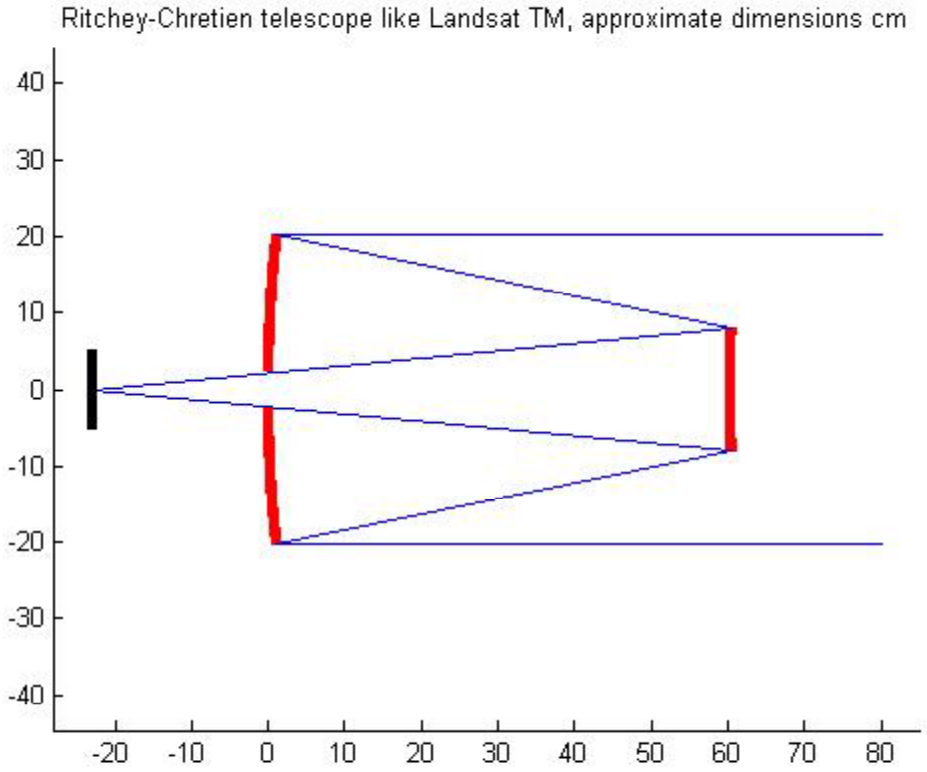
Photogrammetry 1 - Homework 1 - Analytical Ray Tracing

Trace the path of an incoming ray from the right, parallel with the x-axis, reflecting twice off the the primary and seconday mirrors. Find the intersection of the twice reflected ray with the x-axis. This will define the location of the focal plane. Do this in 2D only. For this type of telescope, both of the surfaces are hyperbolas. For each reflection, find the intersection point, the normal vector at that point, the reflection angle, and the reflected ray equation. For the final ray, intersect with the x-axis.



The primary and secondary surfaces are defined by the following equation for a hyperbola which is presented in the form used for optical design, R being the radius of curvature at the origin, K being the conic constant (units are cm). Original ray at y=20.3

$$y^2 - 2R\left(x - x_0\right) + \left(K + 1\right)\left(x - x_0\right)^2 = 0$$

Primary:

$$R = 182.66036092$$
$$K = -1.14513641$$
$$x_0 = 0$$

Secondary:

$$R = 99.55462687$$
$$K = -6.57208629$$
$$x_0 = 60.2$$

You can find the slope of the tangent line at the intersection points either analytically using implicit differentiation or by numerical approximation. At each reflection point report the unit vector of the ray, the unit vector of the surface normal, the angle of reflection, and the equation of the reflected ray. Finally, estimate the "effective focal length" which is the distance at which the angle of the two rays at the focal plane subtends the diameter of the primary aperture, 40.6 cm.

Due Tuesday, 7 September