

*“.....bad collimation is the
number one killer of
telescopes world wide.....”*

Walter Scott Houston

The Collimation of Telescope Optics

St. John Robinson

Topics for discussion

Collimation in general

Recognising what it is

Discussion on errors

Component adjustment

Tools

What is Collimation?

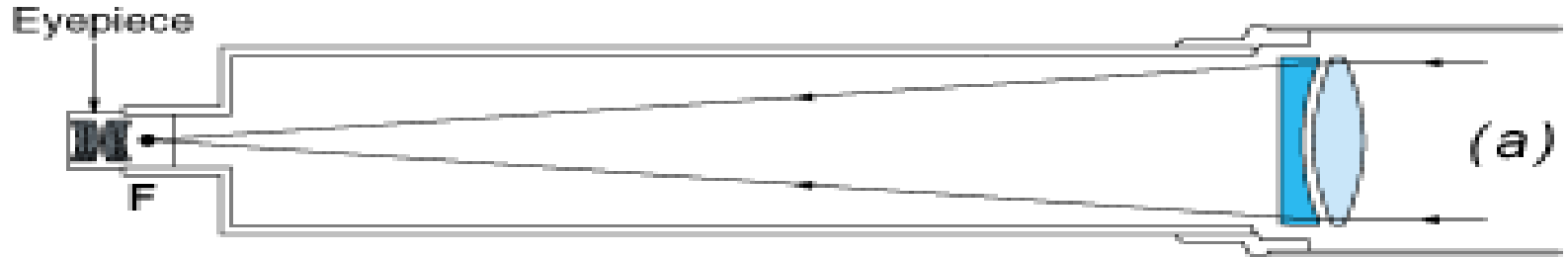
and

Why Collimate ?

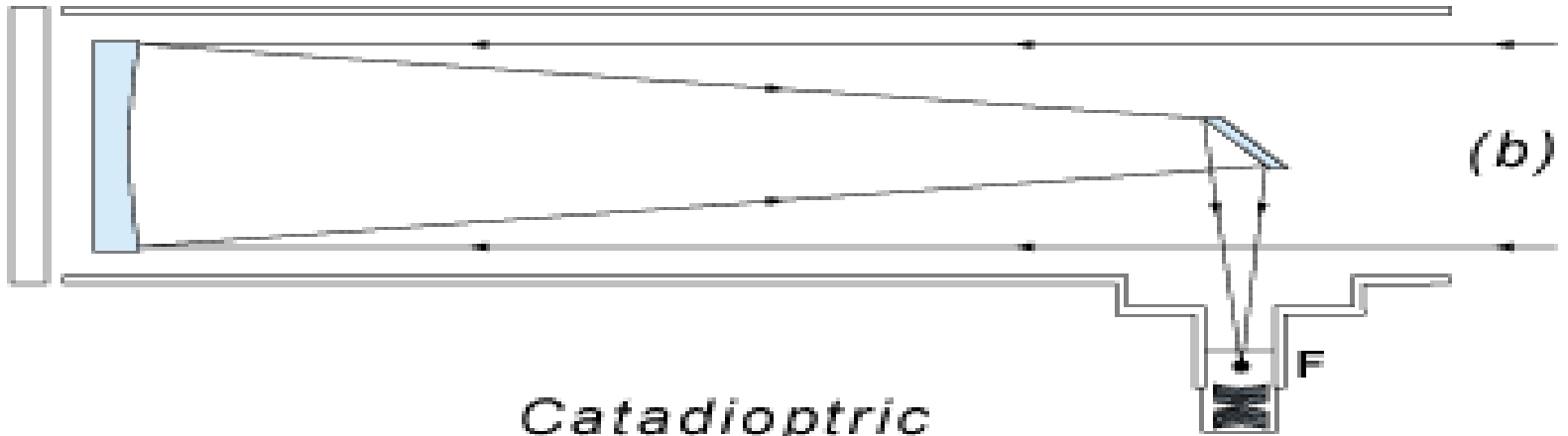
Collimation

...Is the lining up of the optical components in relation to each other.

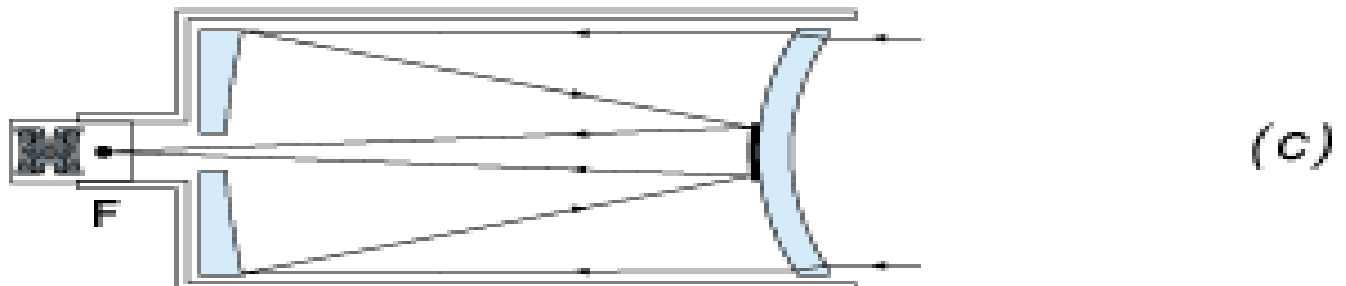
Refracting



Reflecting



Catadioptric



Do I have to do it ?

No you don't

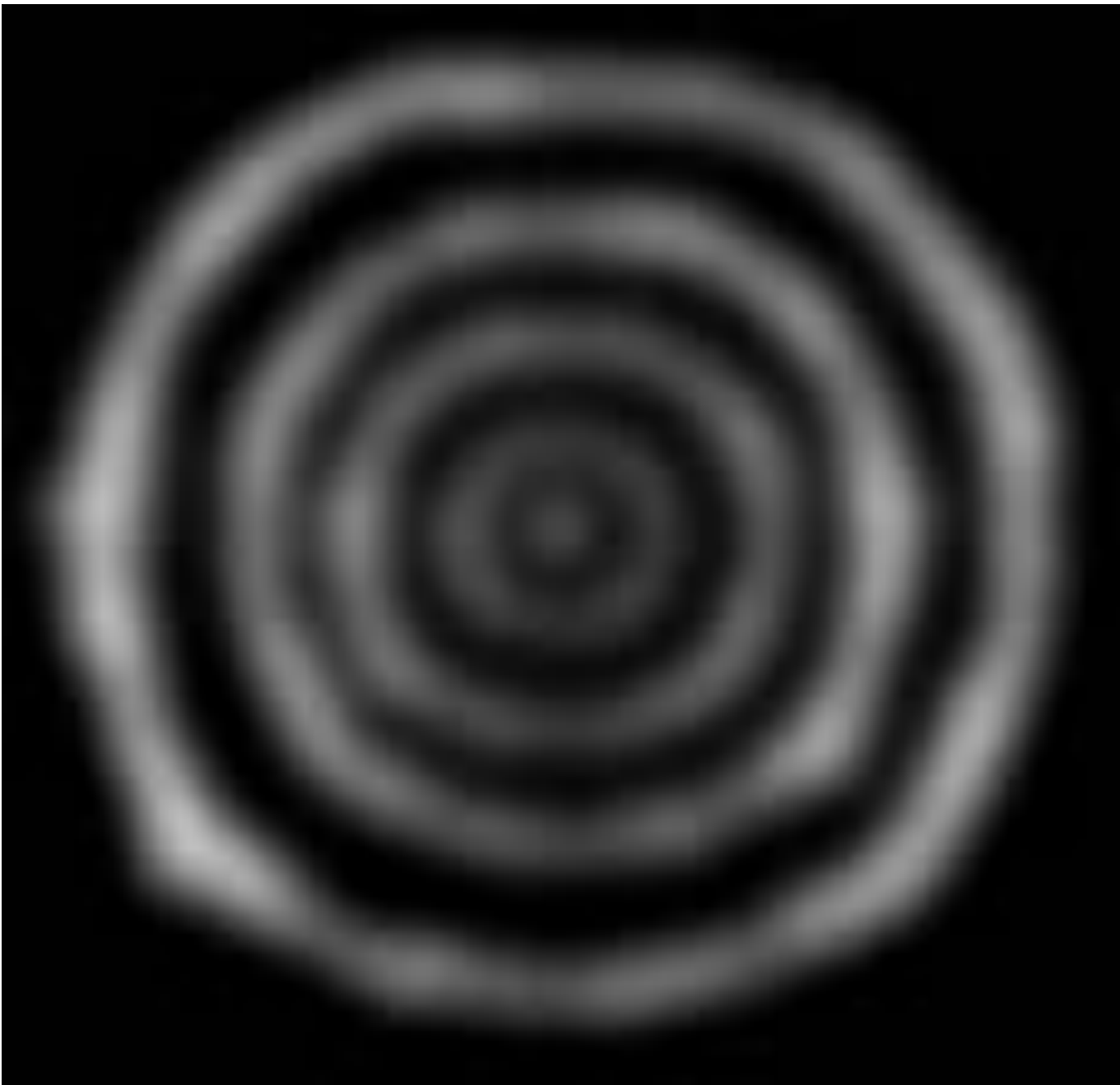
But!

**Ok, So How Do I
Recognize It ?**

And What Can

I Do

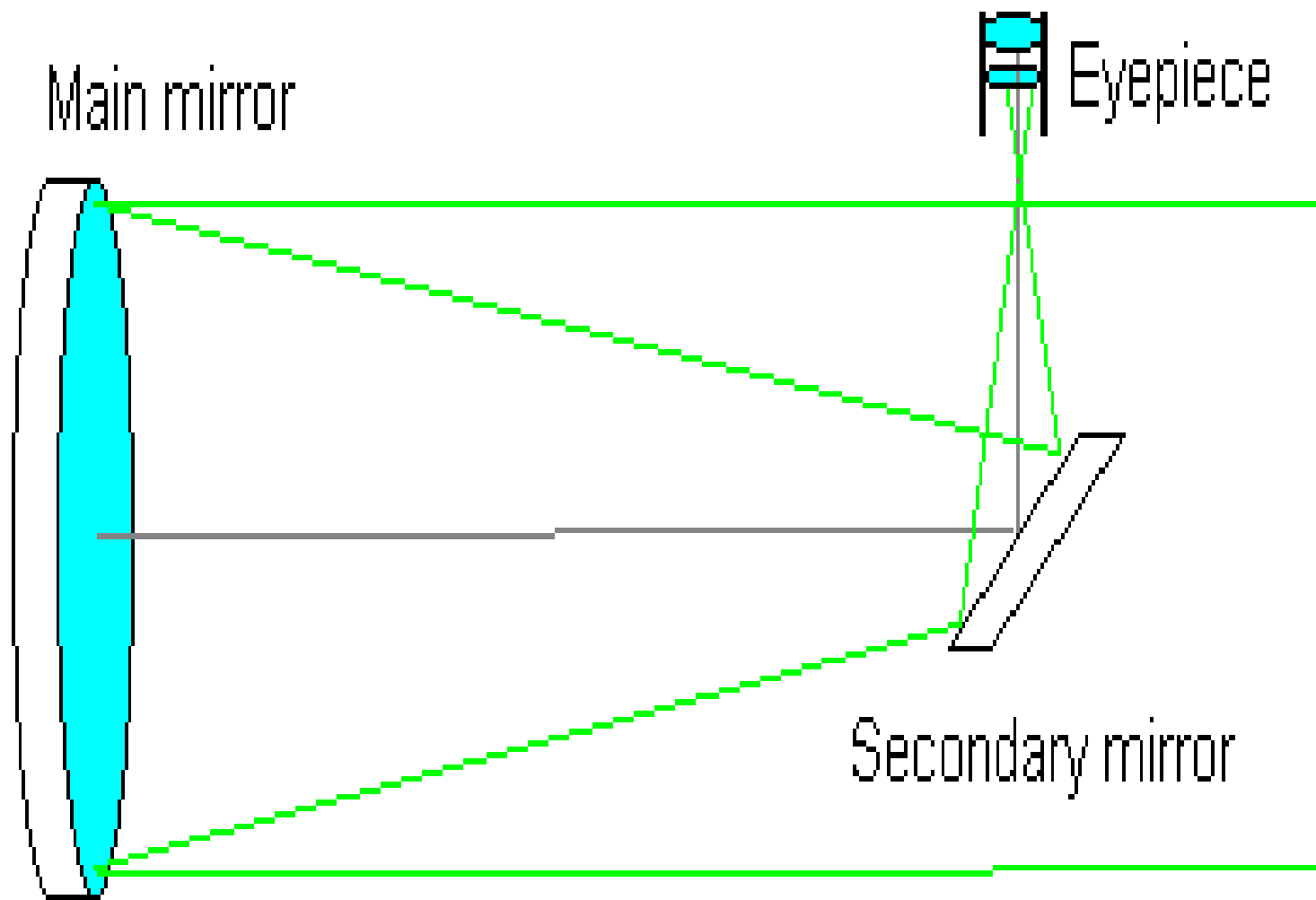
About It ?



What are the parts of the telescope

What do they do

What parts can or need I adjust



Optics of Newtonian telescopes

Remember!

The Main purpose of collimating is to align the two axes to form one common axis

Axis 1

The optical axis of the main or primary mirror

Axis 2

The optical axis of the eyepiece

Error conditions

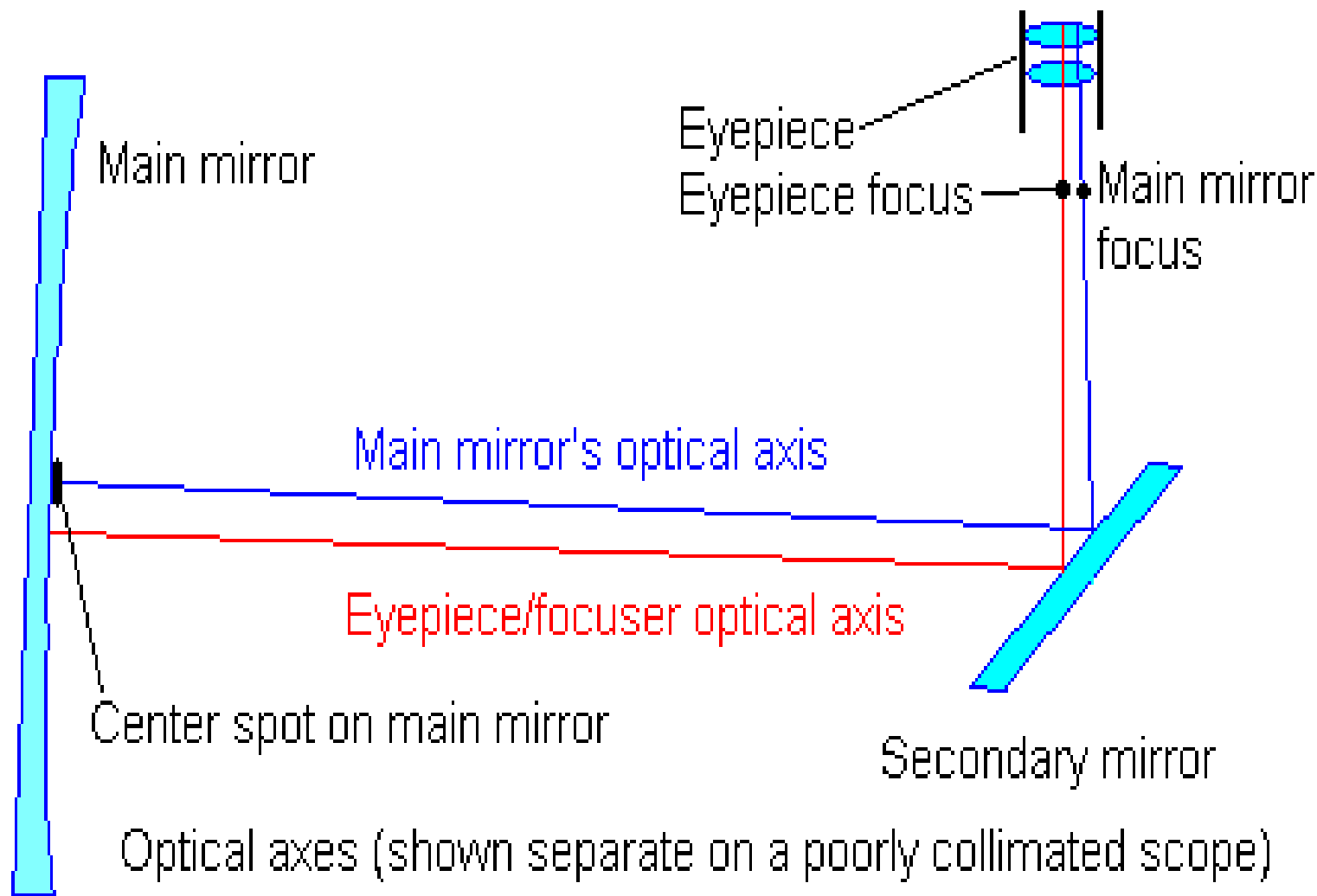
1a. The optical axes are separated at focus

1b. The optical axes are not parallel, but form an angle.

2. The optical axis strikes the secondary mirror at a point away from the optical centre.

3. The combined optical axis is not reflected at 90 degrees.

4. The optical axis is not centered in the tube.

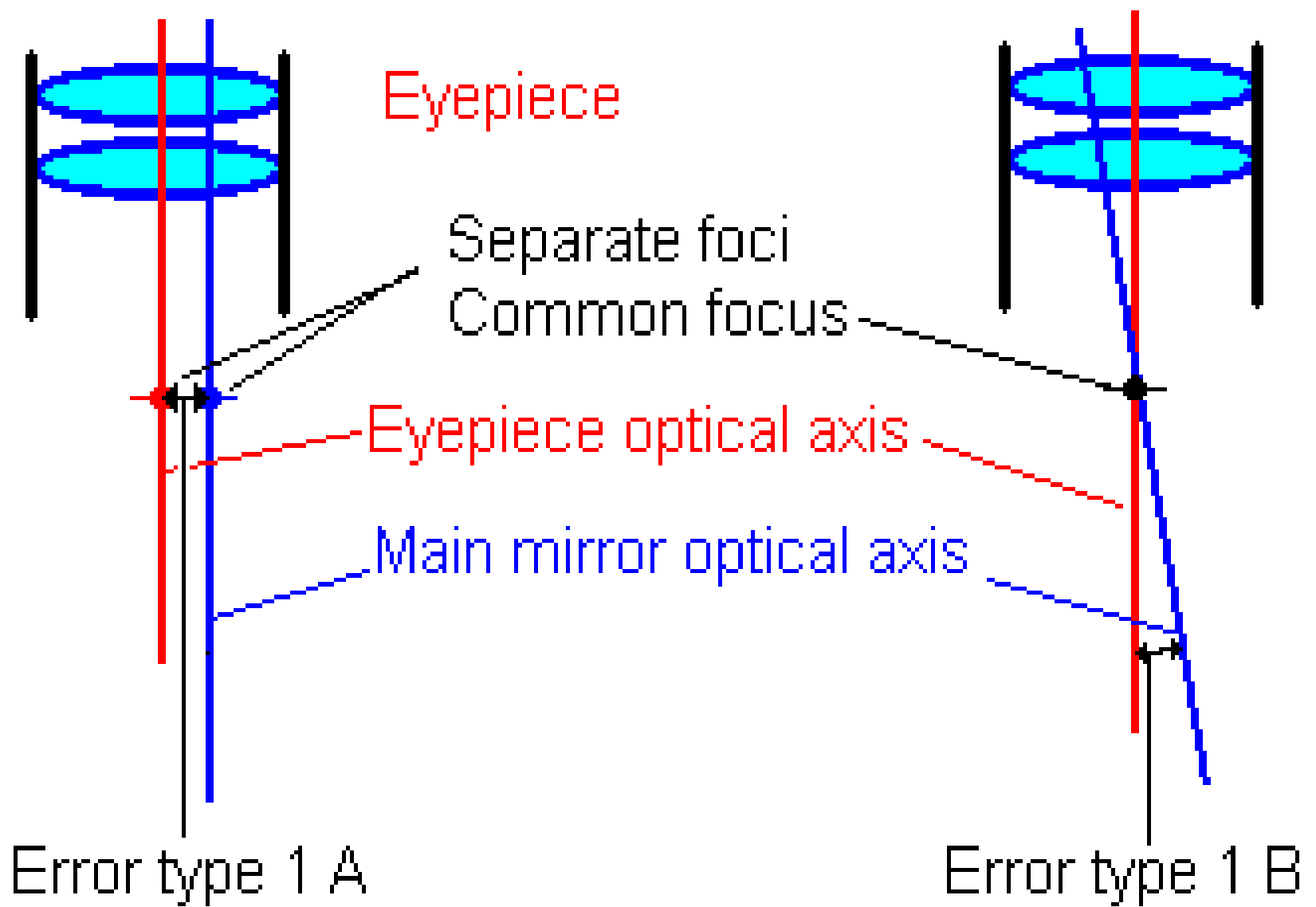


From the foregoing and to simplify error analysis, we can break this down into two parts, giving separate but corresponding errors if violated.....

1a. The optical axes should intersect at a common point of focus.

1b. The optical axes should be parallel.

- **The optical axis should strike the optical centre of the secondary mirror.**
- **The optical axis should be deflected 90 degrees by the secondary mirror.**
- **The optical axis (between the primary and secondary mirrors) should be centred in the supporting tube.**



Error type 1a mechanical analysis

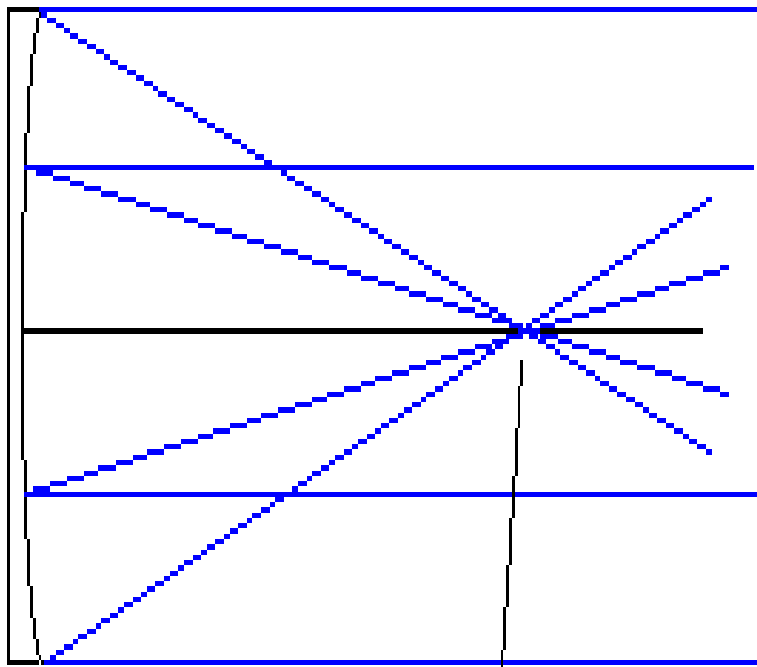
The optical axes are separated at focus by a distance d .

The eyepiece focus is in the primary mirror's focal plane, but at a distance d from its focus.

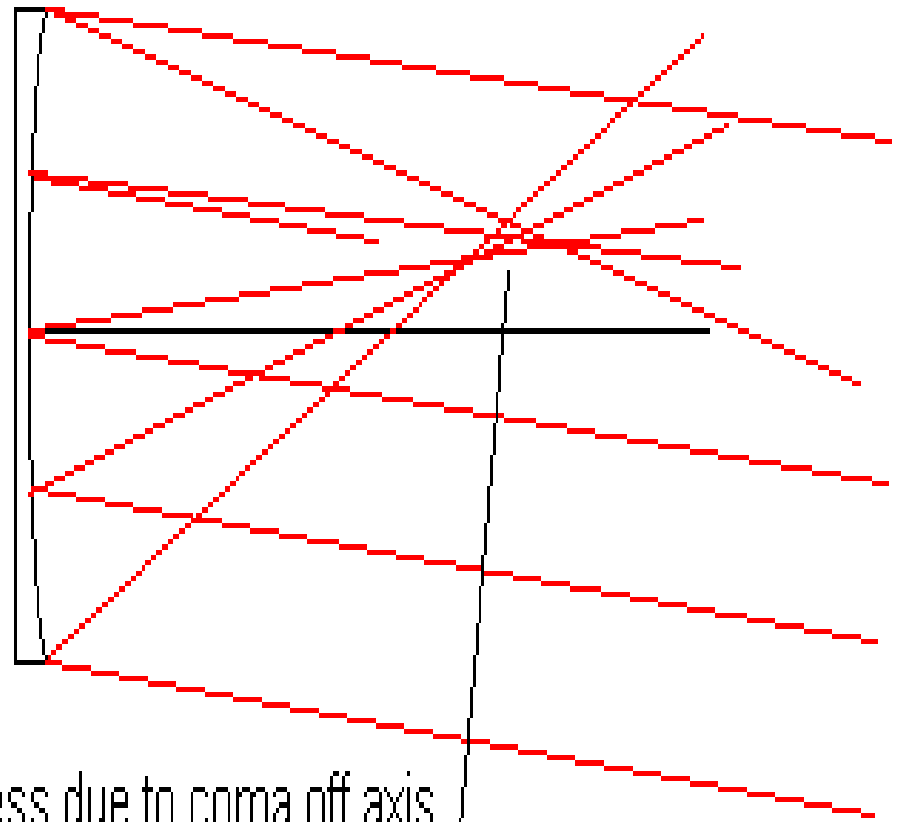
Error type 1a optical analysis

Image is comatic, even on axis - i.e. centre of eyepiece field !

Leading to loss of contrast and detail resolution.



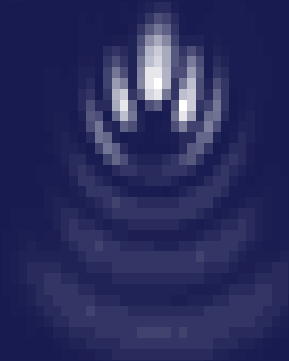
Sharp focus on axis



Unsharpness due to coma off axis

Poor Collimation/coma

You should correct this before you can continue with the star test



focused



defocused

Error type 1b mechanical analysis

The optical axes are not parallel, but form an angle.

This error may cause error type 1a.

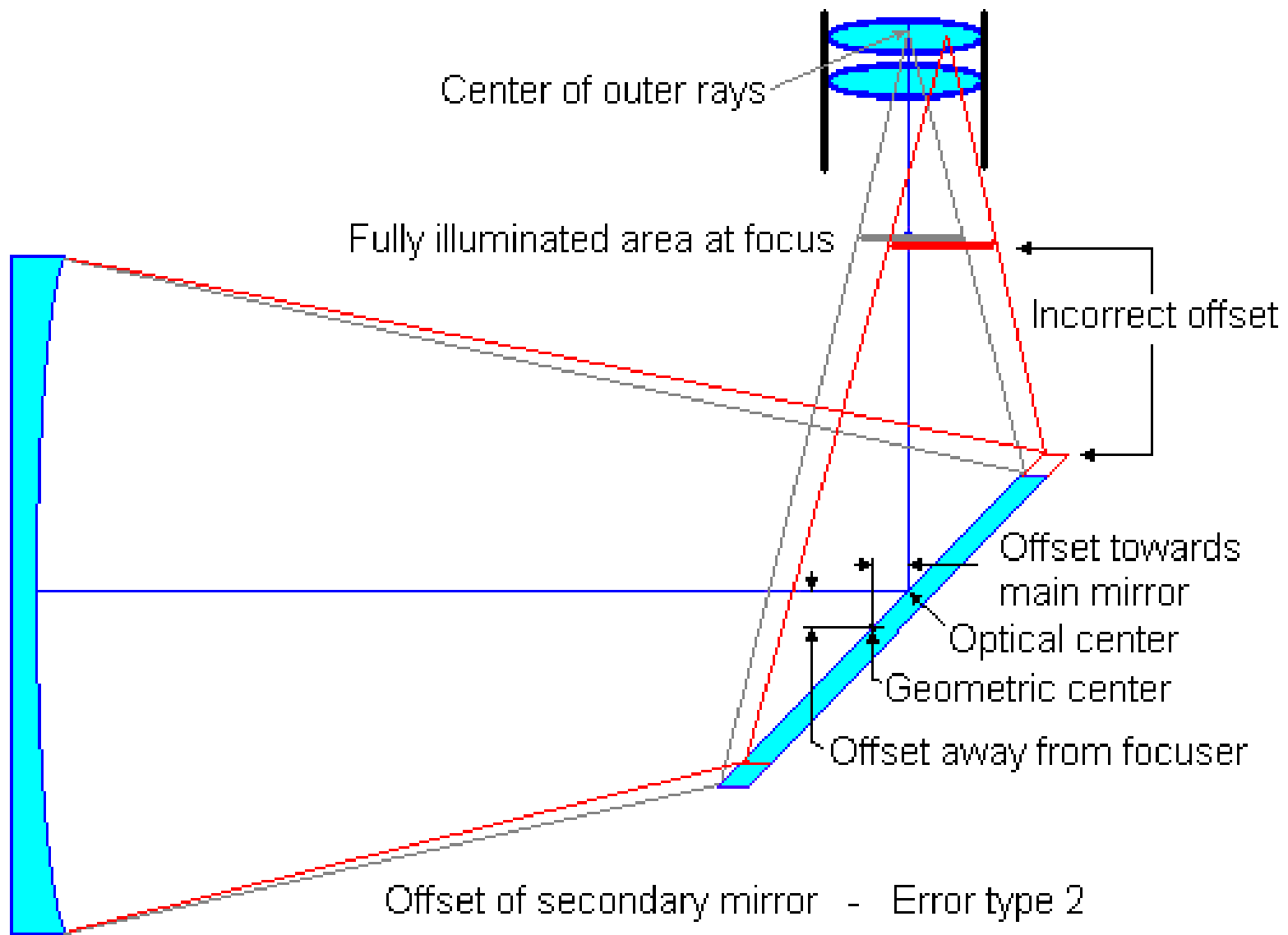
Error type 1b optical analysis

Star image blurred if not focussed within focal plane.

Increase in eyepiece astigmatism.

Error type 2

The optical axis intersects the secondary mirror at a point away from the optical centre....pew!



Error type 2 mechanical analysis

To be optically centred the secondary must be offset in the direction away from the focuser and towards the primary mirror.

Error type 2 optical analysis

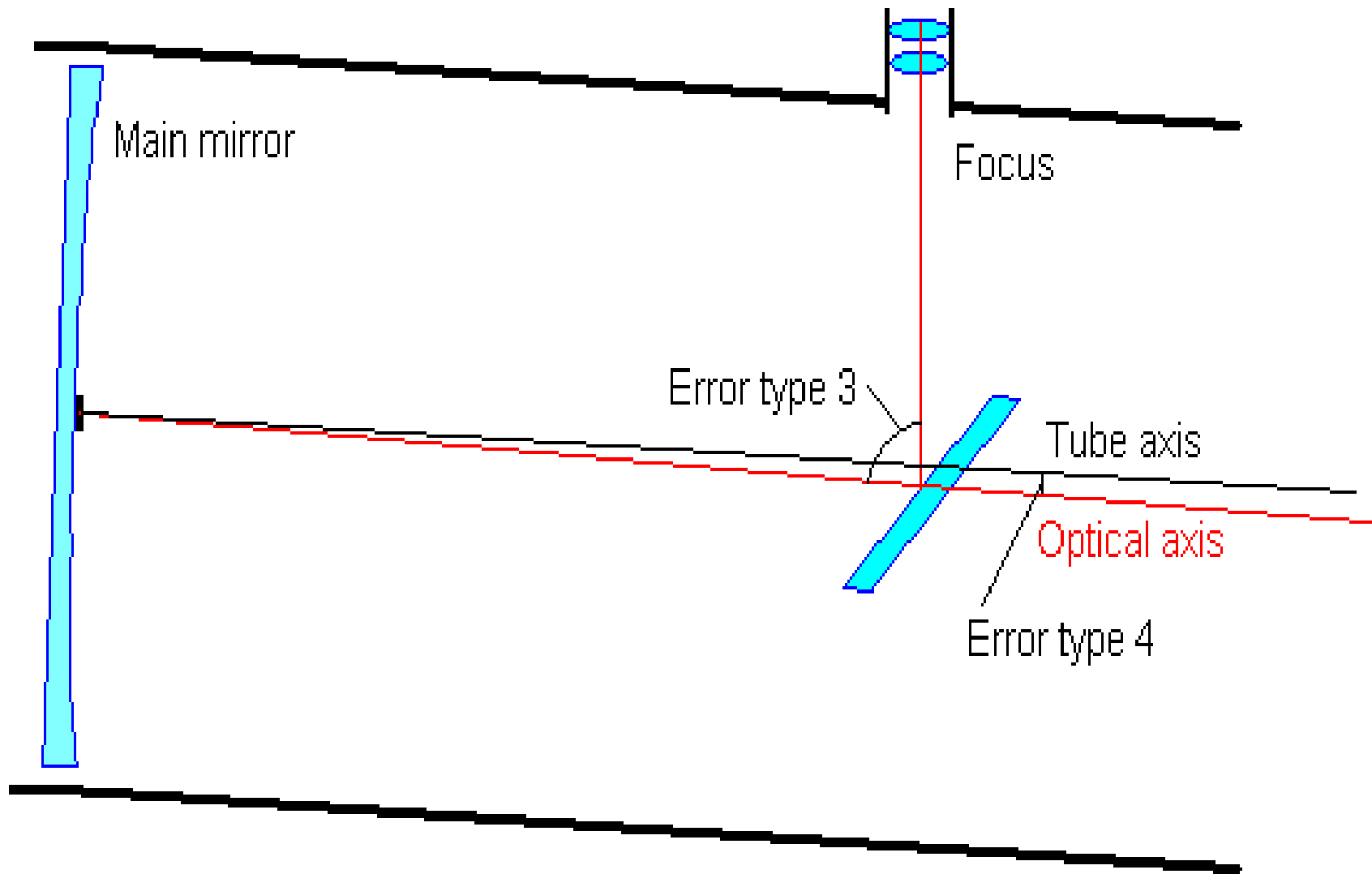
Fully illuminated field is offset relative to focus, causing uneven light loss near the edge of a low power field.

Error type 3

The combined optical axis is not reflected at 90 degrees

Error type 4

The optical axis is not centred in the tube.



A quick re-cap so far.....

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Component adjustment

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Practical demonstration

Component adjustment

Or which bits and in what order do I tweak them !!

1 - Square the focuser (This minimizes error type 3)

2 - Centre the secondary mirror in the tube

(This minimizes error type 4)

3 - Centre the secondary mirror along the tube

(This minimizes error type 2)

4 - Tilt the secondary mirror

(This minimizes error type 1B)

5 - Tilt the main mirror

(This minimizes critical error 1A)

6 - Check the centering of the optical axis in the tube and in the focuser drawtube. (This checks error type 4)

And finally.....

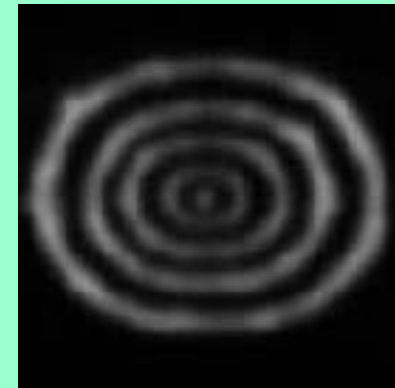
The Star Test

The Star Test

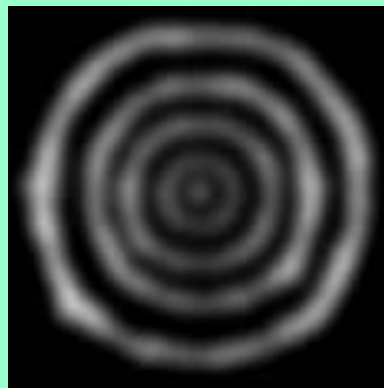
- Collimate your telescope.
- Set-up the telescope outside an hour before the test.
- Use high magnification on a moderately bright star.



Misaligned



Astigmatic



Good



Spherical Aberration



Poor Seeing