Exercise 6 - Homework n° 3. The Cassegrain telescope

a) To ensure that the telescope is perfectly stigmatic, (M_1) should be parabolic ($\infty \to F_1'$)

(M_2) should be hyperbolic ($F_1' \to F'$)

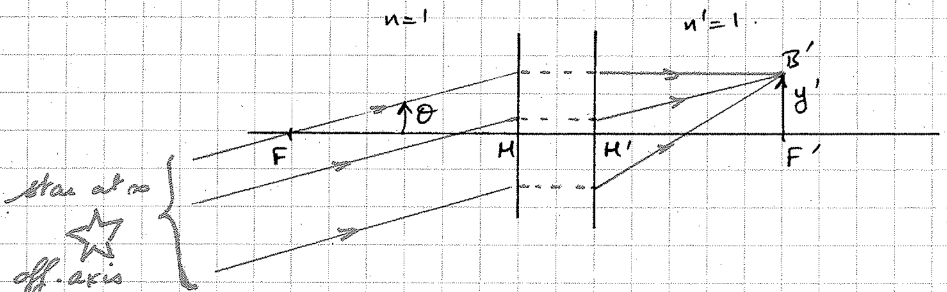
virtual real.

b) • Transverse magnification $(g_y)_2$?

$$\underset{\text{(on axis)}}{\infty} \xrightarrow{(M_1)} F_1' \xrightarrow{(M_2)} F'$$

object off axis with angle θ $\longrightarrow y_1' \longrightarrow y'$

The telescope (2 mirrors) is equivalent to refractive system with principal points H, H'. focal points F and F'

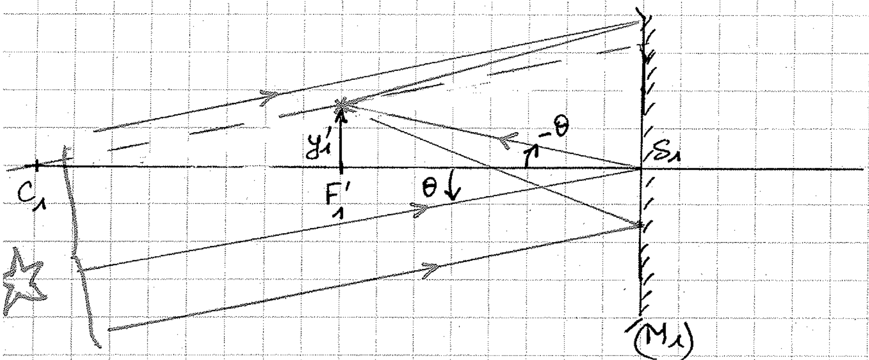


$y' = \overline{FH}\ \theta = -f\ \theta$

$y' = f'\ \theta$ ①

since $n = n'$

Let us calculate y_1' : size of image after reflection on (M_1)



$y_1' = \overline{S_1F_1'} \times (-\theta) = -f_1'\ \theta$ ②

Using ① and ② we get:

$$\boxed{\frac{y'}{y_1'} = -\frac{f'}{f_1'}}$$

focal distance of telescope

focal distance of (M_1)

Note : this is the same reasoning as in lecture ④, paragraph ⑥

Conclusion : $(g_y)_2 = \dfrac{y'}{y_1'} = -\dfrac{f'}{f_1'} = -\dfrac{1000}{-500} = +2$

• Distance $\overline{S_1S_2}$? $\overline{S_1S_2} = \underbrace{\overline{S_1F_1}}_{\frac{R_1}{2}} + \underbrace{\overline{F_1F_2}}_{?} + \underbrace{\overline{F_2S_2}}_{-\frac{R_2}{2}}$

To evaluate $\overline{F_1F_2}$, use Newton's formula for $F_1' \xrightarrow{(M_2)} F'$

$$(g_y)_2 = -\frac{\overline{F_2'F'}}{f_2'} = -\frac{f_2}{\overline{F_2F_1'}} \Rightarrow \overline{F_2F_1'} = -\frac{f_2}{(g_y)_2} = -\frac{R_2/2}{(g_y)_2}$$

So, $\overline{F_2F_1} = \overline{F_2F_1'} = -\dfrac{-360}{(+2)} = \underline{180\ \text{mm}}$

Thus, $\overline{S_1S_2} = \dfrac{R_1}{2} + \dfrac{R_2}{2(g_y)_2} - \dfrac{R_2}{2}$

$= -500 - 180 + 360$

$\underline{\overline{S_1S_2} = -320\ \text{mm}}$

- <u>Position of F'</u> : image focal point of the telescope

Again using Newton's formula: $(g_y)_2 = -\dfrac{\overline{F_2'F'}}{f_2'}$ $\Rightarrow \overline{F_2'F'} = -(g_y)_2\, f_2'$.

$\Rightarrow \overline{F_2'F'} = -2 \times (-360)$

$\overline{F_2'F'} = 720\ \text{mm}$

So $\overline{S_2F'} = \overline{S_2F_2'} + \overline{F_2'F'}$

$= -360 + 720$

$\underline{\overline{S_2F'} = +360\ \text{mm}}$

c) <u>Figure to scale 1:10 along the axis, 1:2 transversely</u>