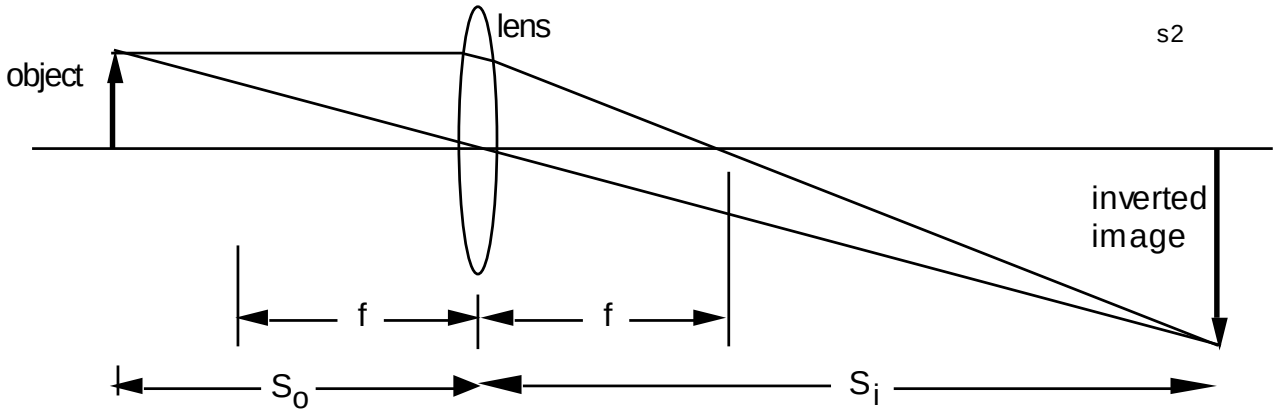
Nanometer Scale Patterning and Processing

Spring 2016

Lecture 6

Optical Lithography - Optical Imaging System

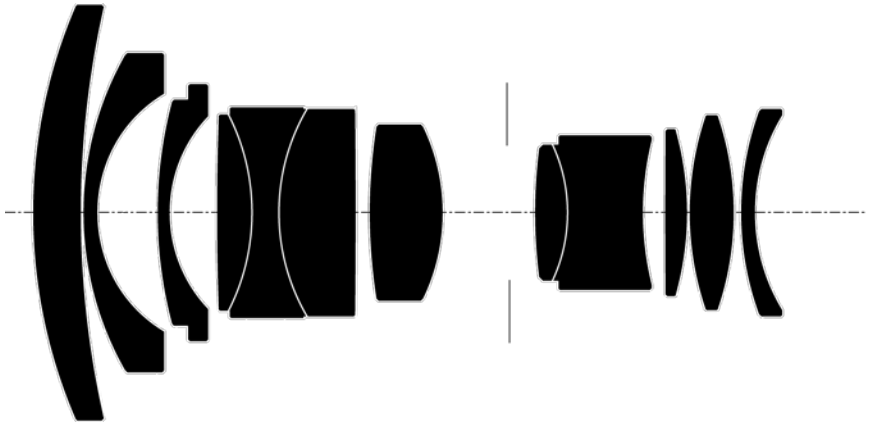
The “Thin” Lens



Lens Equation: $1/S_o + 1/S_i = 1/f$

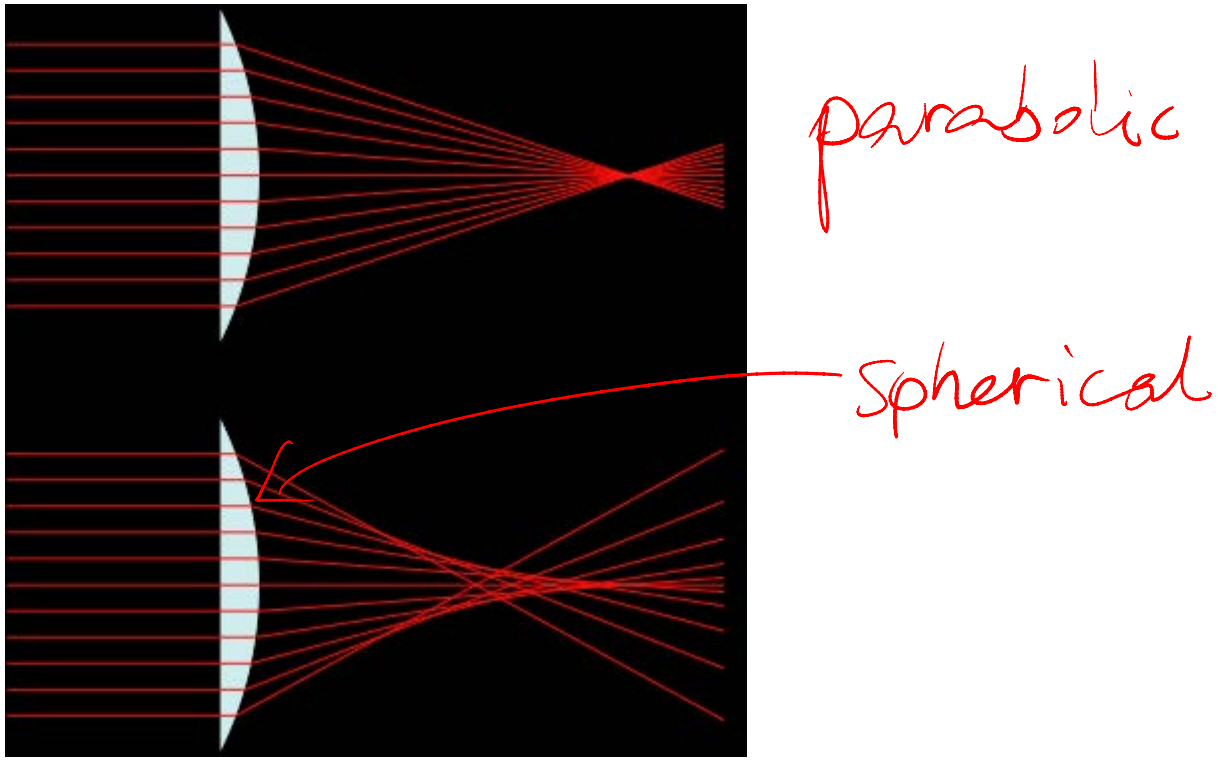
Magnification: $M = -S_i / S_o$

A practical lens for cameras



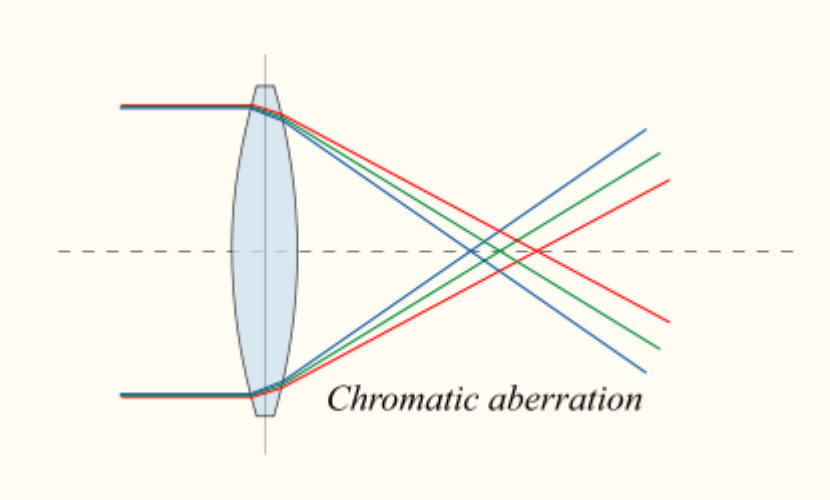
- Aberration and distortions,
- aperture and numerical aperture,
- Resolution and magnification
- Depth of focus

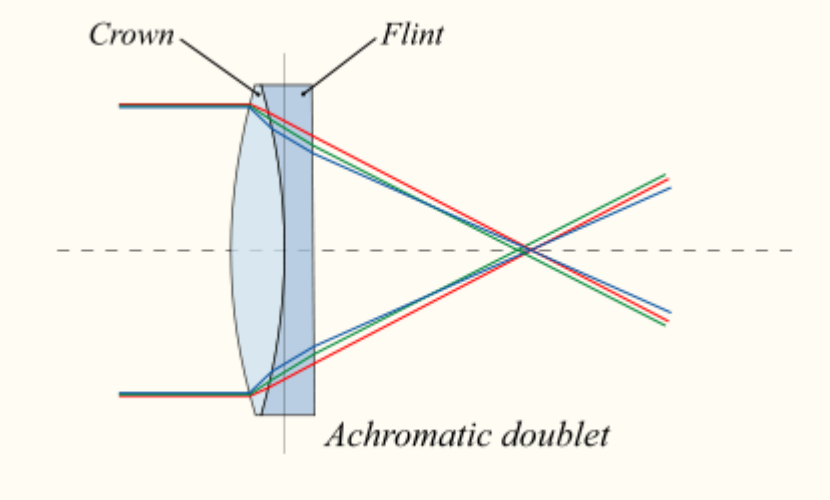
Spherical Aberration



- Focus difference due to spherical shape of the lens
- Can be minimized by combining convex and concave lenses

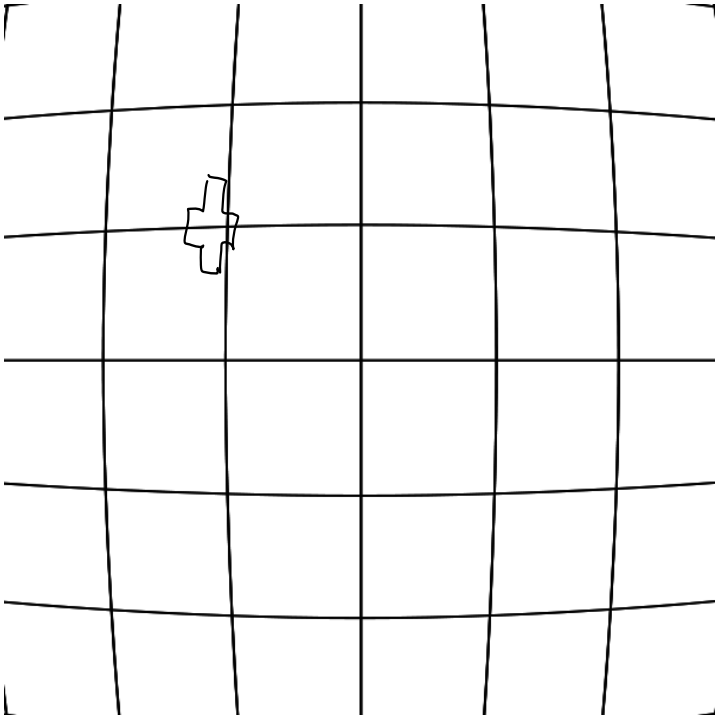
Chromatic Aberration



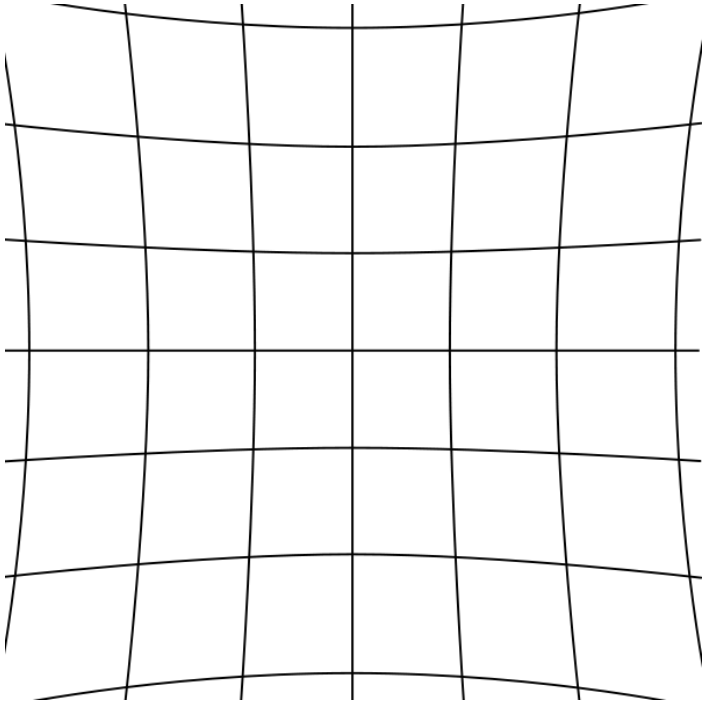


- Caused by index variation at different wavelengths
- Can be corrected by combining concave and convex lenses

Lens Distortion



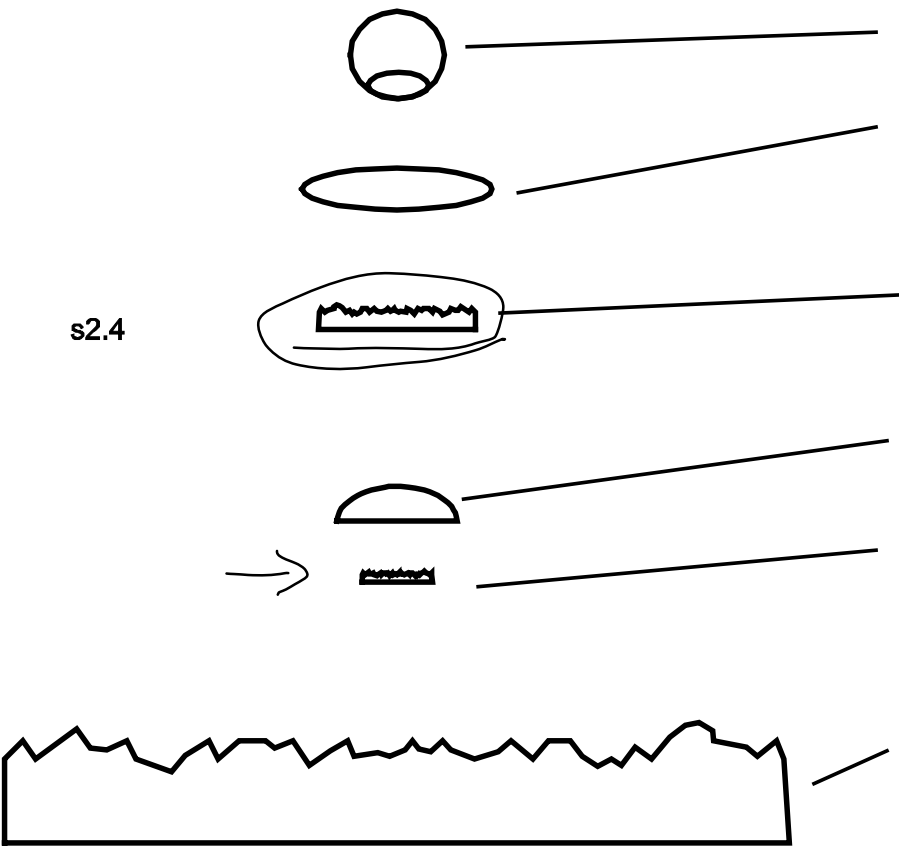
Barrel distortion



Pincushion Distortion

- Shift, rotation, scale and trapezoidal

Microscope



s2.4

A real image is formed on the retina of the eye.

Eyepiece. This forms a virtual image of the first image and magnifies, usually by 10X.

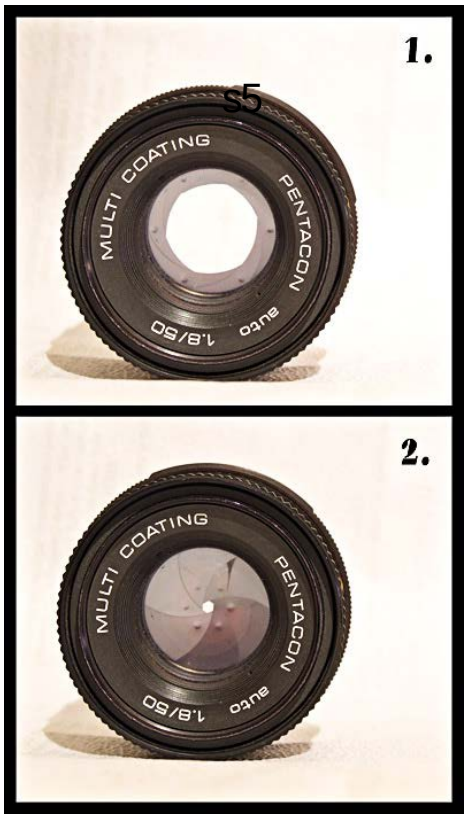
First image (a real image) formed by the objective lens. Magnification between 3 and 160.

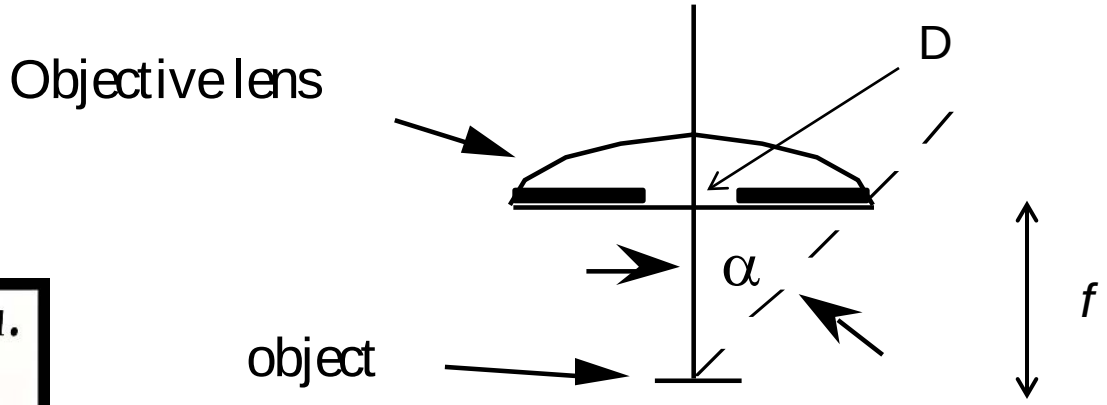
Objective lens, usually multielement

Object, located just outside the front focal plane of the objective lens. Therefore, M>1.

Virtual image formed by the eyepiece appears to the eye as if the object is about 25 cm away. In some systems the virtual image is located at infinity.

Aperture





- A opening through which light is admitted
- *f* stop number N:

$$N = \frac{f}{D}$$ where D is the diameter of the pupil

f is the focal length

$$\text{Aperture area} = \pi\left(\frac{f}{2N}\right)^2$$

- Small aperture increases depth of focus and reduces spherical aberration.

Magnification and Resolution

Digital zoom: gives no resolution enhancement