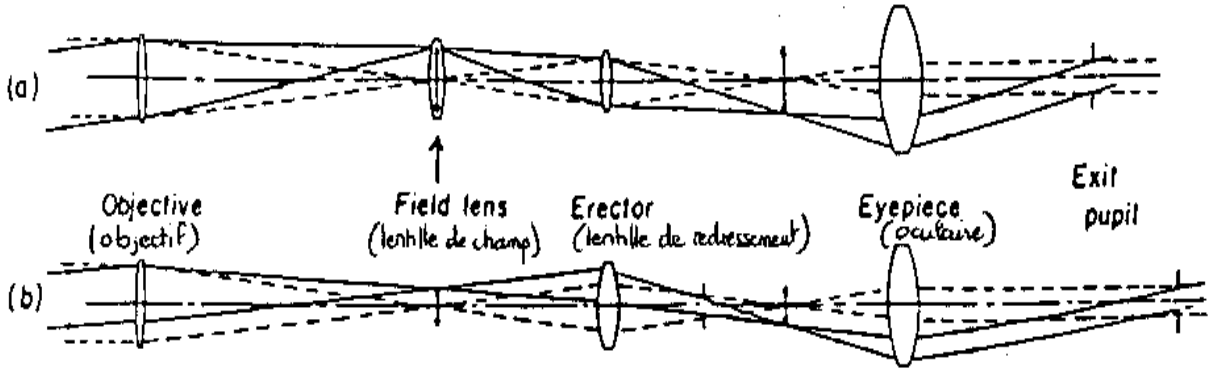
Ray Optics problem n°6

Study of a lens erecting telescope



All the objective and lenses will be considered as thin lenses. The whole problem will be solved in the paraxial approximation. The observer is supposed to be emmetropic.

The focal lengths and apertures of the lenses are :

Objective	$f'_o = 150$ mm	open at f/6	diameter 25mm
Field lens	$f'_f = 60$ mm	open at f/6	diameter 10mm
Erector lens	$f'_{er} = 45$ mm	open at f/2,25	diameter 20mm
Eyepiece	$f'_{ey} = 30$ mm	open at f/2	diameter 15mm

The erector lens is used to produce an uppright image : **its magnification is equal to -1**.

-A- In this whole first part of the problem, the telescope does not include the field lens (fig. b).

1. Position the elements of the system for a telescope adjusted for an object at infinity. Make a drawing with the scale x 1/2 along the optical axis , x 2 in the transverse direction.
2. Trace a bundle of rays coming from an object at infinity on axis.
3. What is the magnification G of the whole telescope ?
4. Determine which is the aperture stop of the system, calculate its entrance and exit pupils (diameters and positions).
5. Calculate the diameter corresponding to the edge of the bright field (no vignetting) in the object and image spaces.
6. Calculate the diameter of the total field in the object and image spaces.

-B- To avoid this large vignetted field and increase the size of the bright field, we add a field lens to the system (cf fig.a). This lens is placed in the plane conjugate with the object through the objective lens (= focal plane of the objective).

7. make a new drawing of the telescope, including the field lens, the whole system always adjusted for an object at infinity, with x 1/2 longitudinal scale , x 2 transverse scale.
8. Trace a bundle of rays coming from an object at infinity on axis.
9. Determine the new exit pupil of the telescope.
10. Calculate the new diameter of the bright field.
11. Calculate the diameter of the total field.
12. What should be the diameter of the field lens to suppress the vignetted field ?