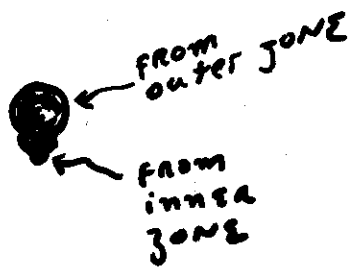
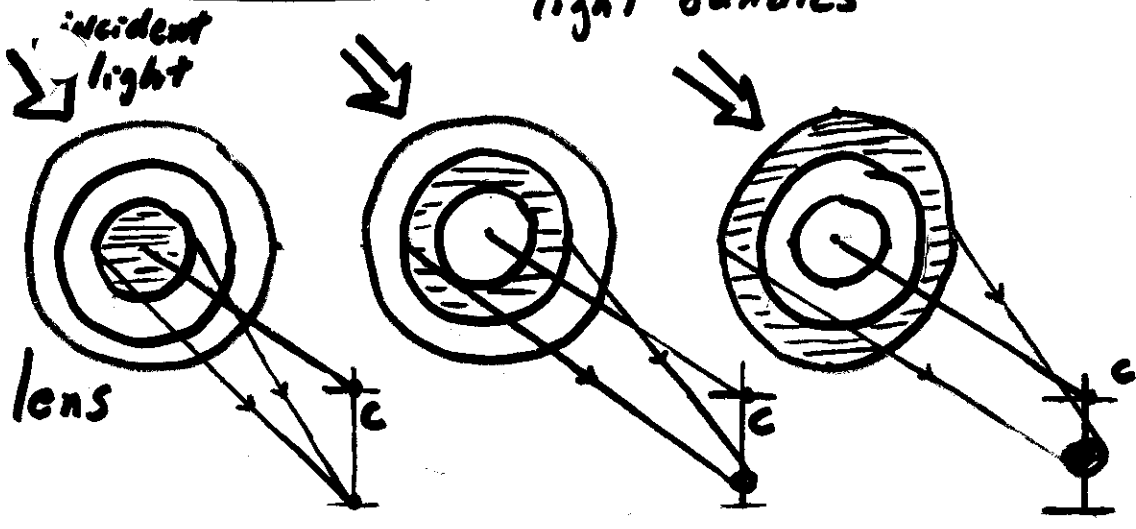
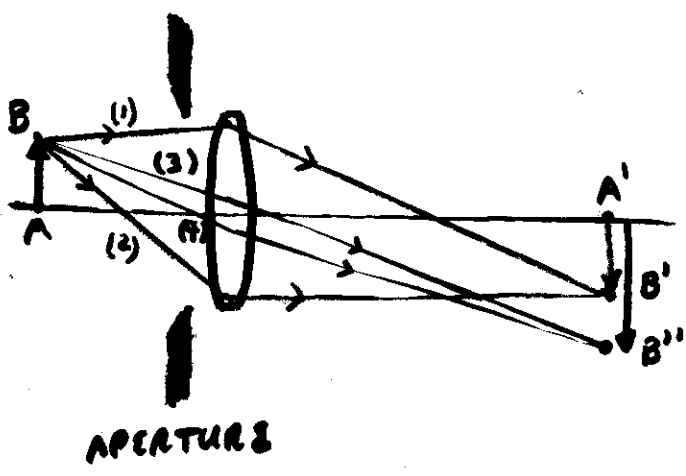


# 2. COMA

Aberration that afflicts off-axis light bundles



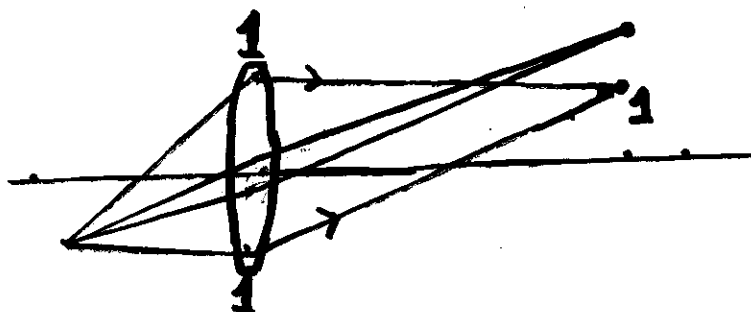
Each annulus focuses onto the image plane at a slightly different height and with a different spot size.



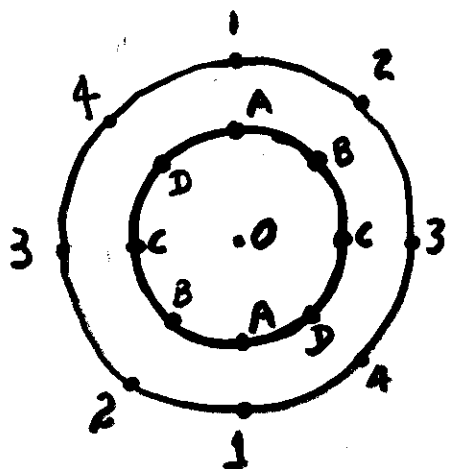
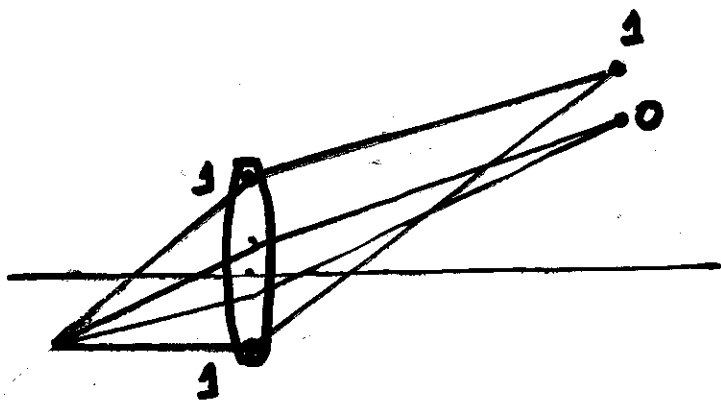
A lens with coma produces images of different magnification depending on the APERTURE.

Rays 1 and 2 passing through the edge portion of the lens are imaged at a different height than the rays 3 and 4 passing through the center annulus.

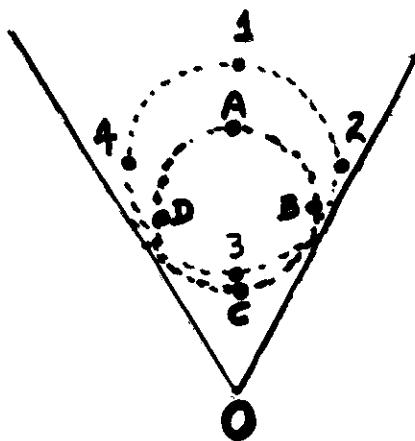
NEGATIVE COMA



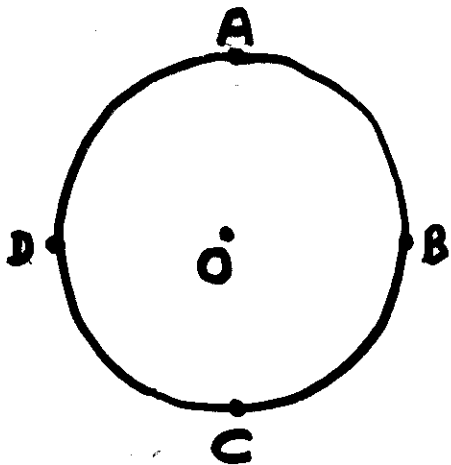
POSITIVE COMA



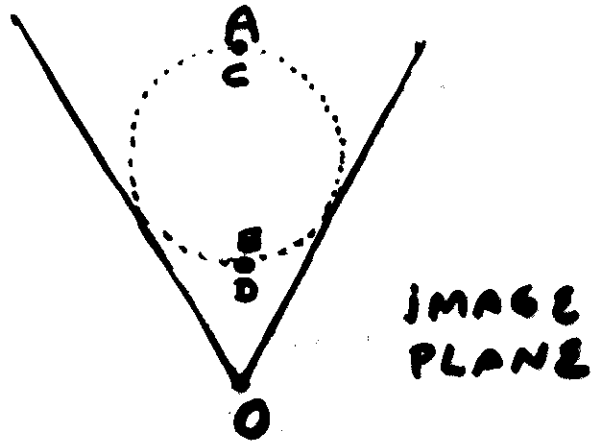
Points on the lens



Corresponding points on the image plane

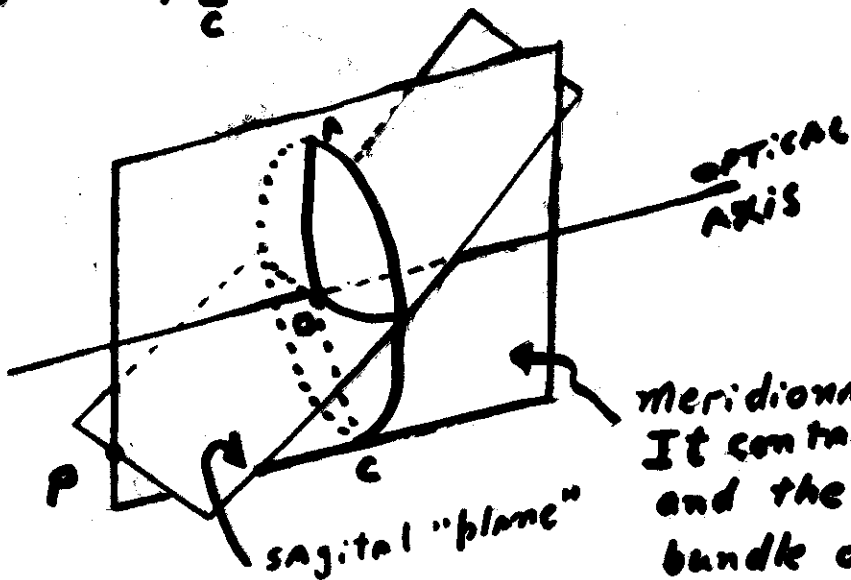
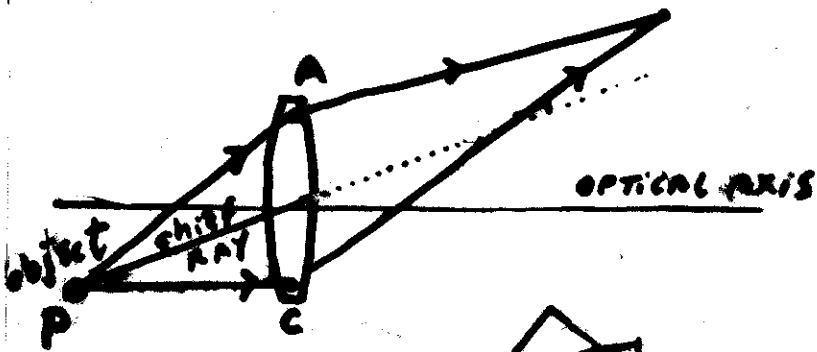


Points on the lens



The distance  $\overline{OA}$  is the tangential coma

The distance  $\overline{OB}$  is the sagittal coma



Meridional or Tangential plane  
It contains the OPTICAL AXIS and the chief RAY of the bundle of RAYS leaving the object point P

The sagittal plane is a plane that contains the chief ray and perpendicular to the meridional plane.

Notice: A sagittal plane change slope as the chief ray navigates through the optical system

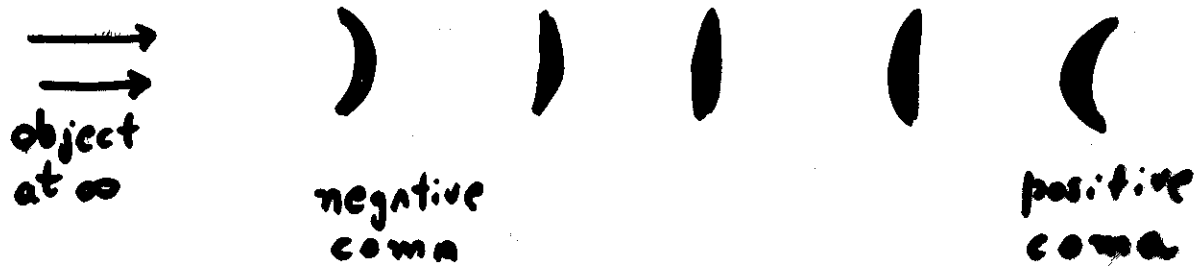
Meridional ray: One in the meridional plane  
It intersects the optical axis

Skew ray: One that doesn't intersect the optical axis.

Sagittal rays: Skew rays from the object point lying in a sagittal plane

Hence the names <sup>of</sup> meridional or tangential coma and sagittal coma

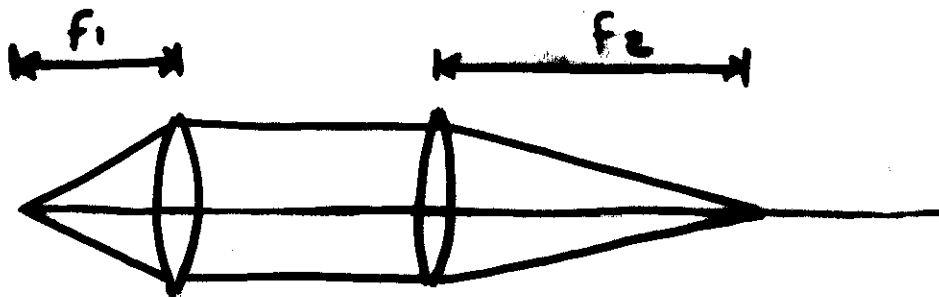
• COMMA depends on the shape of the lens <sup>23</sup>



Note: A well-corrected lens for the case in which one conjugate is at  $s_o = \infty$ , may not work well when the object is at a finite position.

SOLUTION:

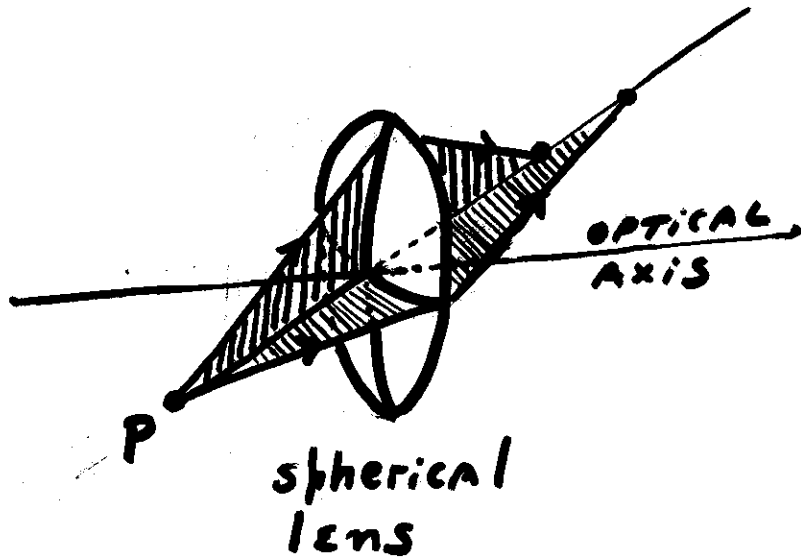
Use two infinite conjugate lenses



Two infinite conjugate lenses yield a system that operates at finite conjugates.

### 3. ASTIGMATISM

29

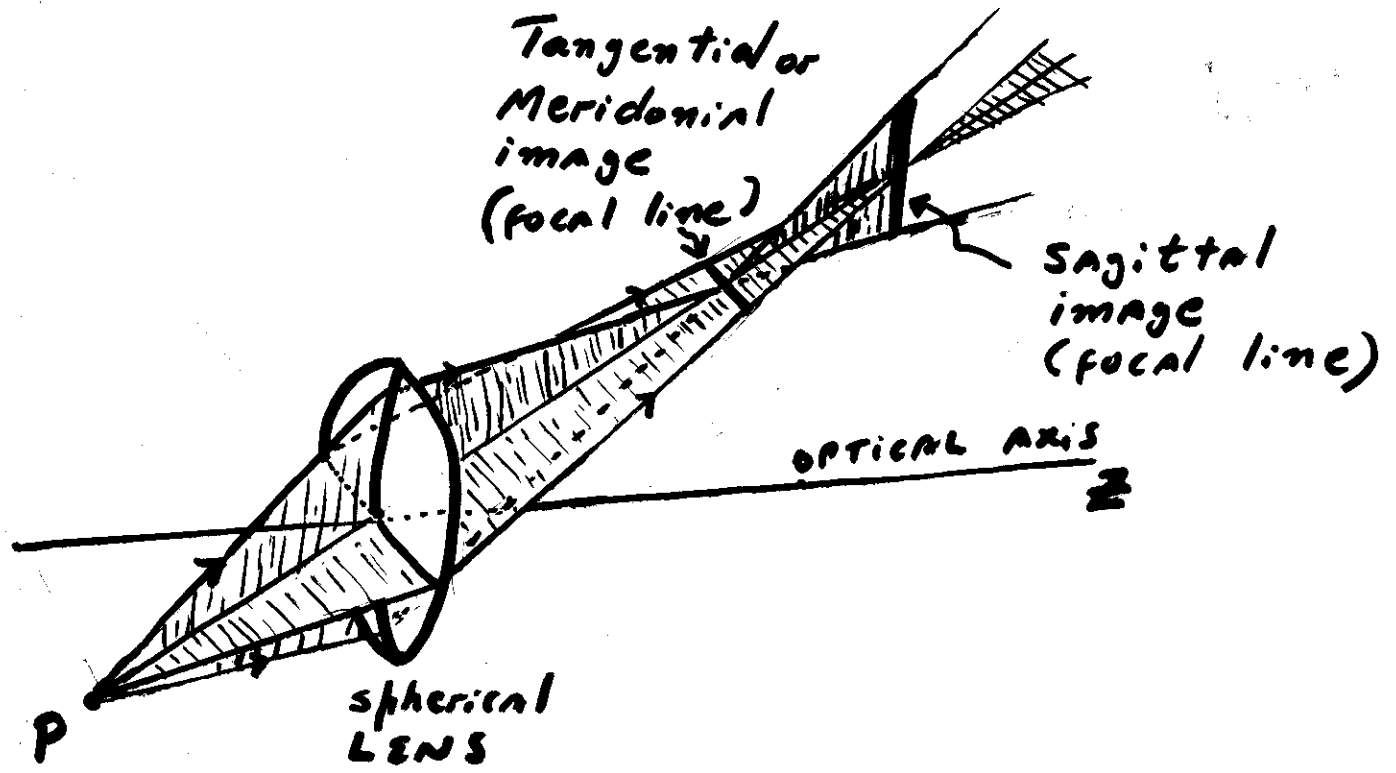


RAYs from a  
off axis object  
point P focus on  
different focal  
points.

When P is located on the optical axis, the symmetry of the spherical lens makes unnecessary the distinction between meridional and sagittal rays. (Both "see" the same thing).

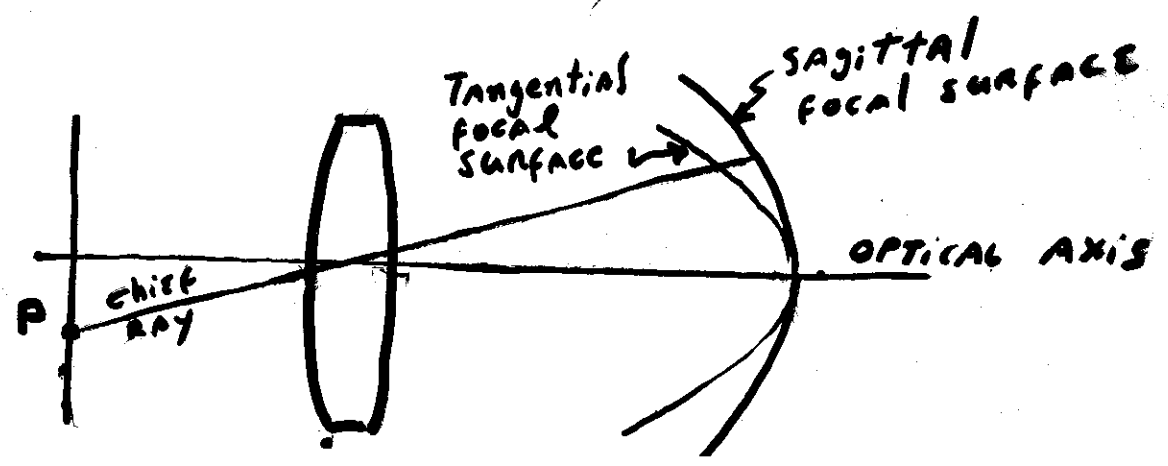
When P is located off-axis, meridional rays are tilted more than the sagittal rays, and thus have shorter focal length.

This focal difference, so called "astigmatic difference", increases rapidly as P moves farther off the optical axis.



**MEASURING ASTIGMATISM**

For different points P, located at different height from the OPTICAL AXIS, the z-coordinate of the corresponding tangential and sagittal image points describes a paraboloidal surface centered on the OPTICAL AXIS



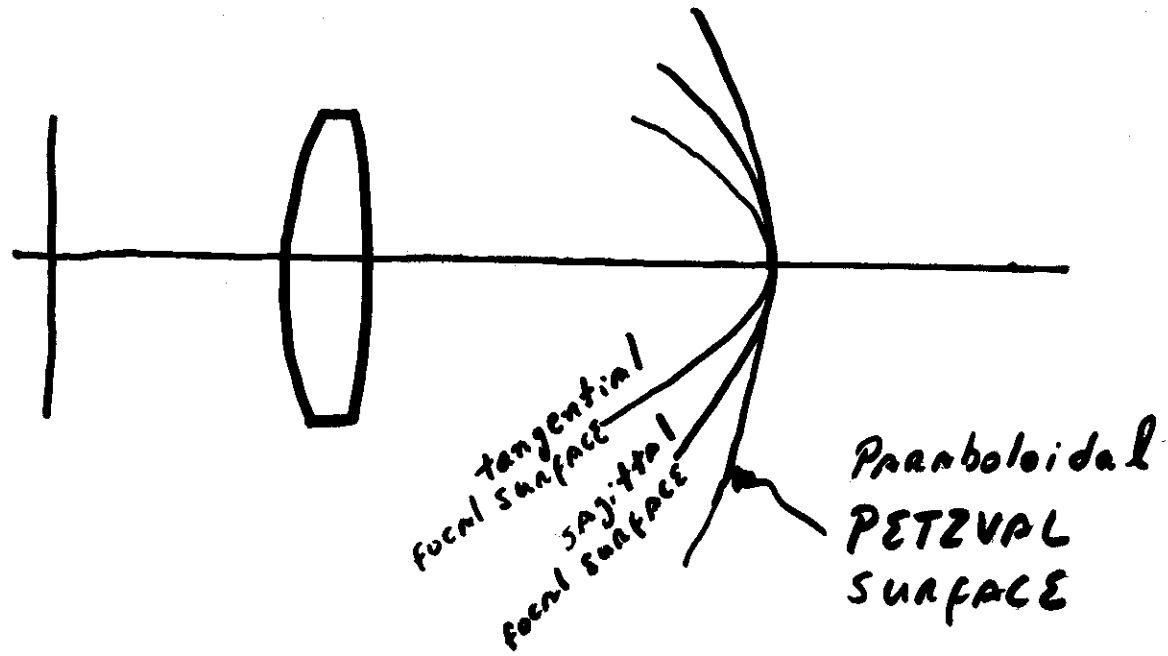
A measurement of astigmatism is the distance between the tangential and sagittal image points for a particular chief ray.

#### 4. PETZVAL FIELD CURVATURE

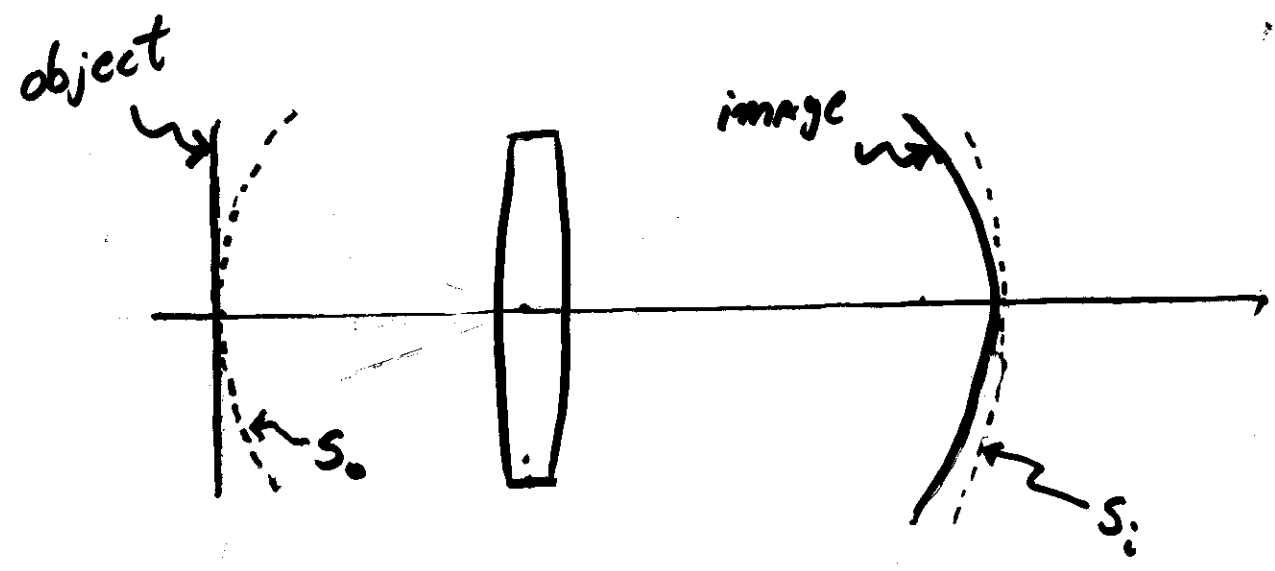
APLANAT is a lens corrected for spherical aberration and coma

ANASTIGMAT is an aplanat lens corrected also for astigmatism.

In an anastigmat the tangential and sagittal surfaces collapse to a single image surface called the PETZVAL SURFACE



The Petzval field curvature aberration refers to the imaging of a flat surface onto a paraboloidal surface



### 5. DISTORTION

Unique aberration that does not affect the quality of the image in terms of sharpness or focus.

Rather, distortion affects the shape of the image

