We already know that wave number can be expressed as:

$$k^2 = \frac{\omega^2}{c^2}\varepsilon(\omega)$$

We know that:

$$\sqrt{\varepsilon(\omega)} = n' = n - i\varkappa$$

in other words, we determined what is it refractive index.

Let's open k:

$$k = \frac{\omega}{c}n' = \underbrace{\frac{\omega}{c}n(\omega)}_{k'} - i\underbrace{\frac{\omega}{c}\varkappa(\omega)}_{k''} = k' - ik''$$

k appears to be complex number.

What is the physical meaning of k being complex number?

Let's assume that plane wave is propagating in the medium:

$$E = E_0 e^{i(\omega t - kz)} = E_0 e^{-k''z} e^{i(\omega t - k'z)}$$

The surface of equal phase will move with speed:

$$v = \frac{\omega}{k'} = \frac{c}{n}$$ – phase speed in the medium

Now, what about the amplitude?

Amplitude depends on z and decrease with z.

$$E_A = E_0 e^{-\frac{\omega}{c}\varkappa(\omega) z}$$

Hence, intensity decreases as light propagates:

$$I = I_0 e^{-\frac{2\omega}{c}\varkappa(\omega) z}$$

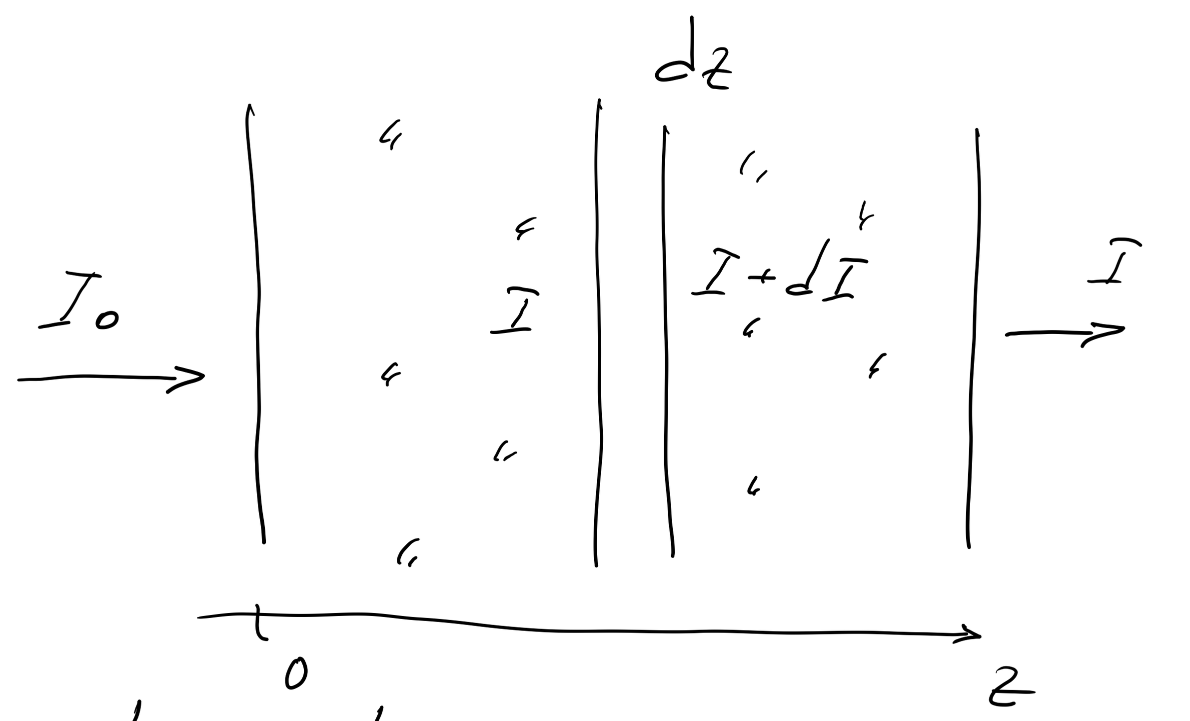
It decreases, as it depends on $\varkappa(\omega)$, i.e. decaying of oscillator.

This law was discovered by Bouguer in 1729. Later it was confirmed by Beer and Lambert. Beer 1852, Lambert 1760

Lambert noticed dependance on path length

Beer established concentration dependence

Of cours, there were no e/m theory in 1729, thus Bouguer had the following logic:



$dI < 0$

$$dI = -\alpha I dz$$

$$\int_{I_0}^{I} \frac{dI}{I} = -\int_0^z \alpha\, dz$$

$$I = I_0 e^{-\alpha z} \qquad \alpha = \frac{2\omega}{c}\varkappa(\omega)$$

In case of solutions

$$I = I_0 e^{-\alpha l c}$$ c – concentration

Bouguer – Lambert – Beer law