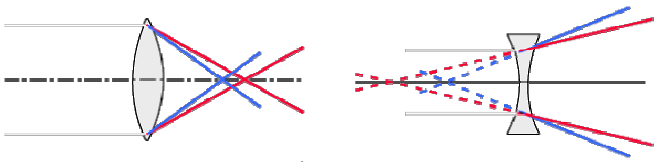
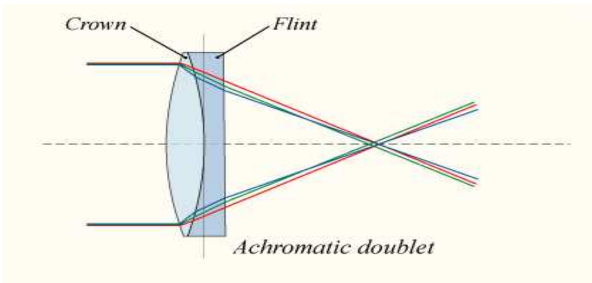
Aberrations Latin *aberrare* "go astray"

Chromatic Aberration

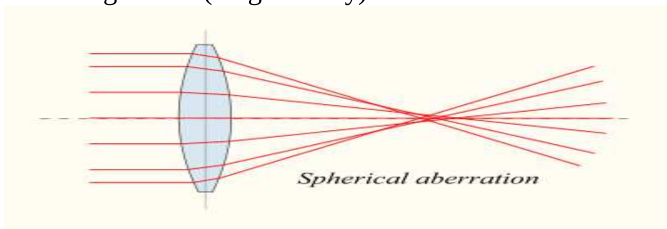


Problem: $n = n(\lambda)$.
Correction:
Use a reflecting system.
Use a lens pair with the strongest lens (smallest f) of low dispersion coupled with a weaker one of high dispersion calculated to match the focal lengths for two chosen wavelengths. Cemented doublets (achromats) of this type are a mainstay of lens design.



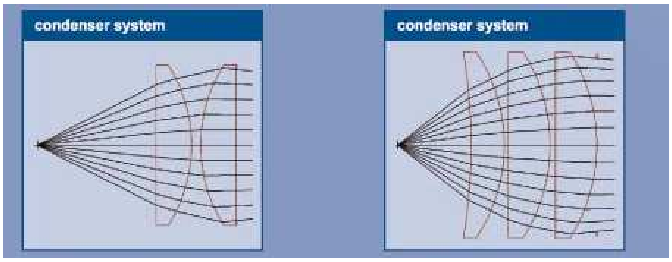
Spherical Aberration

Problem: For light rays parallel to the optical axis, at large distances (h) from the axis, small angle approximation breaks down. So there is not a single focal length.
focal length f = f(height of ray)

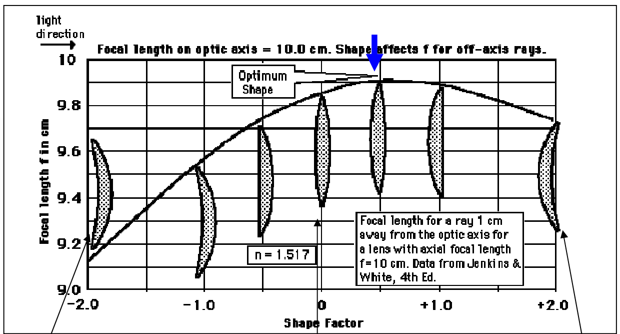


Correction: Restrict h with **aperture stop,** but get much less light.

Correction: **Multiple lenses/mirrors** allow cancelations when chosen carefully.

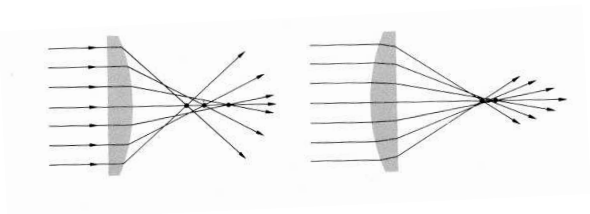


S. A. Correction: Single lens: change shape among those below. Light is from left. For object at infinity, SA is least when $R_2 = -3R_1$.



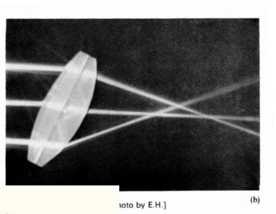
$R_2 = \frac{1}{3}R_1$ $R_2 = -R_1$ $R_2 = 3R_1$

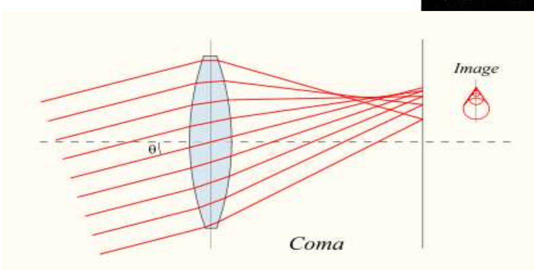
Example: To best focus a laser beam, or want to form a collimated beam from a focus, and use a plano-convex lens, turn the flat side toward the ______________ wavefronts



Coma (comet shaped)

Problem: For light rays **not parallel** to the optical axis, rings of different h get focused at different y's.
$M = M(h, \theta, \phi)$.





"Worst aberration" …very asymmetric

Correction: Aperture or "aperture stop" to restrict h

Correction: Single lens: Optimize shape of lens to compromise between minimizing spherical aberr. and coma. Coma can be made exactly zero for one object distance. Multiple lenses: try to cancel with positive and negative coma lenses