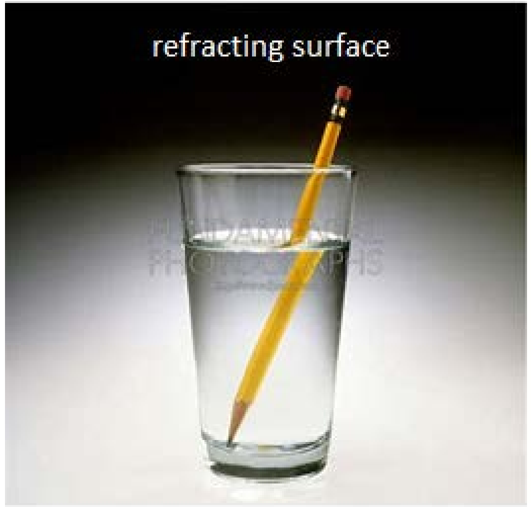
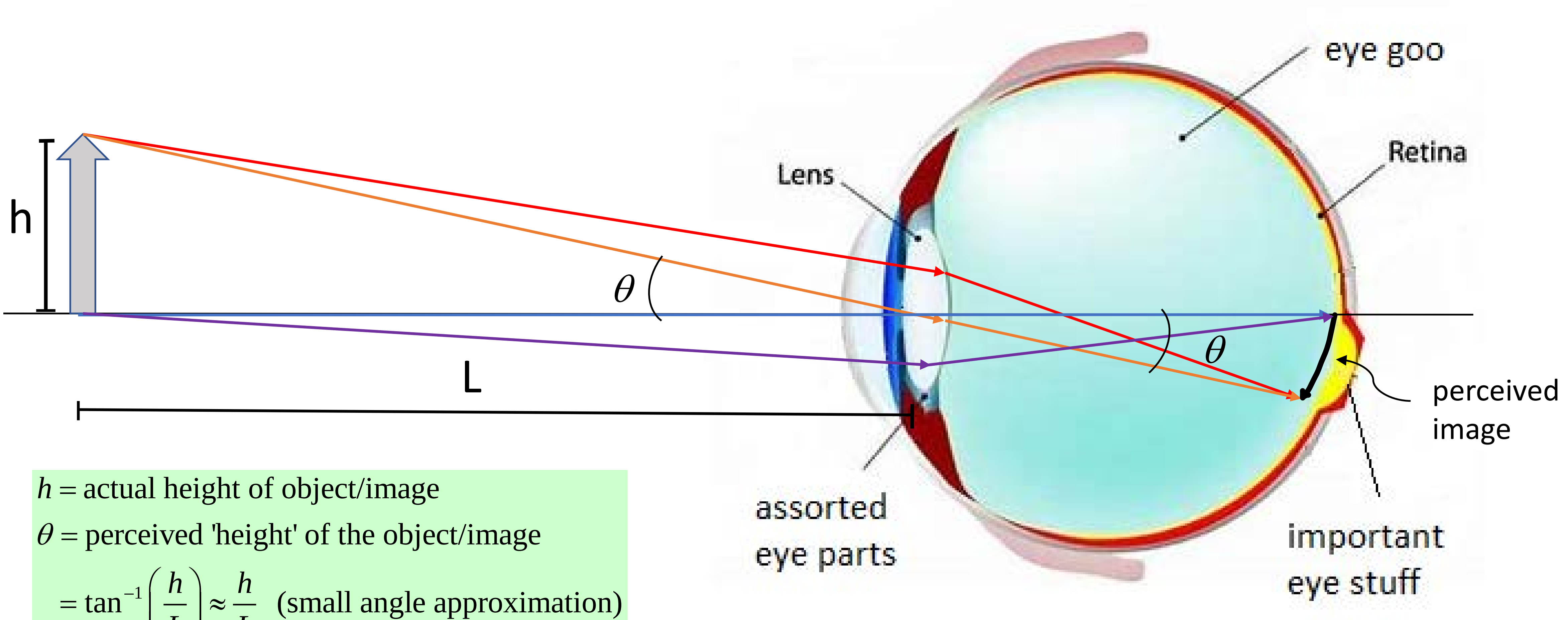
# E. Images

Having investigated how waves interact with matter, we are in position to consider, in particular, how light waves do so, with the aim ultimately of ascertaining how images are perceived by the eye, and how they can be manipulated by optical instruments like mirrors, refracting surfaces, and lenses.


# E. Images

First, we want to consider how the eye, in adequate detail for us, perceives images, whether they be of the object itself, or some image manufactured image of it.




$h$ = actual height of object/image

$\theta$ = perceived 'height' of the object/image

$$= \tan^{-1}\left(\frac{h}{L}\right) \approx \frac{h}{L} \quad \text{(small angle approximation)}$$

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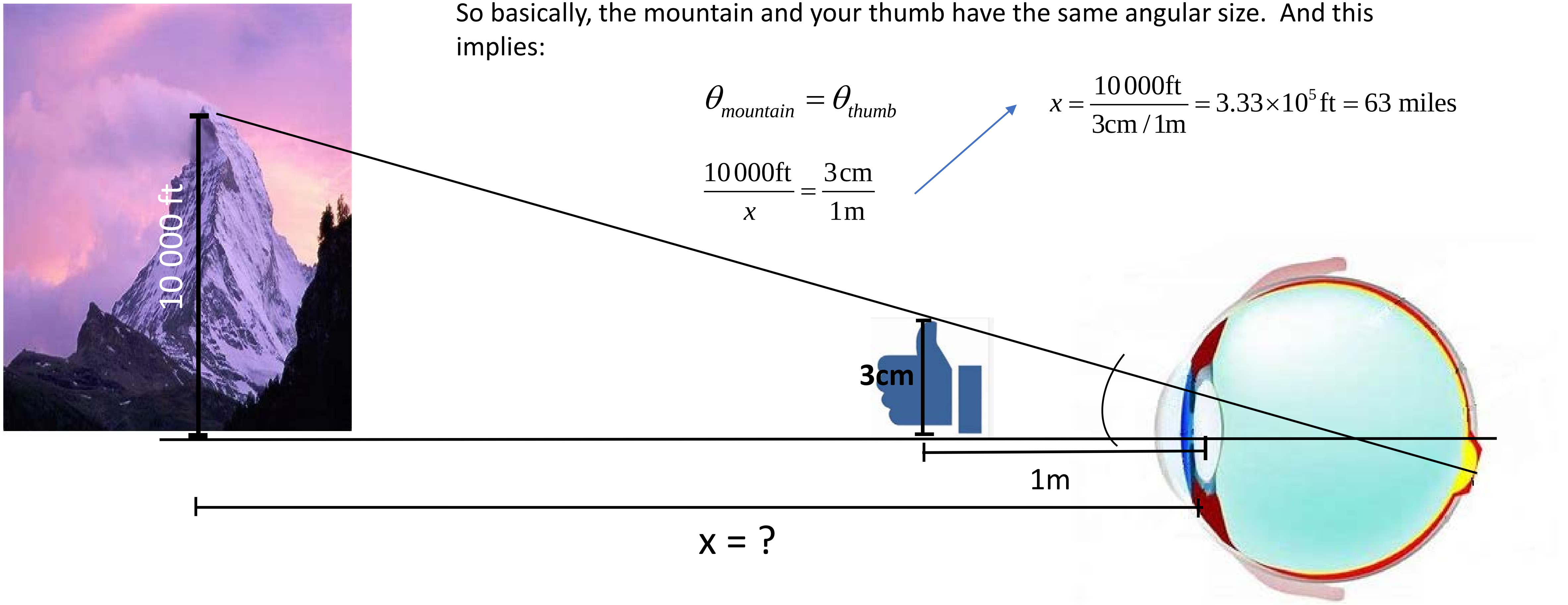
Say your thumb is about 3cm long.  Holding it up 1m away from your eye, you can completely obscure a 10 000ft mountain off in the distance.  How far away is the mountain?

So basically, the mountain and your thumb have the same angular size.  And this implies:

$$\theta_{mountain} = \theta_{thumb}$$

$$\frac{10\,000\text{ft}}{x} = \frac{3\,\text{cm}}{1\,\text{m}}$$

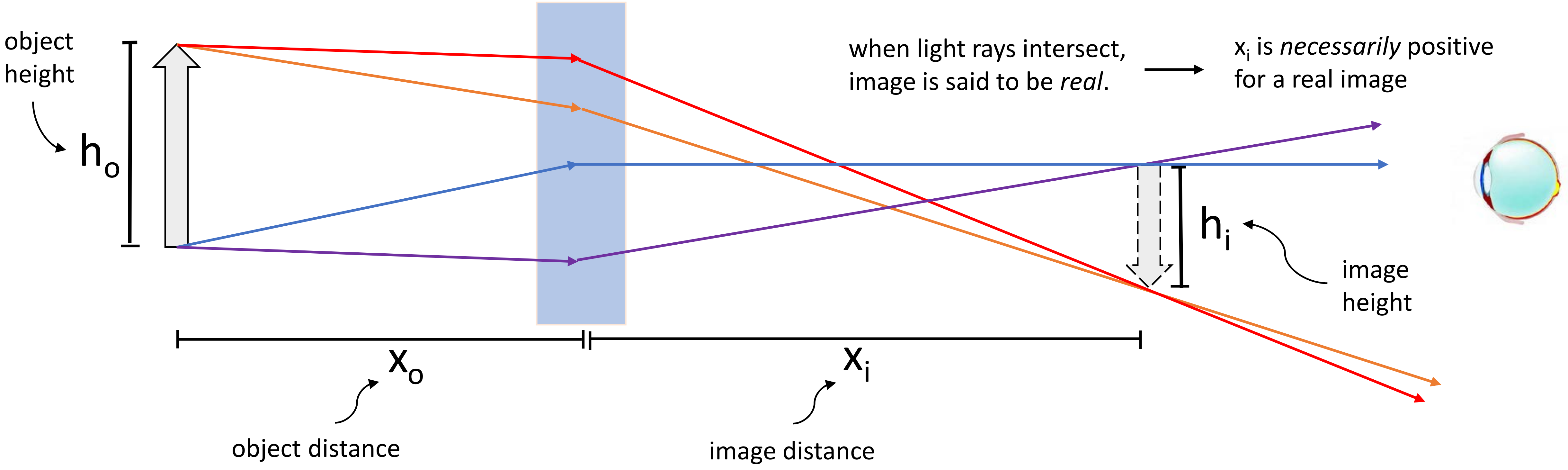
$$x = \frac{10\,000\text{ft}}{3\text{cm}/1\text{m}} = 3.33\times10^{5}\,\text{ft} = 63\text{ miles}$$



# E. Images

Now we're going to introduce some basic terminology pertaining the distortions optical instruments induce onto an object's image.
Since the terminology is the same regardless of the type of optical instrument, I'm going to refrain from specifying it.
So let's represent by a box the optical instrument – could be mirrors, refracting surfaces, lenses, whatever.

region where light came from: $x_o > 0$ | region where light went: $x_i > 0$



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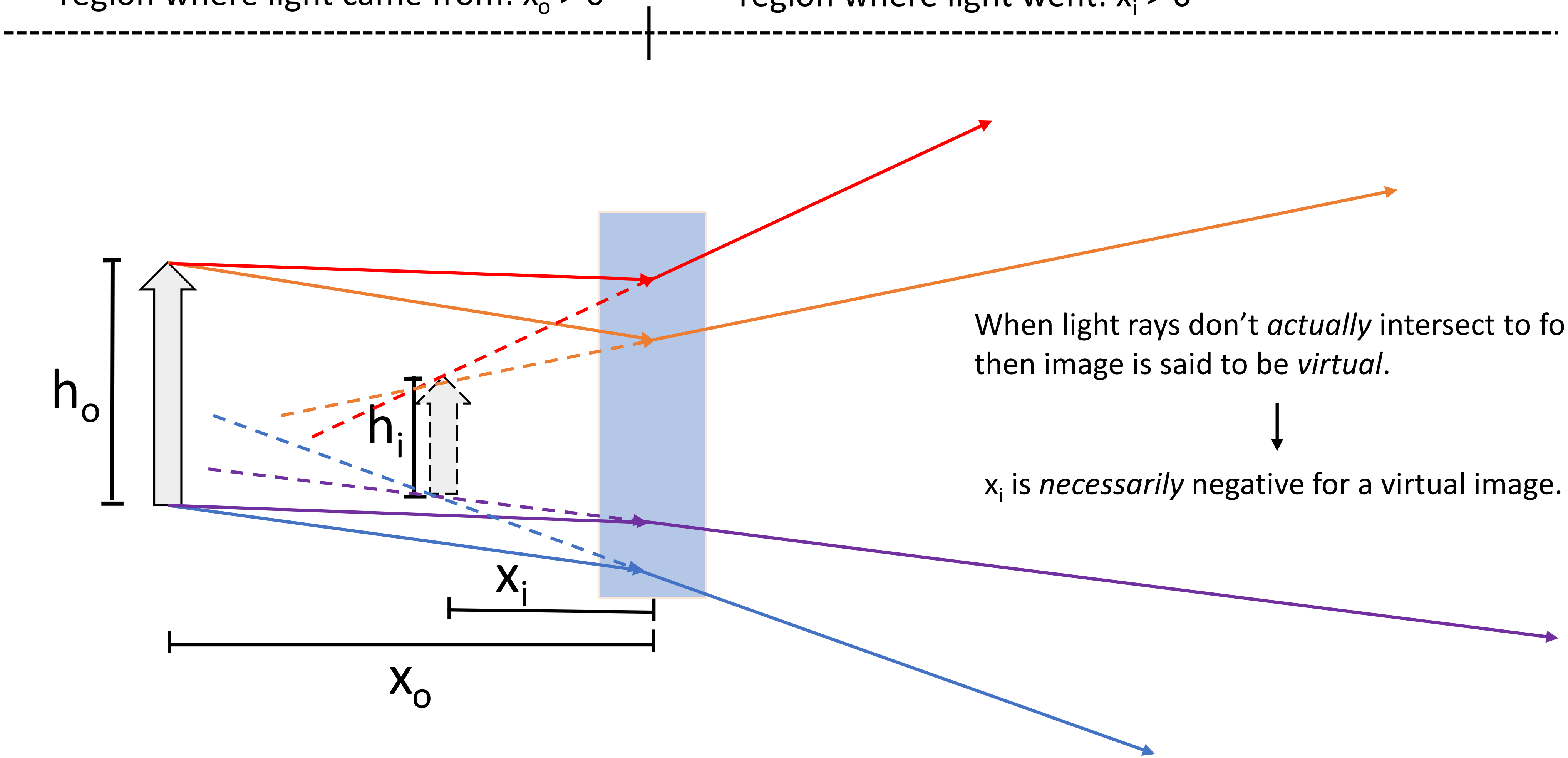
Another possibility is that the light rays don't actually converge after having passed through/off of the optical instrument. Nothing really changes vis a vis the definitions or sign conventions.

region where light came from: $x_o > 0$ | region where light went: $x_i > 0$




When light rays don't *actually* intersect to form an image, then image is said to be *virtual*.

↓

$x_i$ is *necessarily* negative for a virtual image.

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Generally, we'll be interested in four characteristics of the images created by these optical devices….

1. Nature of the image: real or virtual.
2. Location of the image, $x_i$.
3. Size of the image, $h_i$ and associated magnification: $m = h_i/h_o$.
4. Apparent size of the image, $\Theta_i$, and associated magnification $m_\Theta = \Theta_i/\Theta_o$.

And so we'll investigate mirrors next, and see if we can predict these image properties, based on knowledge of the object's and mirror's properties.