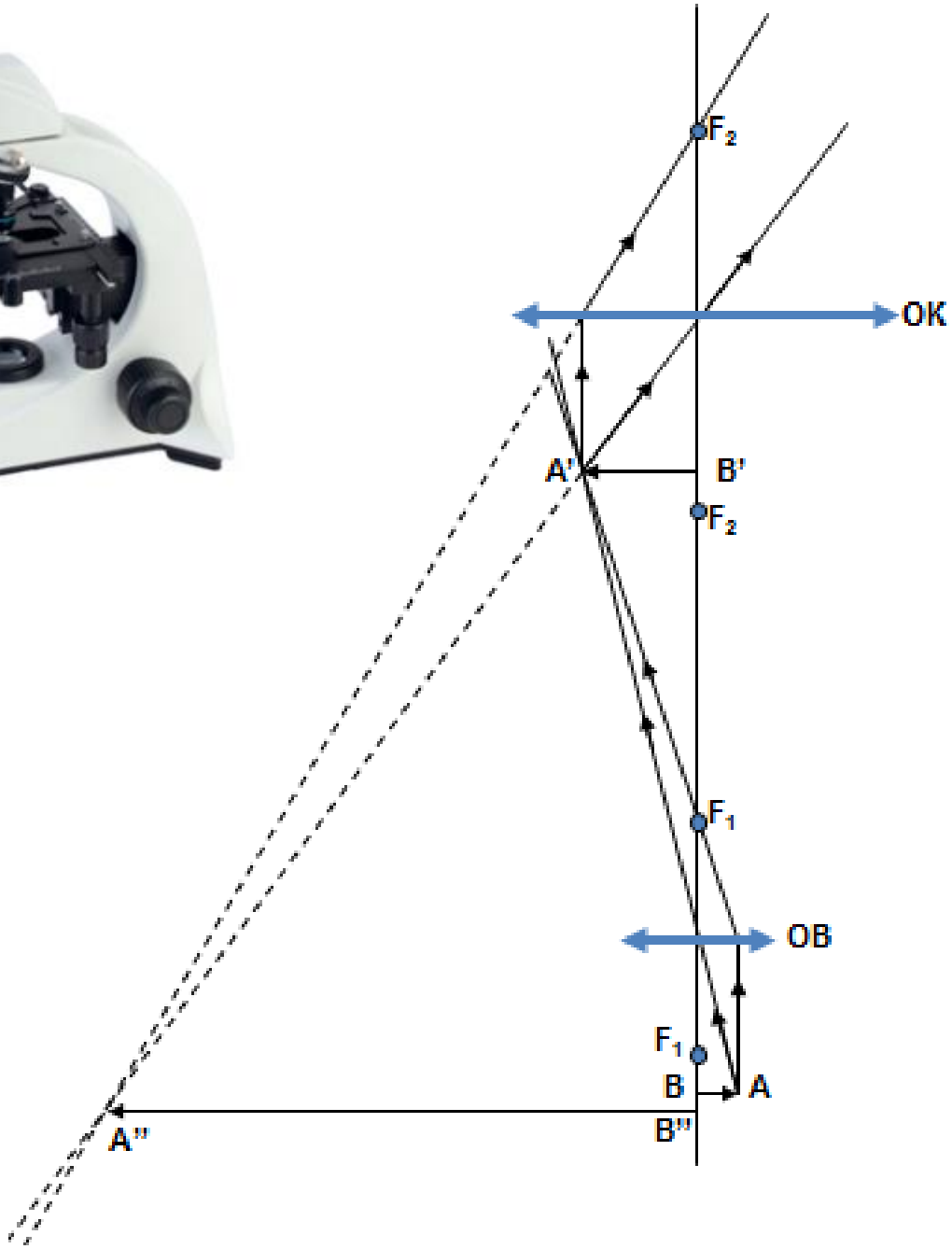

F2
OK
A'
B'
F2
F1
OB
F1
B
A
A''
B''

A lens is a transparent piece of glass or plastic with at least one curved surface. It gets its name from the Latin word for "lentil" There's no real reason for this other than that the most common kind of lens (called a convex lens) looks very much like a lentil!

How do lenses work?
A lens bends light rays as they pass through it so they change direction.

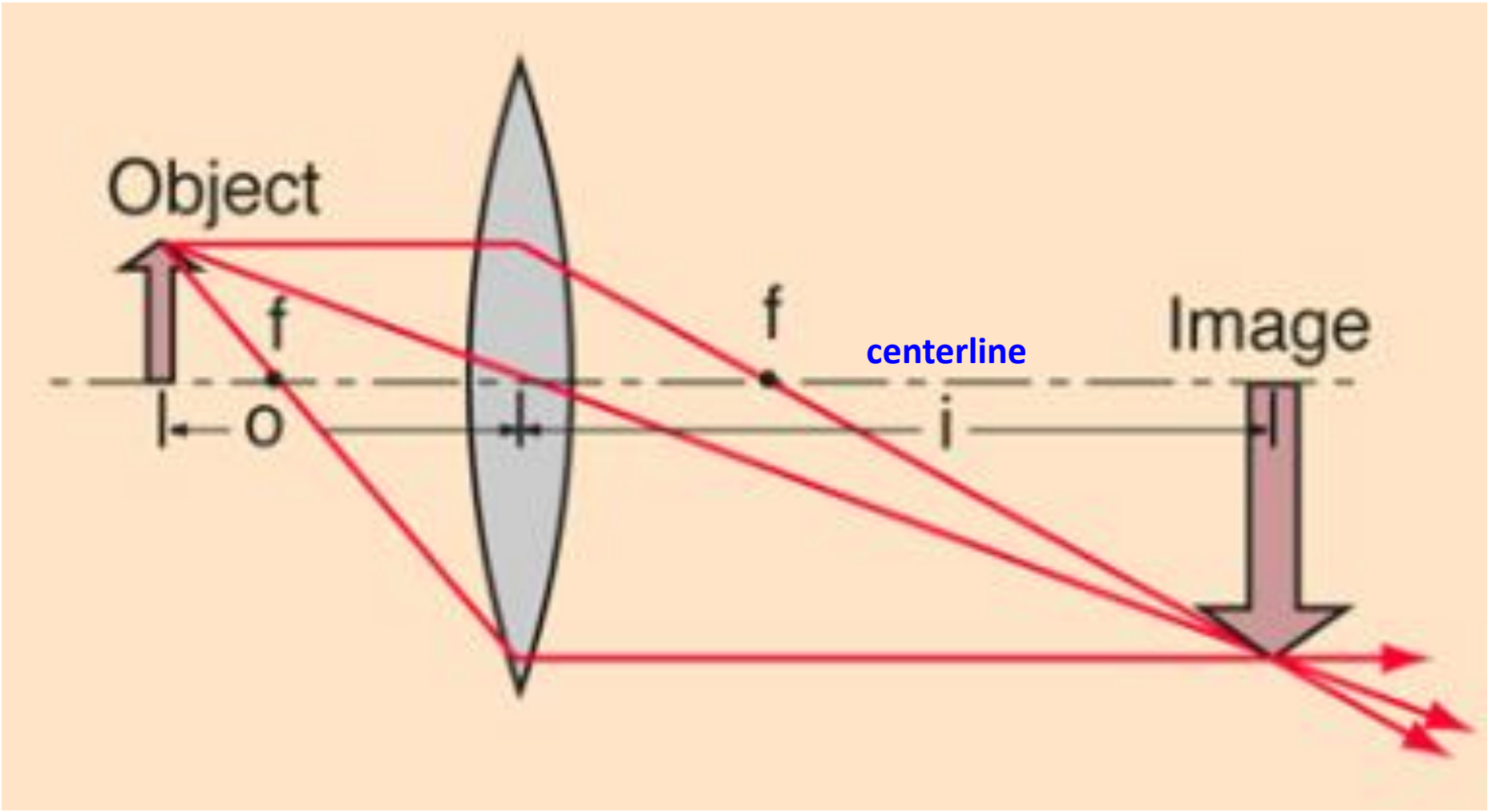
Types of lenses
There are two main types of lenses, known as convex (or converging) and concave (or diverging).

The distance from the center of the lens to the focal point is the focal length of the lens. The focal point is on the opposite side of the lens to that from which the light rays originate. Convex lenses are used in things like telescopes and binoculars to bring distant light rays to a focus in your eyes.

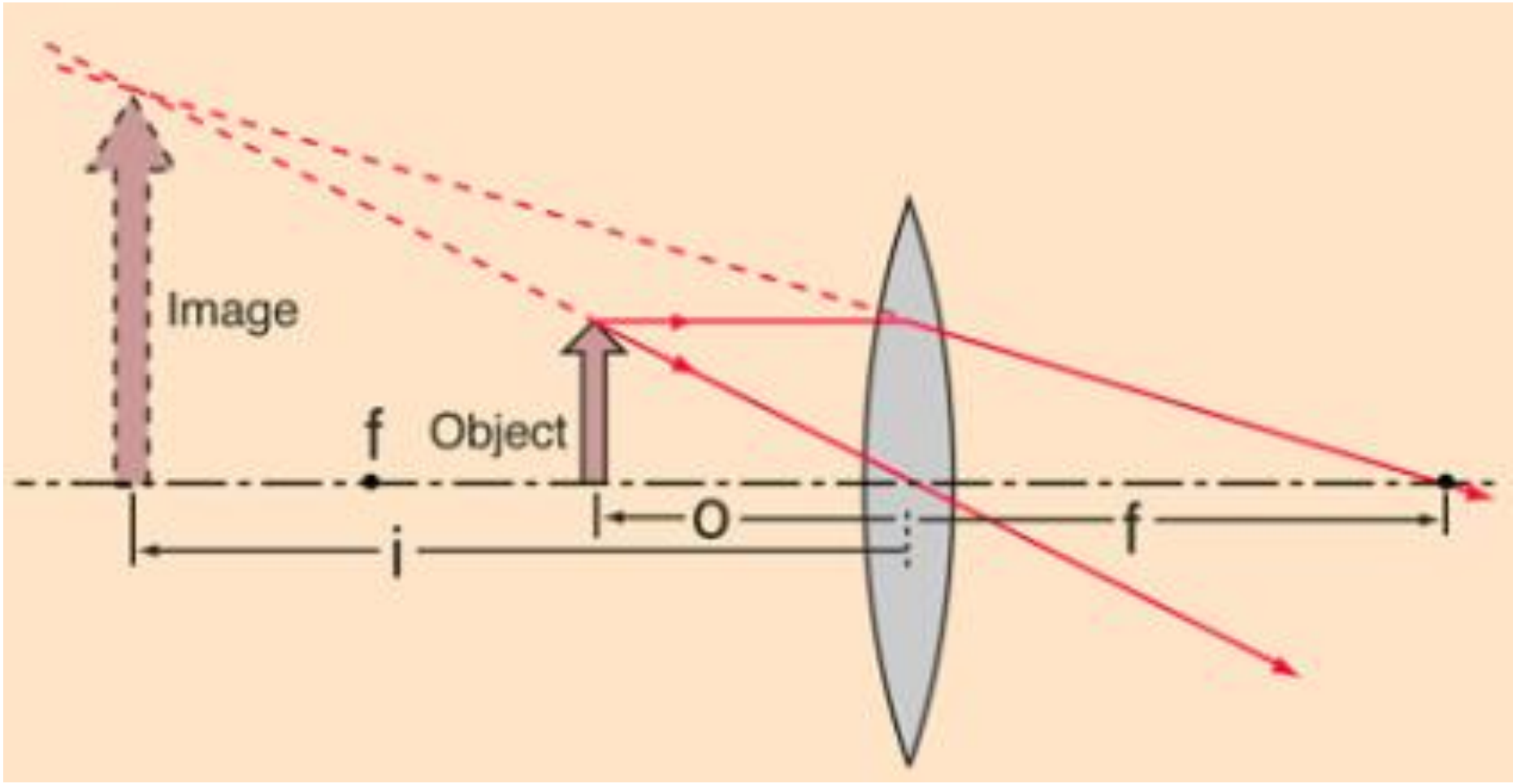
The "three principal rays" which are used for visualizing the image location and size are:

- **A ray from the top of the object proceeding parallel to the centerline perpendicular to the lens. Beyond the lens, it will pass through the focal point..**
- **A ray through the center of the lens, which will be undeflected. (Actually, it will be jogged downward on the near side of the lens and back up on the exit side of the lens, but the resulting slight offset is neglected for thin lenses.)**
- **A ray through the focal point on the near side of the lens. It will proceed parallel to the centerline upon exit from the lens. The third ray is not really needed, since the first two locate the image.**

Convex lens

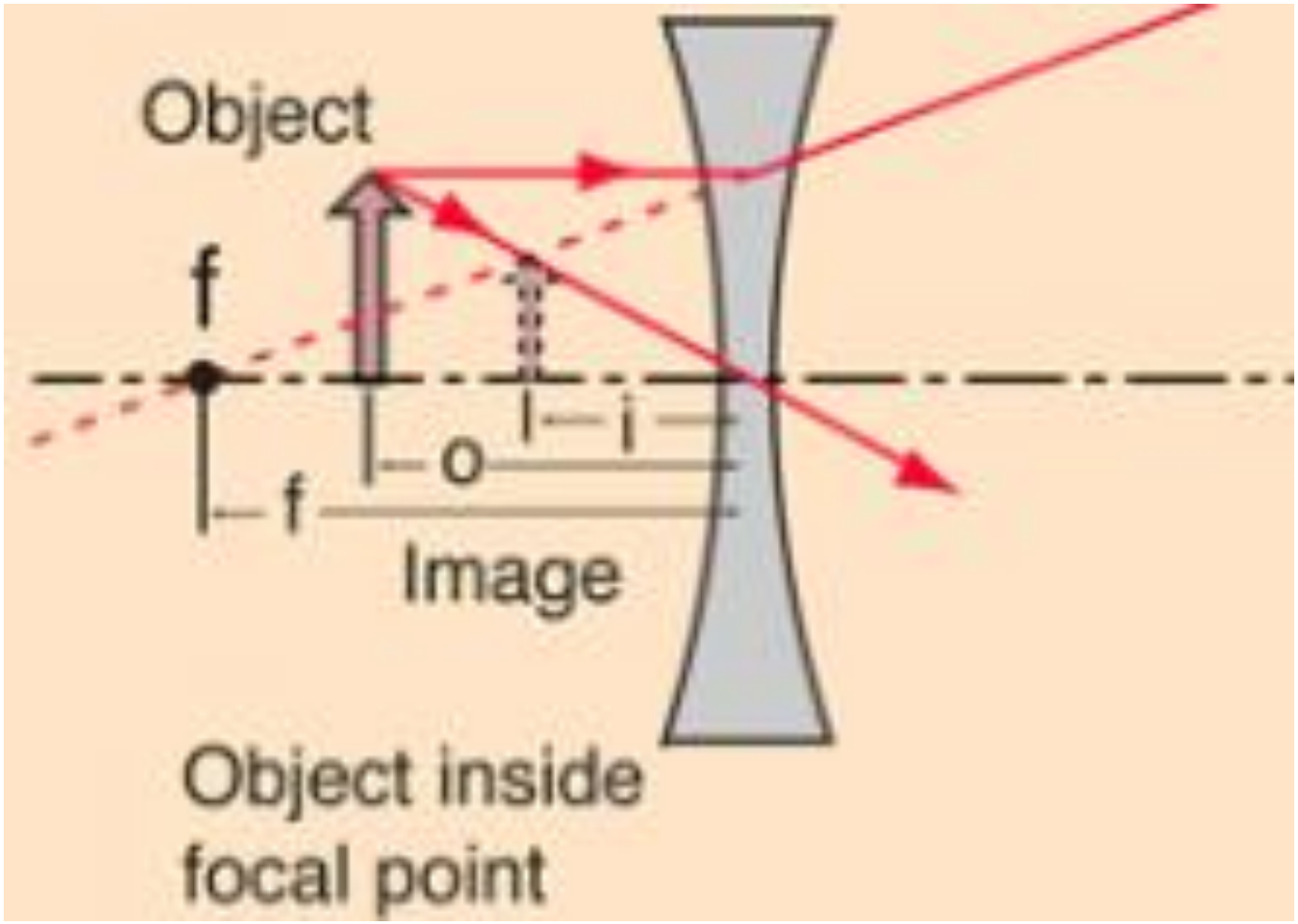


For an object outside the focal point, a real inverted image will be formed.

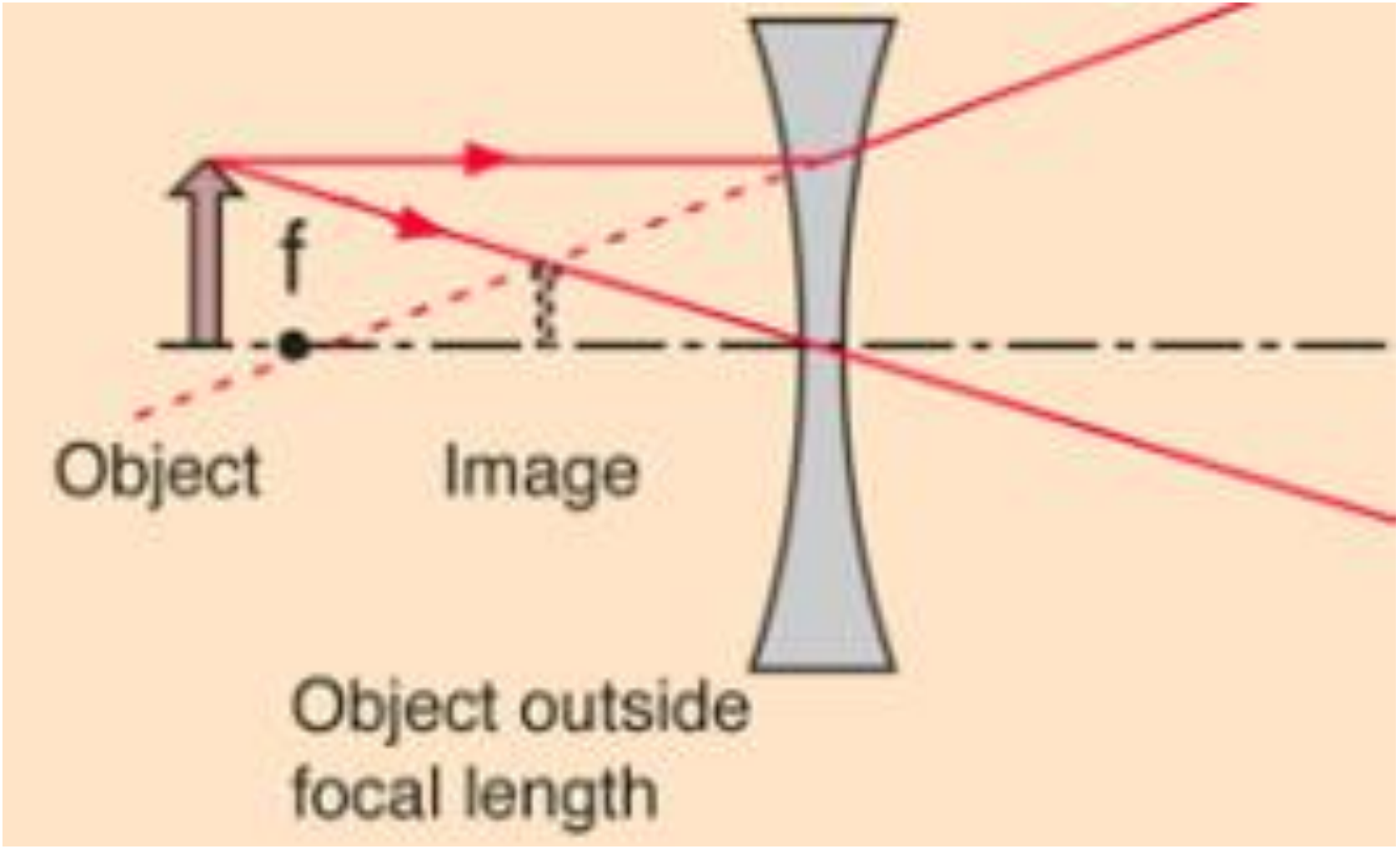


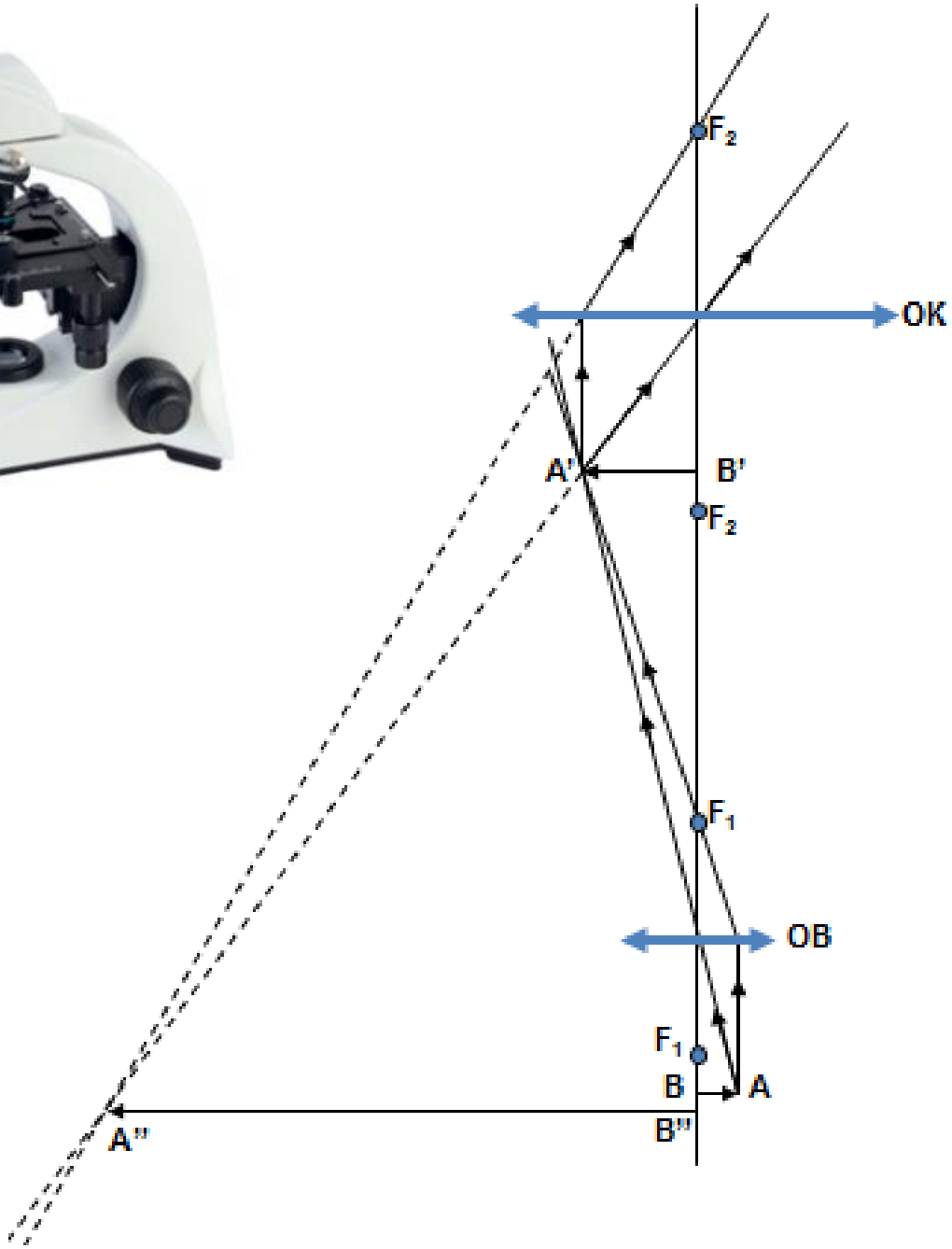
For an object inside the focal point, a virtual enlarged image will be formed.

Concave lens

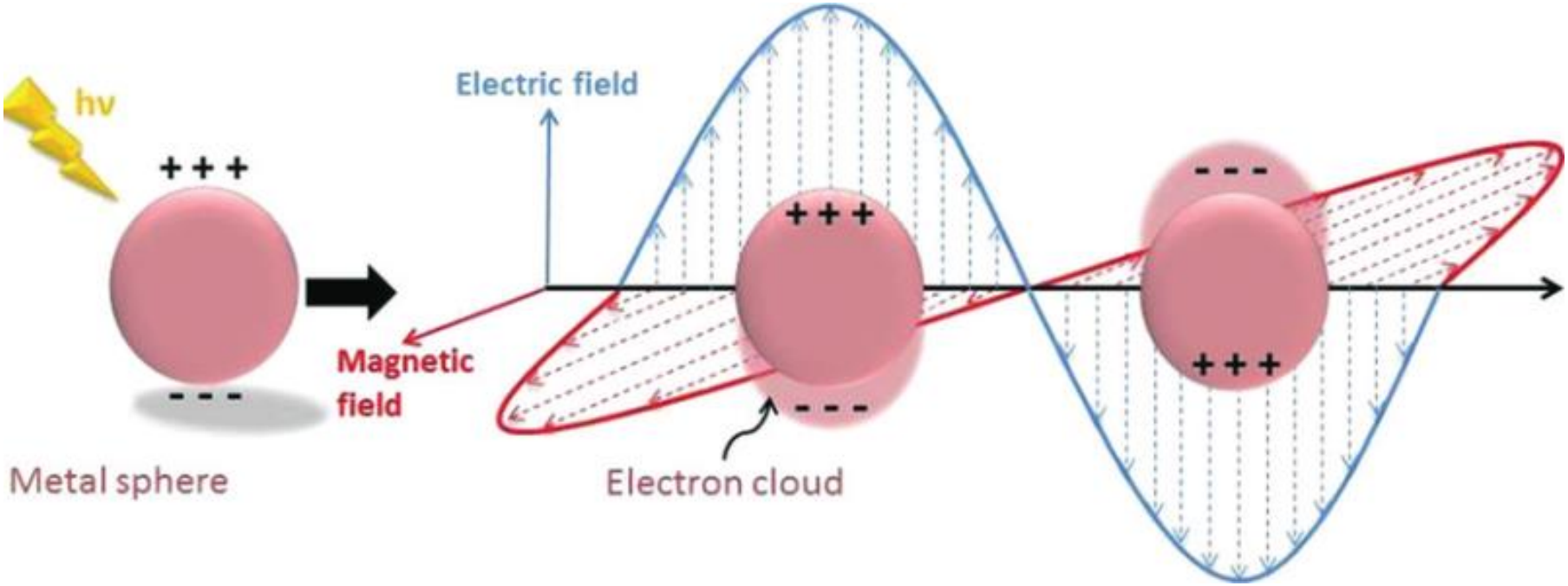


For an object outside the focal point, smaller and closer image will be formed.

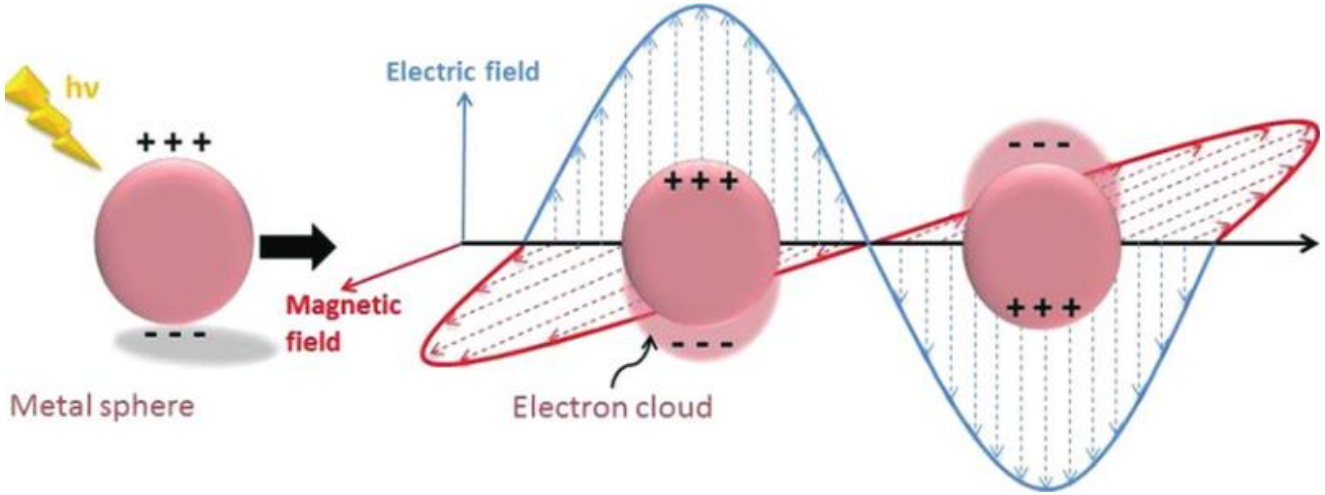

f
Object
Image
Object outside
focal length


F2
OK
A'
B'
F2
F1
OB
F1
B
A
A''
B''

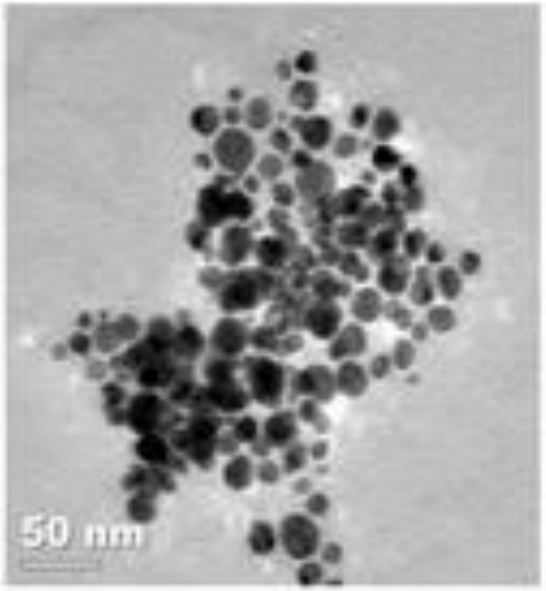
LSP

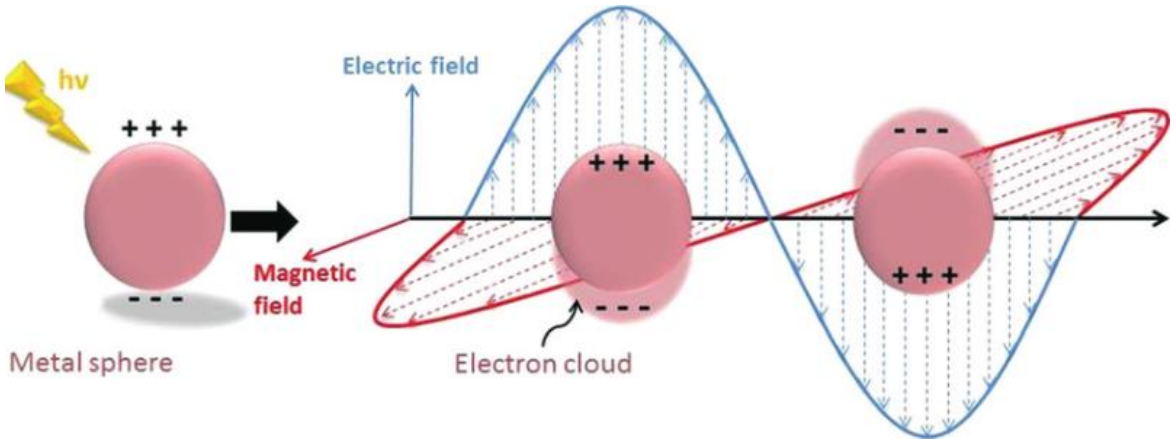

hv
+ + +
- - -
Metal sphere
Magnetic field
Electric field
+ + +
- - -
Electron cloud
- - -
+ + +

Plasmons can be described in the classical picture as an oscillation of electron density with respect to the fixed positive ions in a metal. To visualize a plasma oscillation, imagine a cube of metal placed in an external electric field pointing to the right. Electrons will move to the left side (uncovering positive ions on the right side) until they cancel the field inside the metal. If the electric field is removed, the electrons move to the right, repelled by each other and attracted to the positive ions left bare on the right side. They oscillate back and forth at the plasma frequency until the energy is lost in some kind of resistance or damping. Plasmons are a quantization of this kind of oscillation.



Plasmons play a large role in the optical properties of metals and semiconductors. Light of frequencies below the plasma frequency is reflected by a material because the electrons in the material screen the electric field of the light. Light of frequencies above the plasma frequency is transmitted by a material because the electrons in the material cannot respond fast enough to screen it. In most metals, the plasma frequency is in the ultraviolet, making them shiny (reflective) in the visible range





Surface plasmons (**SPs**) are coherent delocalized electron oscillations that exist at the interface between any two materials where the real part of the dielectric function changes sign across the interface (e.g. a metal-dielectric interface, such as a metal sheet in air).