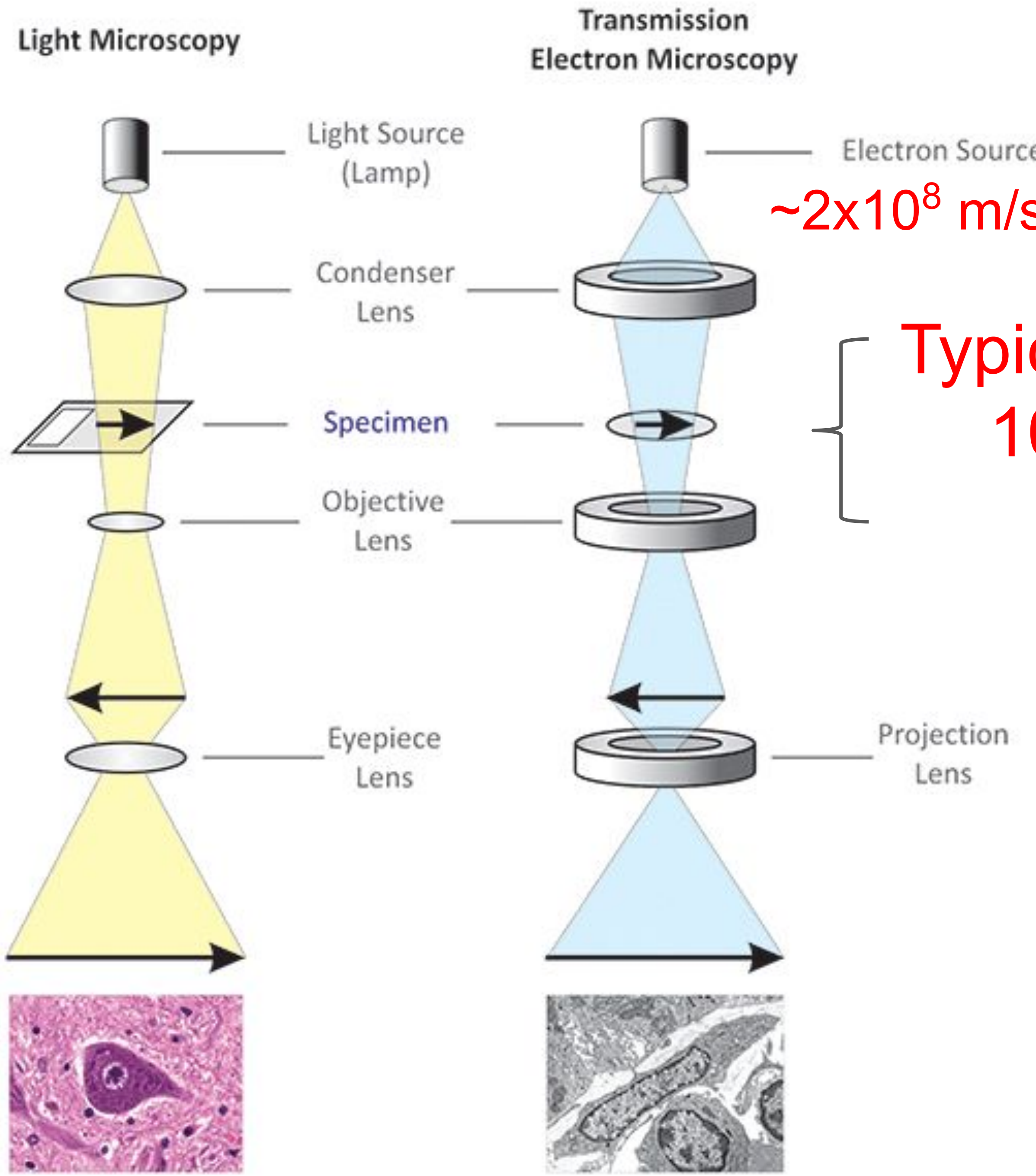
CTF

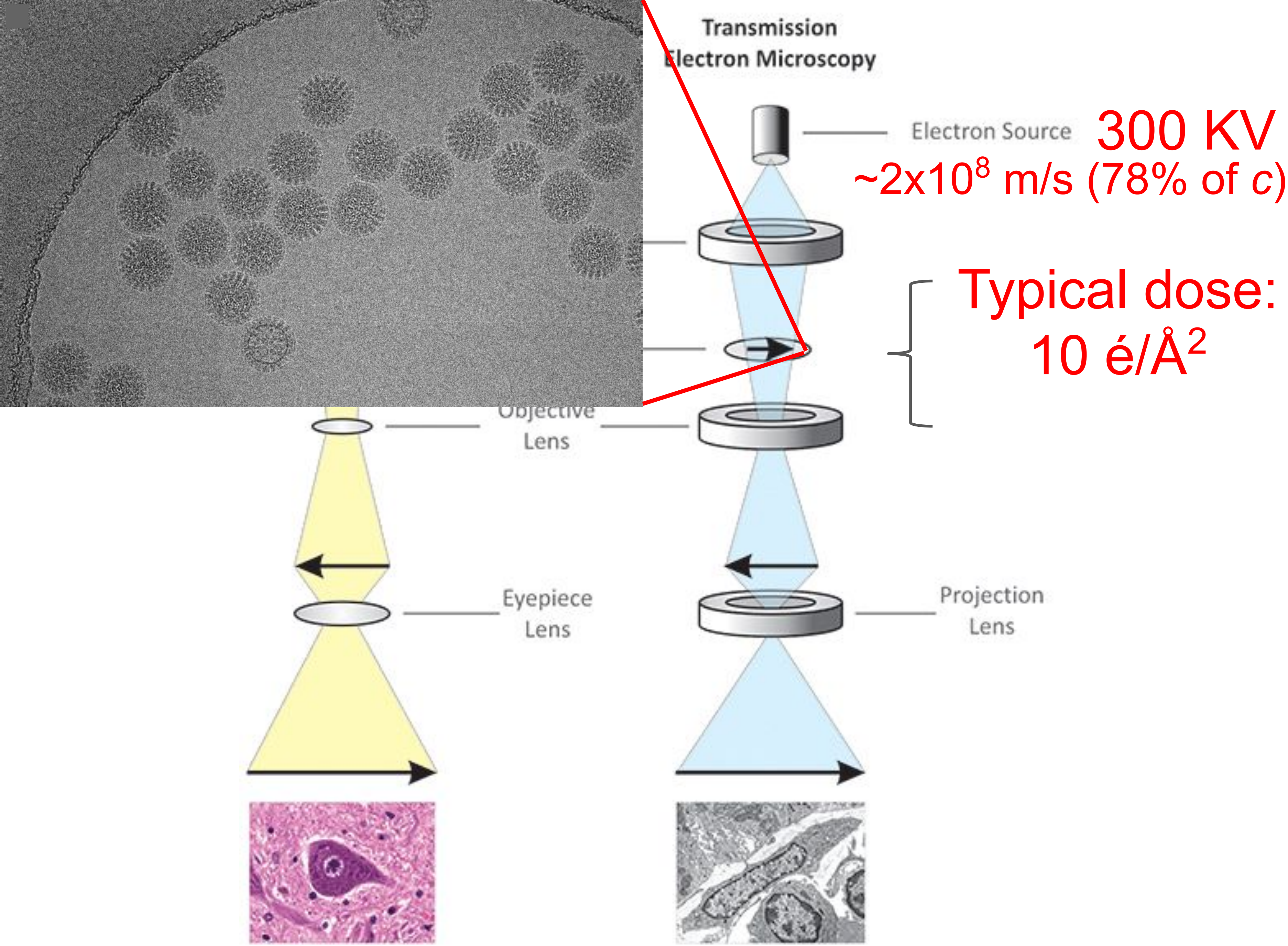


300 KV

~2×10^8 m/s (78% of *c*)

Typical dose:
10 é/Å^2

From: http://www.microbiologyinfo.com/differences-between-light-microscope-and-electron-microscope/



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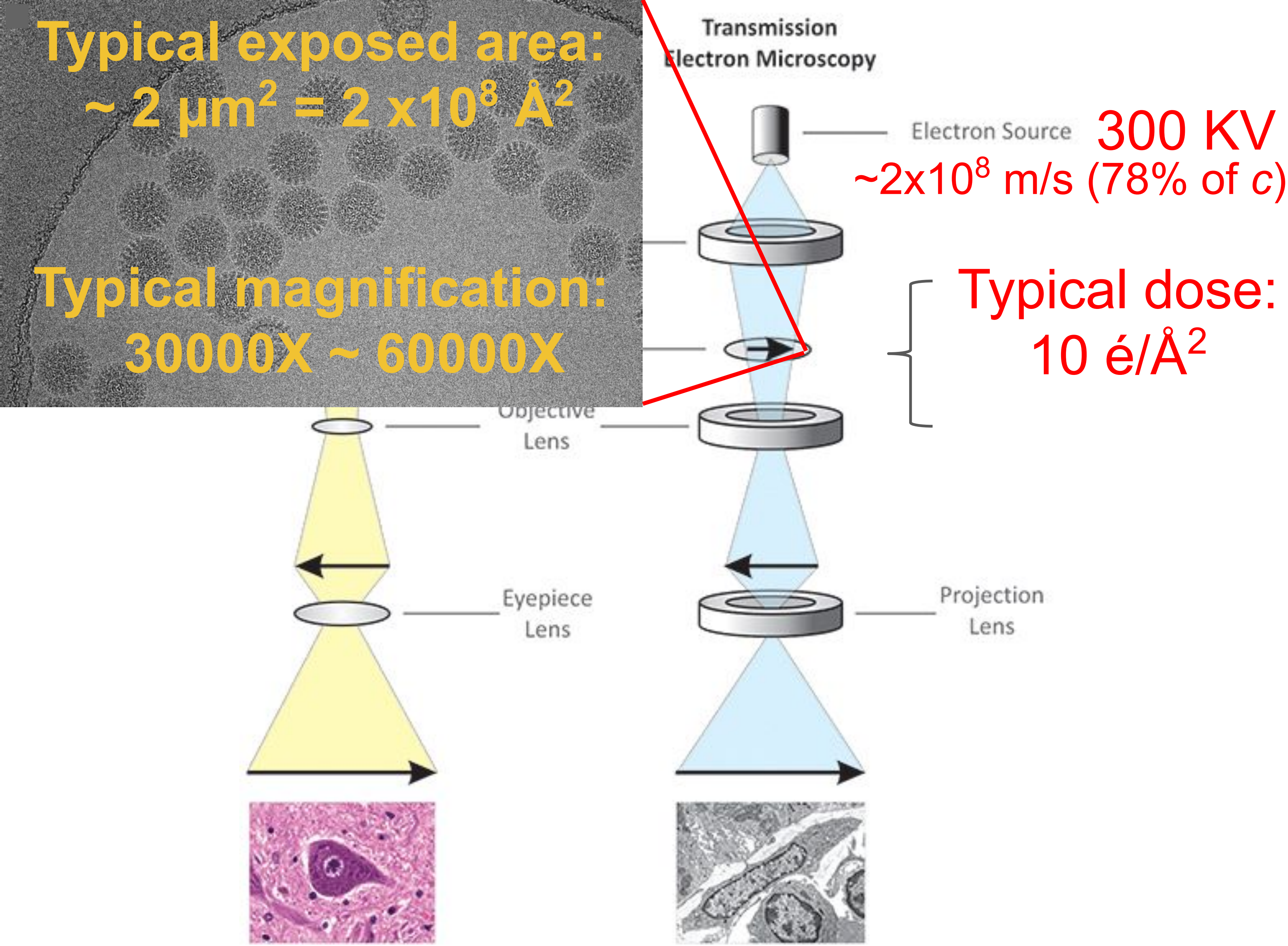
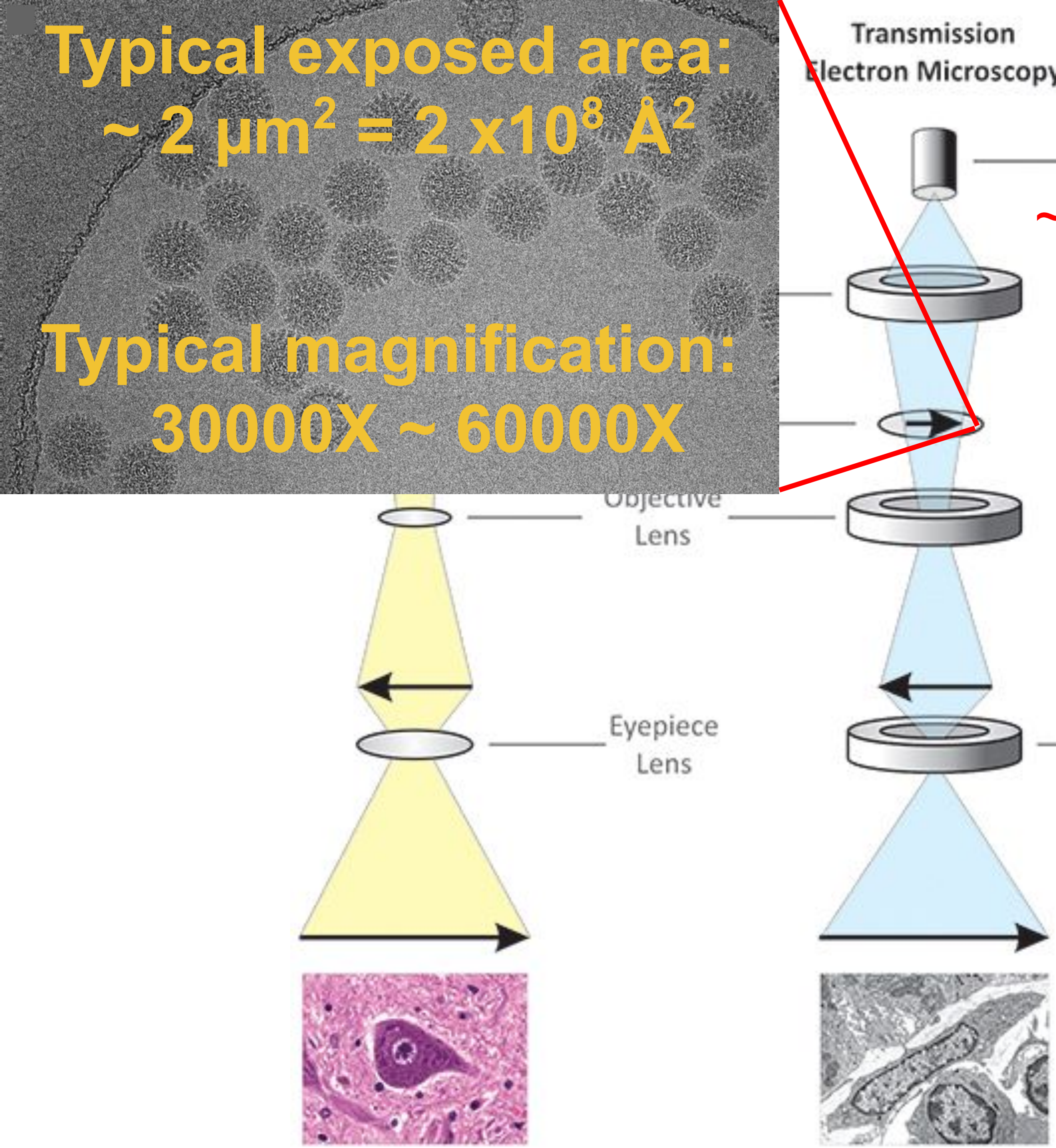


From: http://www.microbiologyinfo.com/differences-between-light-microscope-and-electron-microscope/

Typical exposed area:
~ 2 μm^2 = 2 x10^8 Å^2

Typical magnification:
30000X ~ 60000X



300 KV
~2x10^8 m/s (78% of *c*)

Typical dose:
10 é/Å^2
or 20x10^8 é

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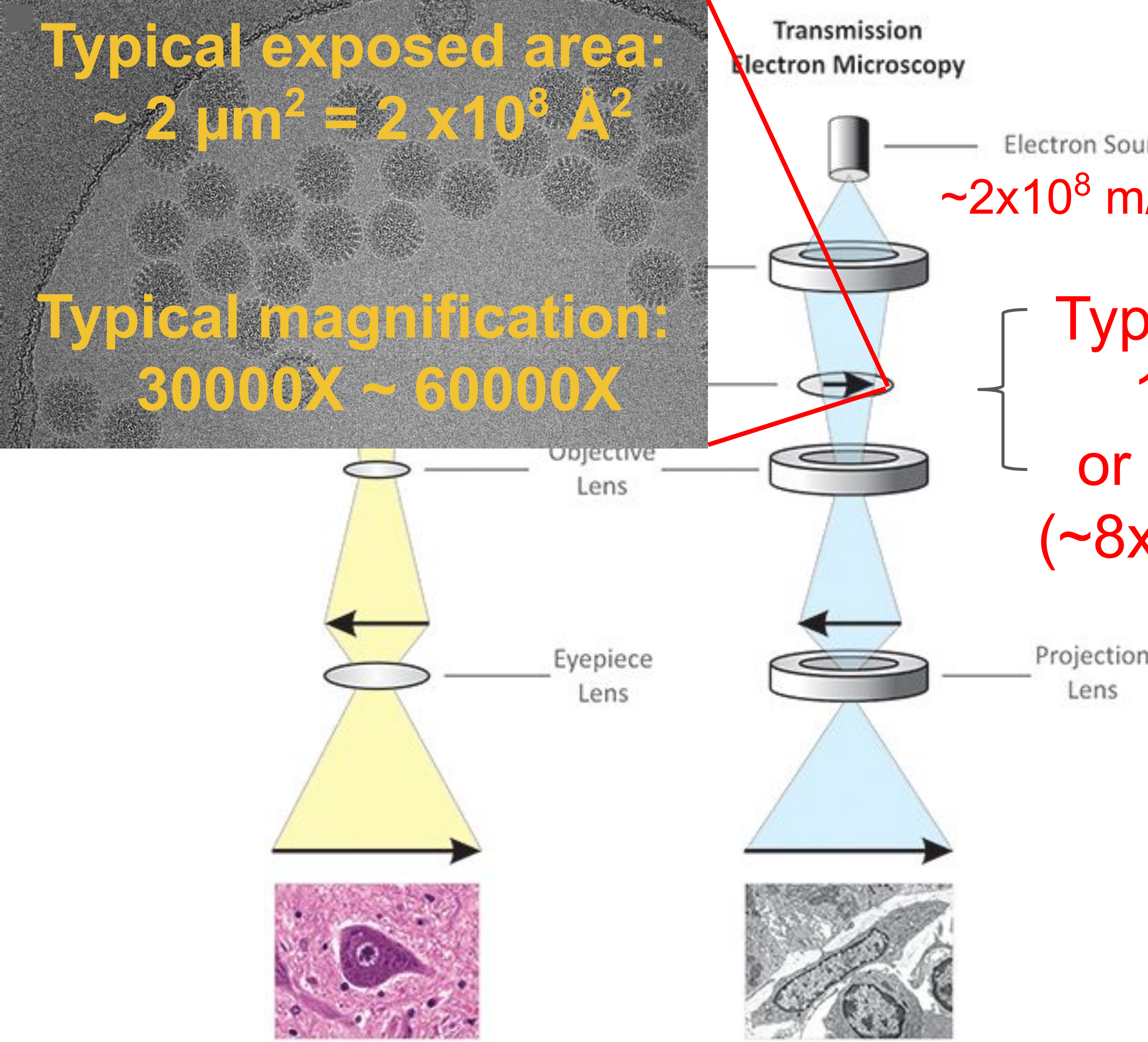

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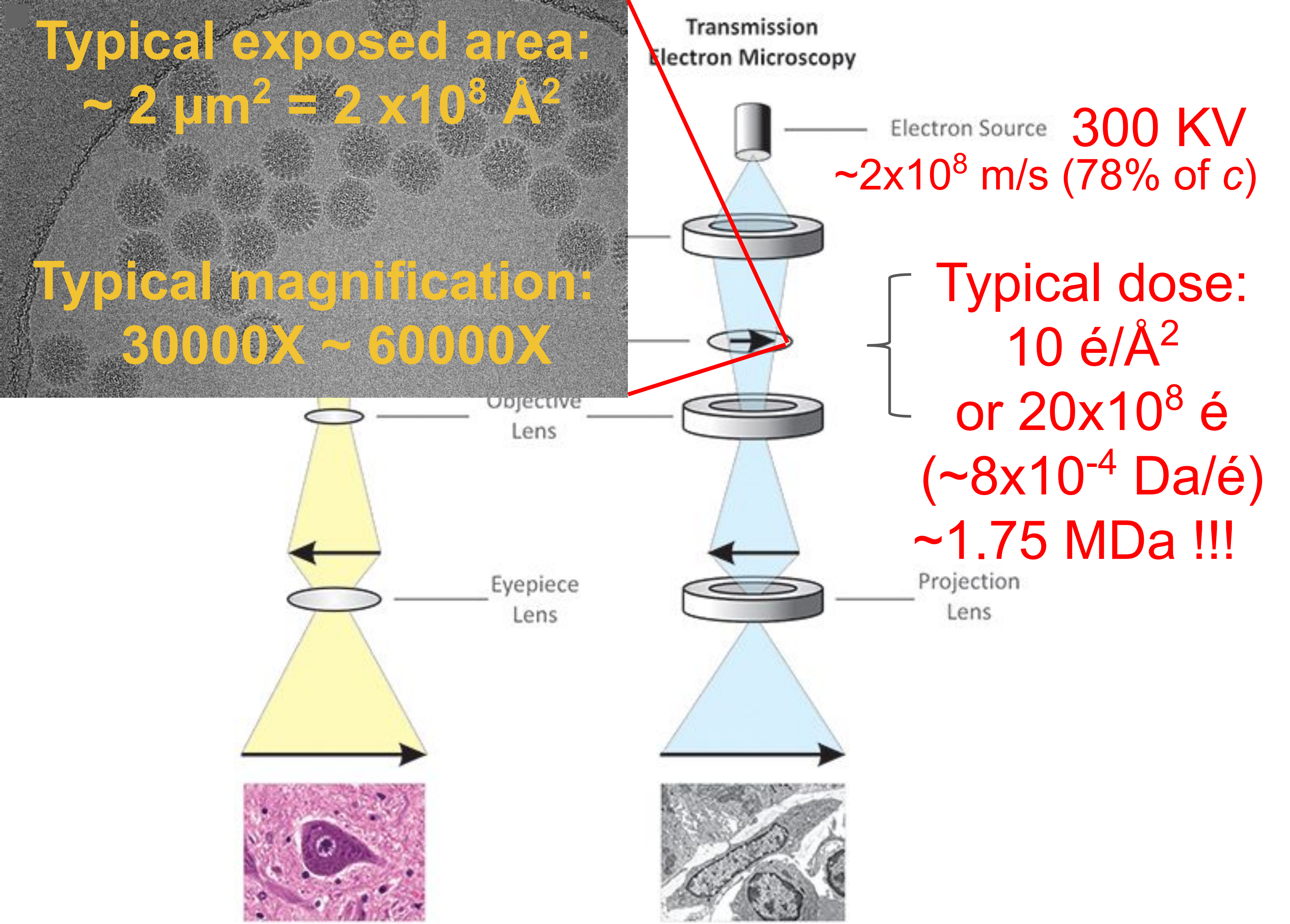

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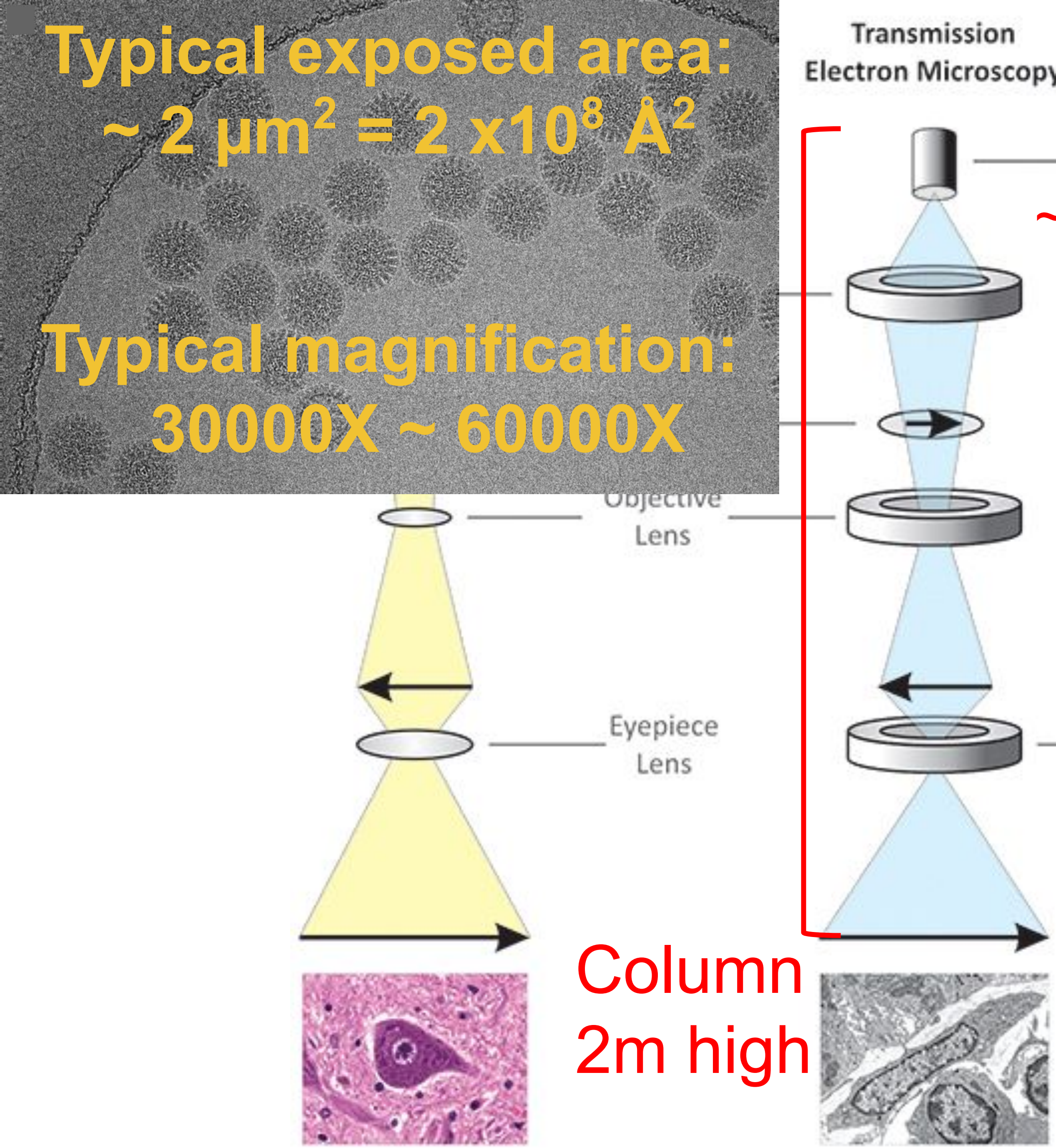

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~1.75 MDa !!!

Column
2m high

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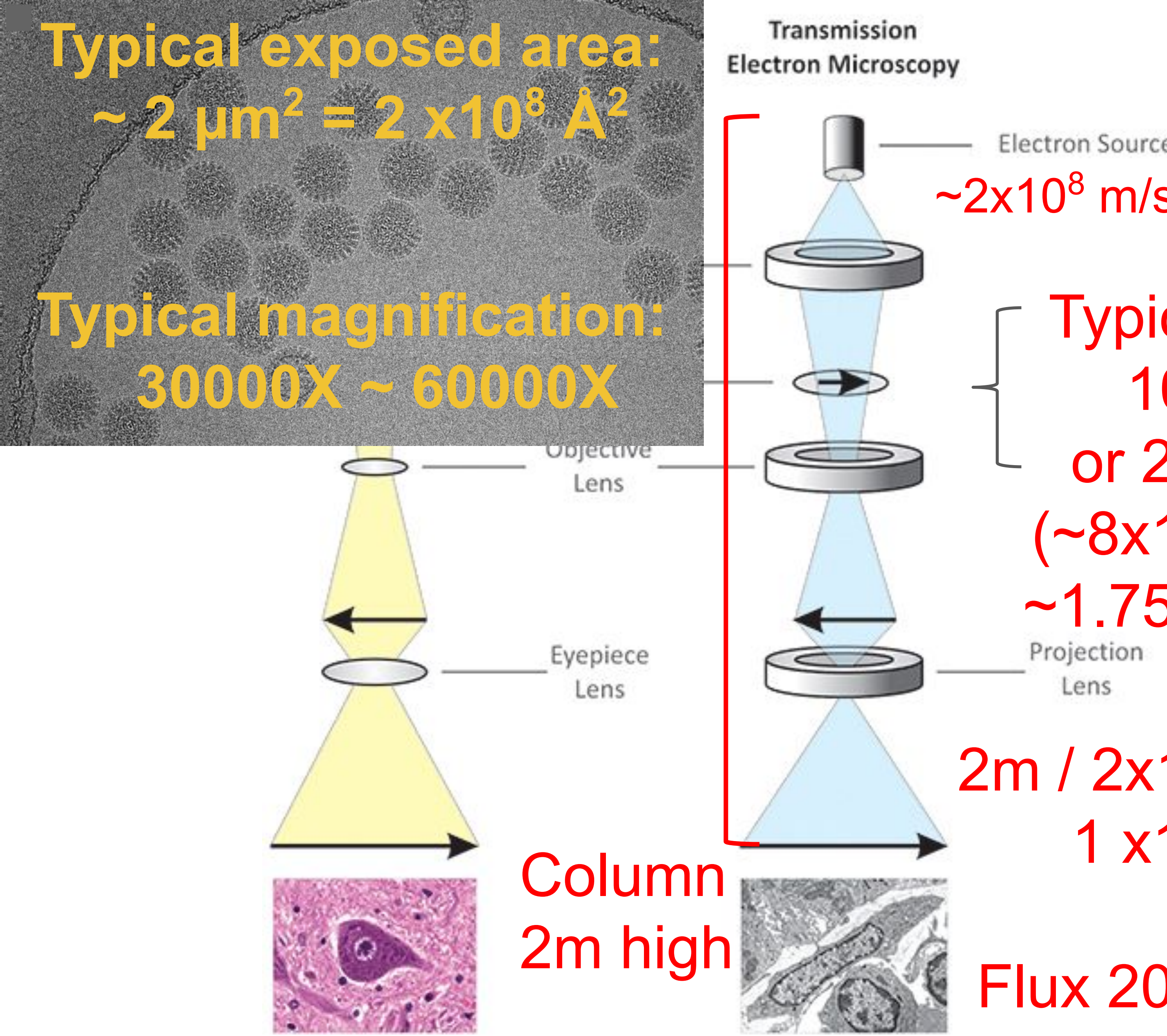

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Column
2m high

2m / 2x10^8 m/s =
1 x10^{-8} s

Flux 20x10^8 é/s

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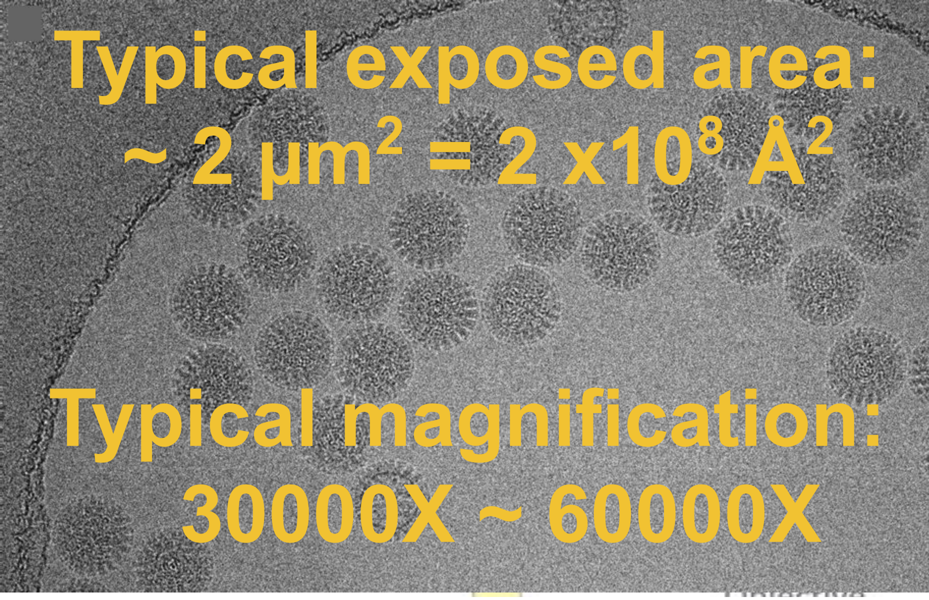

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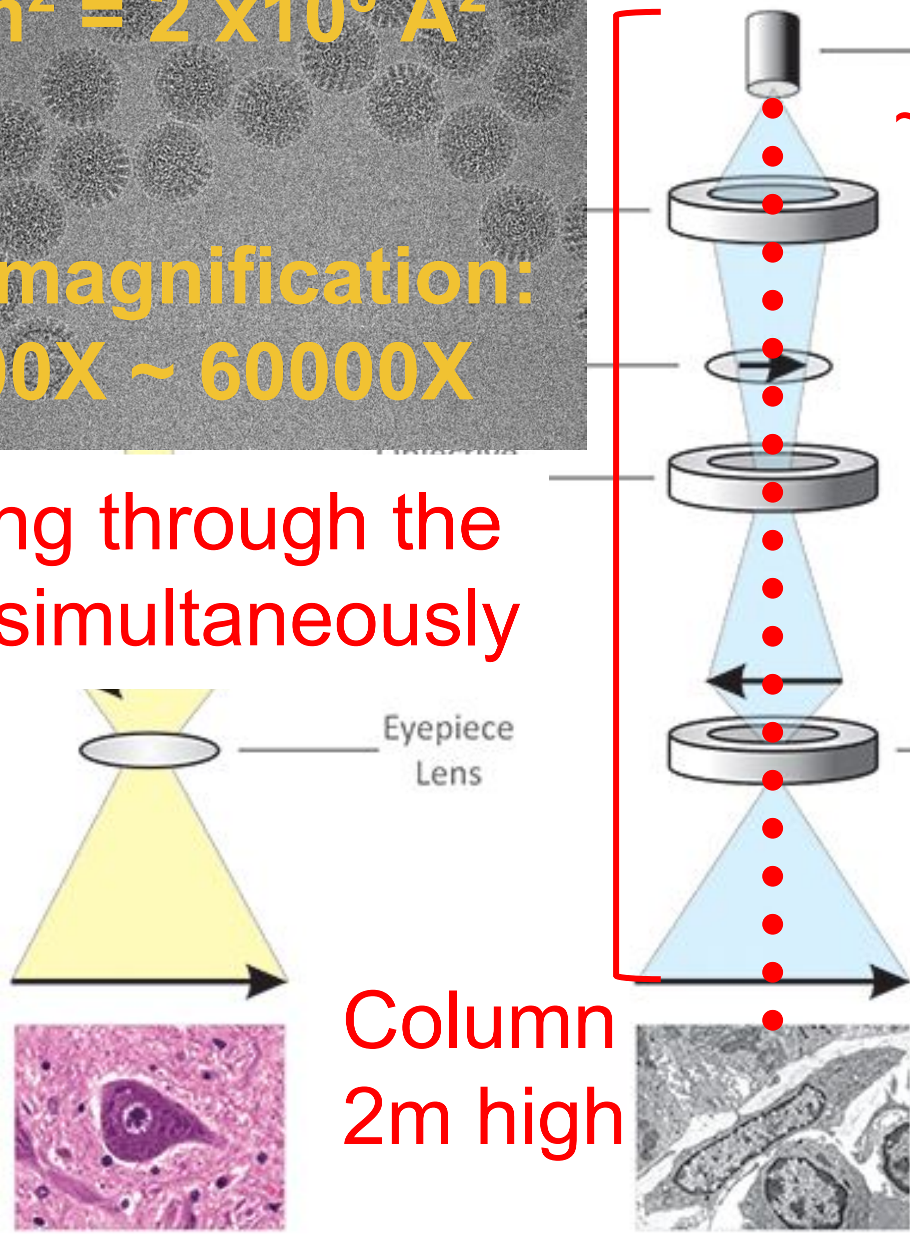

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Typical dose:
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or 20x10^8 é
(~8x10^{-4} Da/é)
~1.75 MDa !!!

20 é flying through the column simultaneously

2m / 2x10^8 m/s =
1 x10^{-8} s

Column
2m high

Flux 20x10^8 é/s

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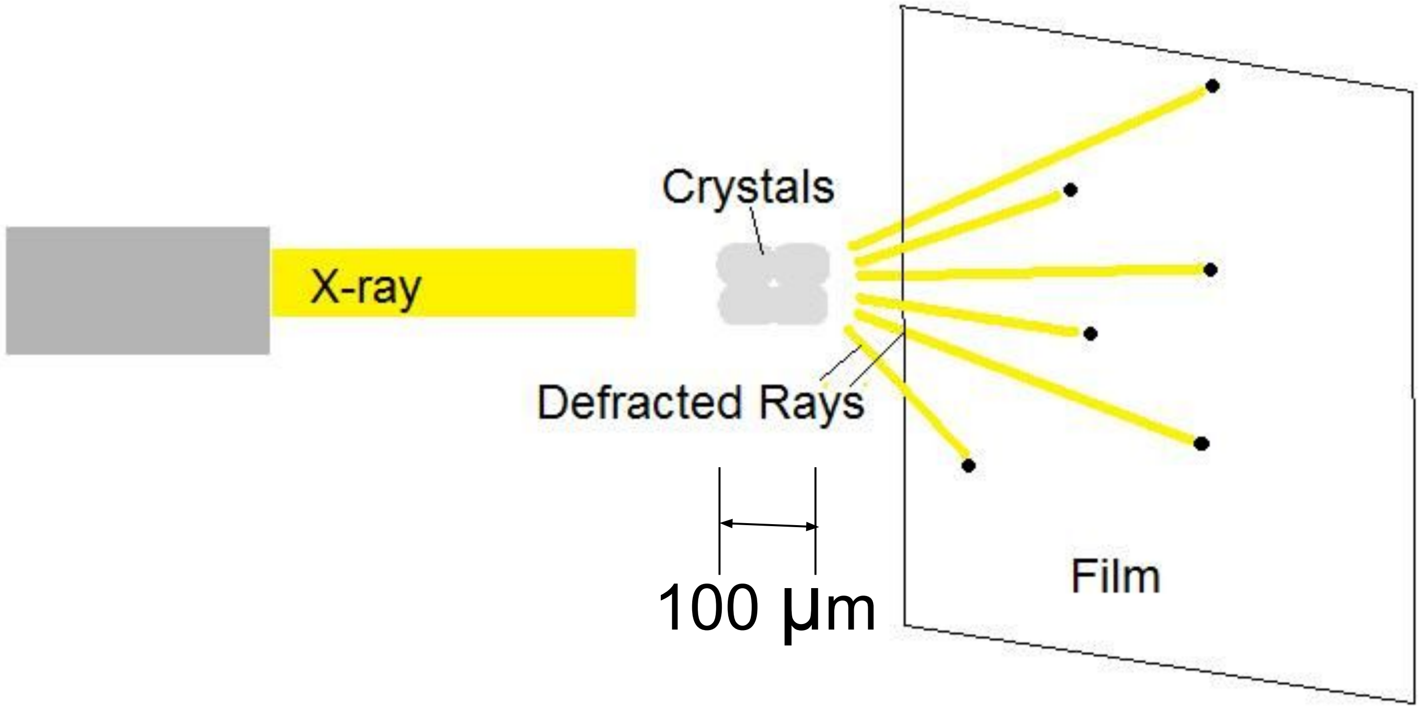

at the detector level: 10^8 photons / s / mm^2

Detector surface: ~25220 mm^2

10^8 * 25220 = 2.522 * 10^{12} photons / s

100 µm / 3*10^8 m/s = 3.3*10^{-14} s ~= 33 fentoseconds

2.522*10^{12} photons/s * (3.3 *10^{-13} s) =

8.4 photons/100 µm (inside the crystal)

i.e. the photons are spaced by ~12 µm !

$$i\hbar\frac{\partial}{\partial t}\Psi(\mathbf{r},\,t) = -\frac{\hbar^2}{2m}\nabla^2\Psi(\mathbf{r},\,t) + V(\mathbf{r})\Psi(\mathbf{r},\,t)$$

"

Where did we get that (equation) from? Nowhere. It is not possible to derive it from anything you know. It came out of the mind of Schrödinger.

"

—Richard Feynman

$$i\hbar\frac{\partial}{\partial t}\Psi(\mathbf{r},t) = -\frac{\hbar^2}{2m}\nabla^2\Psi(\mathbf{r},t) + \underbrace{V(\mathbf{r})}_{V(\mathbf{r})_{microscope} + V(\mathbf{r})_{sample}}\Psi(\mathbf{r},t)$$

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$$e^{ix} = \cos x + i \sin x$$

$$\Psi(\vec{r}) = |\Psi_0|\, e^{i\phi_0(\vec{r})}$$

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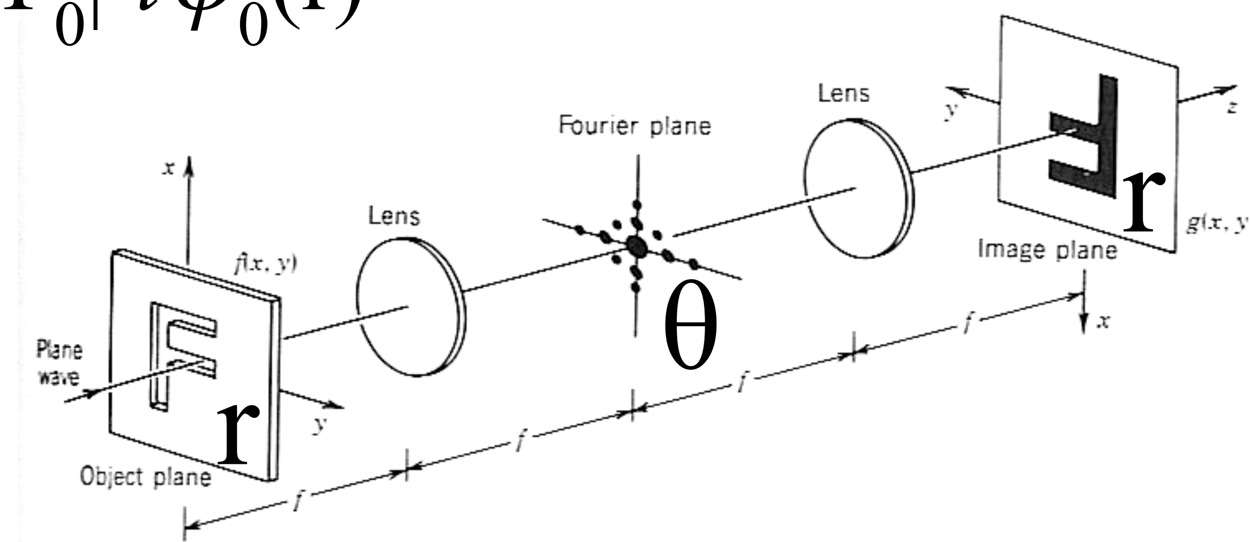

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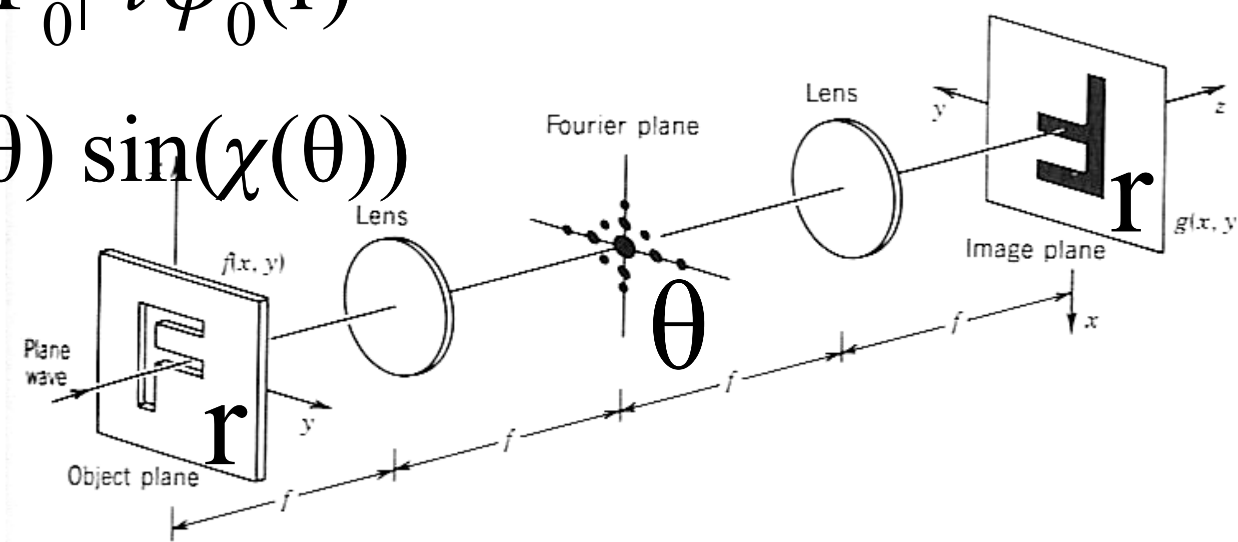
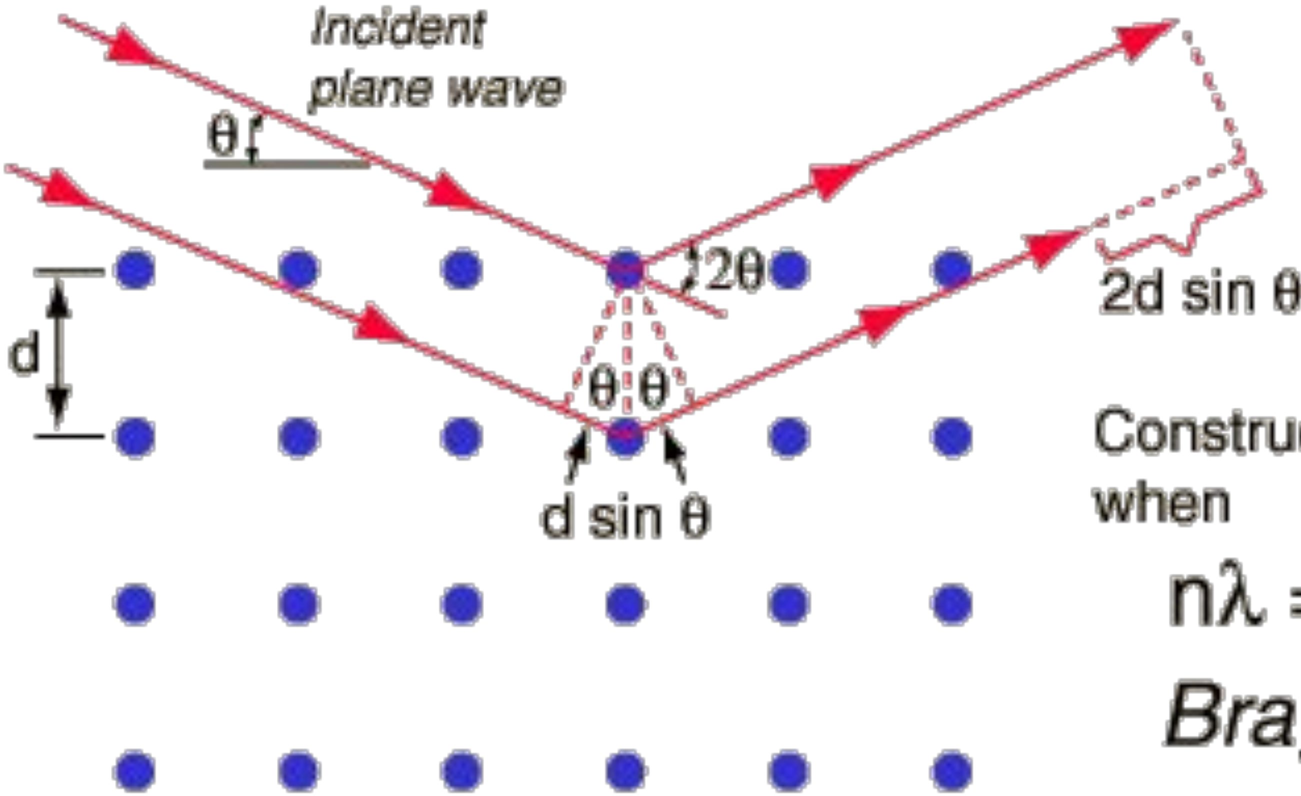
$$\mathrm{I}(\theta) = \delta(\theta) + \phi_0(\theta)\,\sin(\chi(\theta))$$

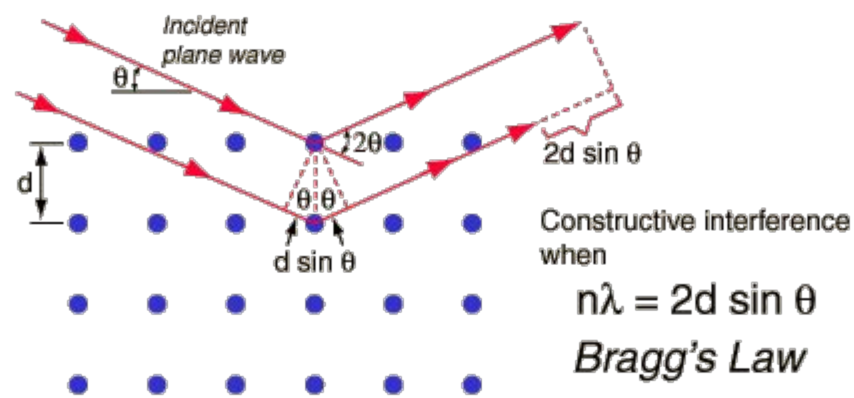




Constructive interference when

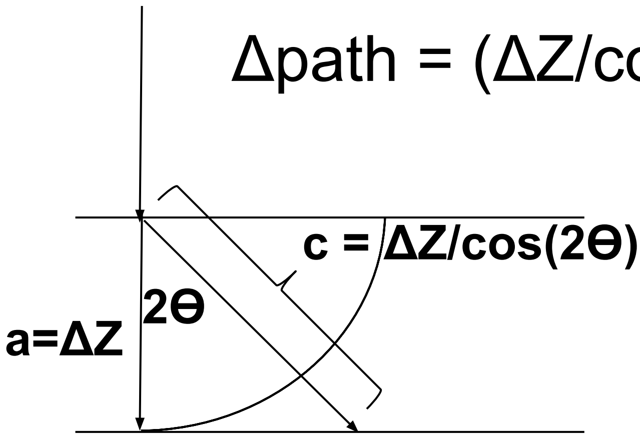
$$n\lambda = 2d \sin \theta$$

Bragg's Law

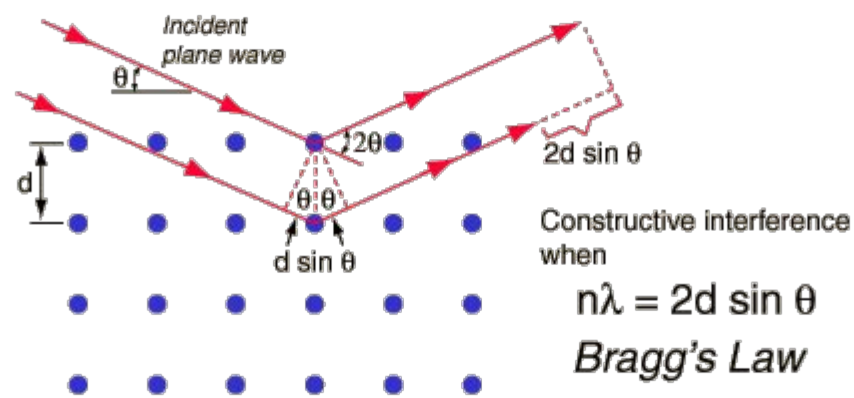


Incident
plane wave
θ
2θ
d
θ θ
d sin θ
2d sin θ
Constructive interference
when
nλ = 2d sin θ
Bragg's Law

$$\Delta\text{path} = (\Delta Z/\cos(2\Theta) - \Delta Z)$$



$$a = c \cdot \cos(2\Theta)$$
$$c = a / \cos(2\Theta)$$



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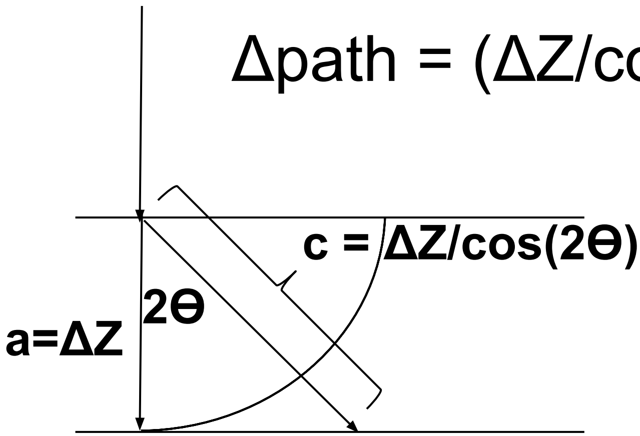

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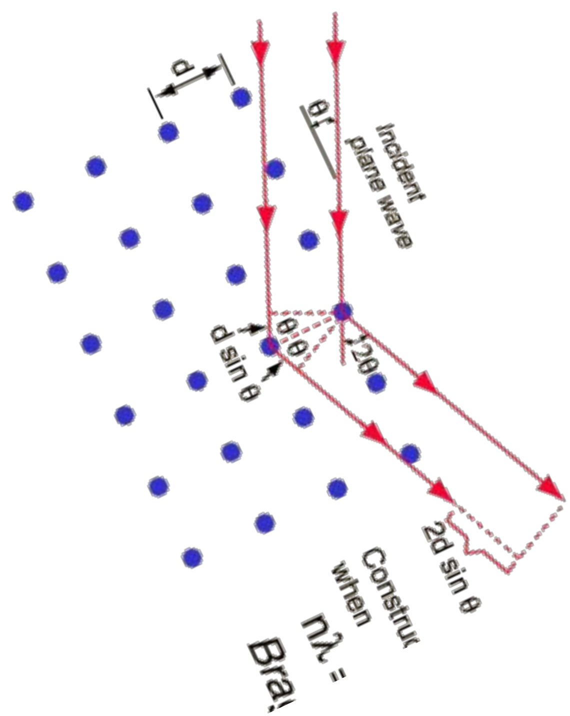
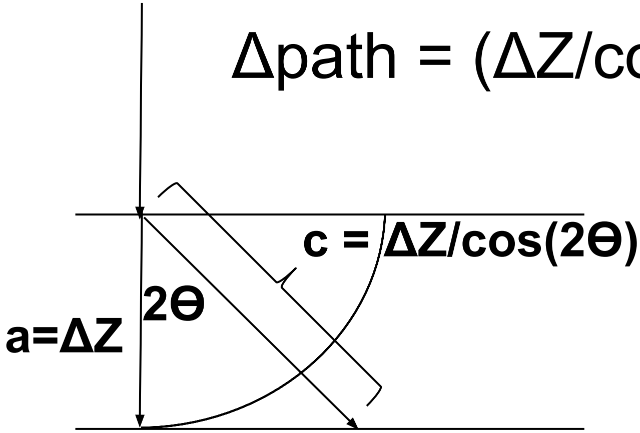


$$\Delta path = (\Delta Z/\cos(2\Theta)-\Delta Z)$$

$$\chi = (2\pi/\lambda)\ (\Delta Z/\cos(2\Theta)-\Delta Z)$$



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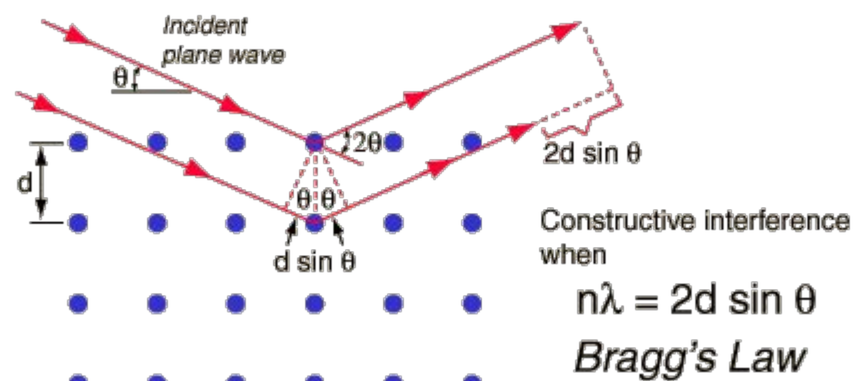

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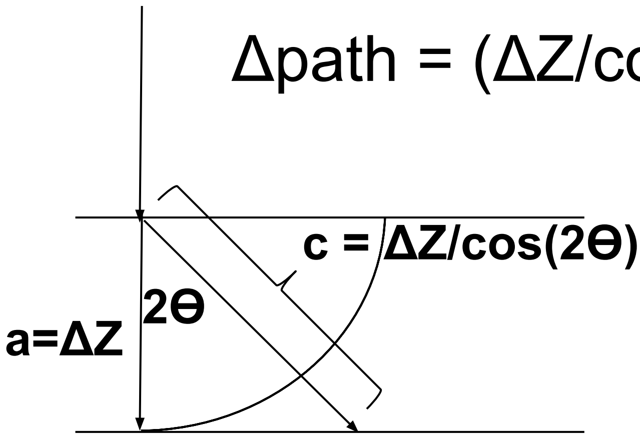

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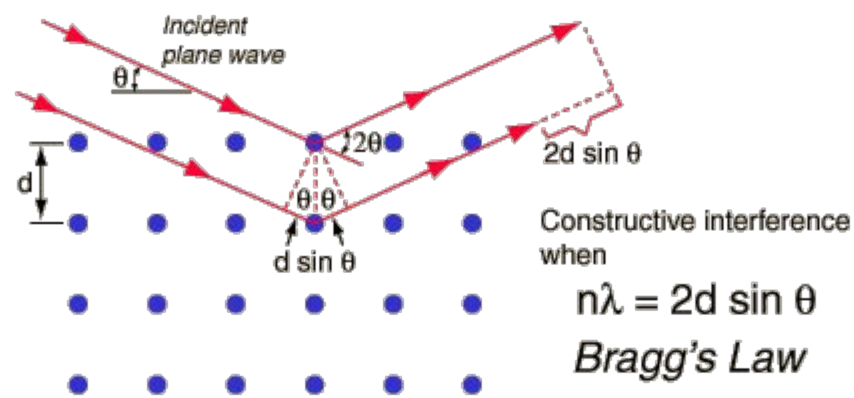

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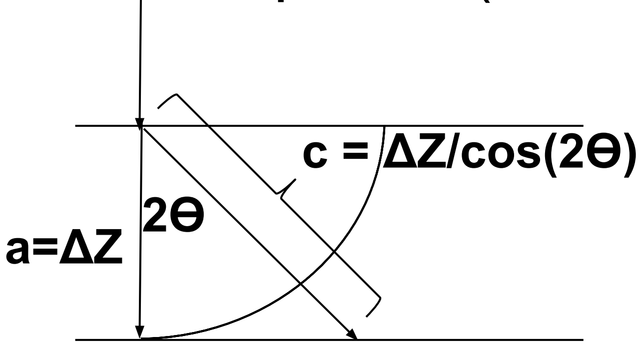

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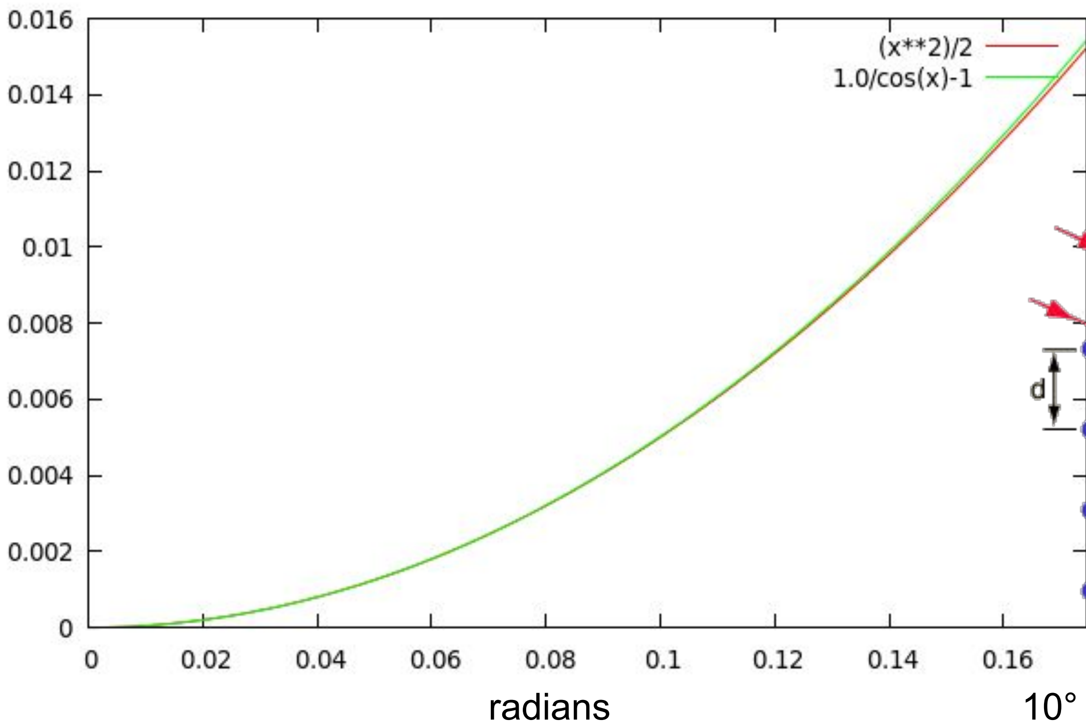

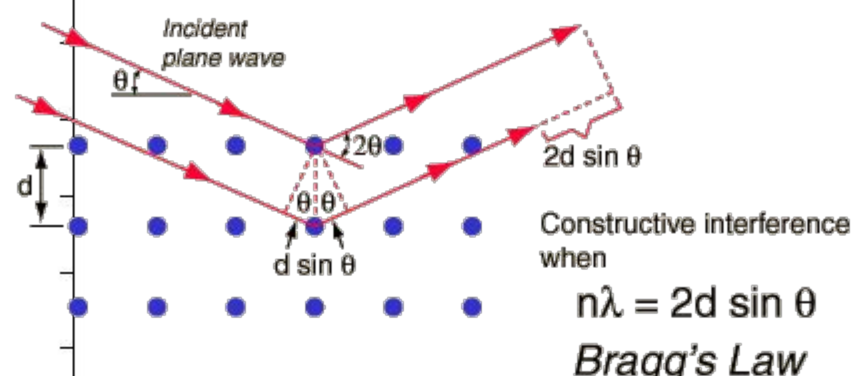

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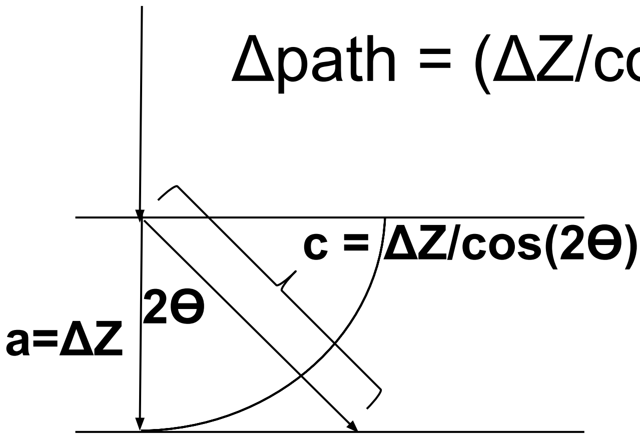

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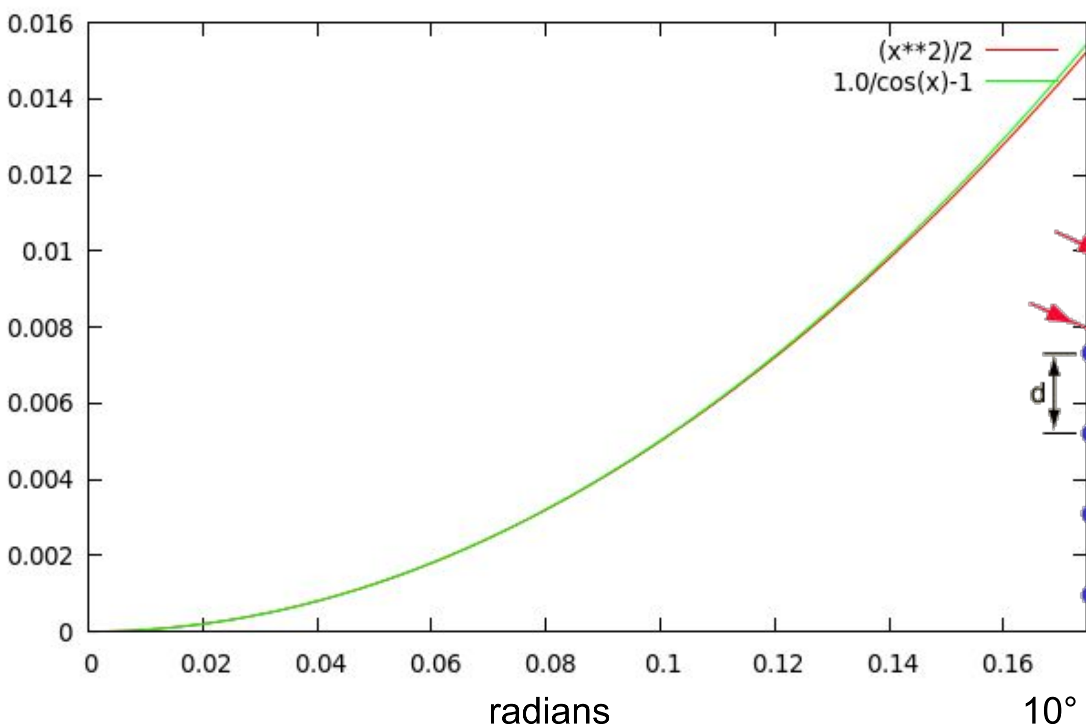

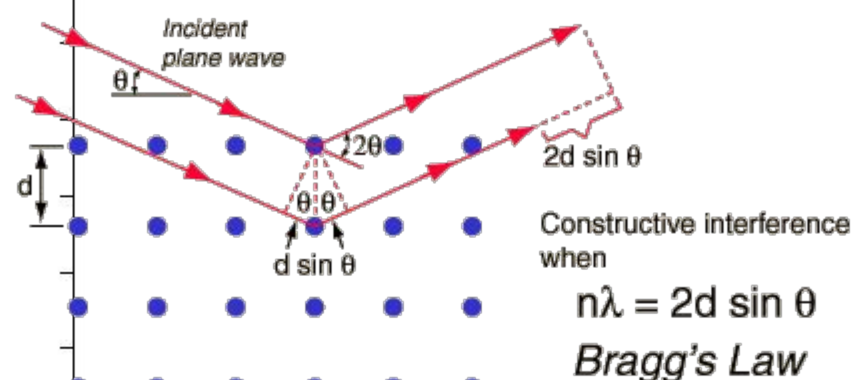

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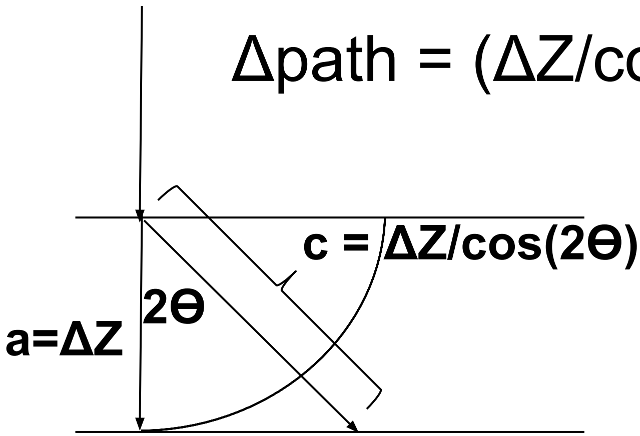

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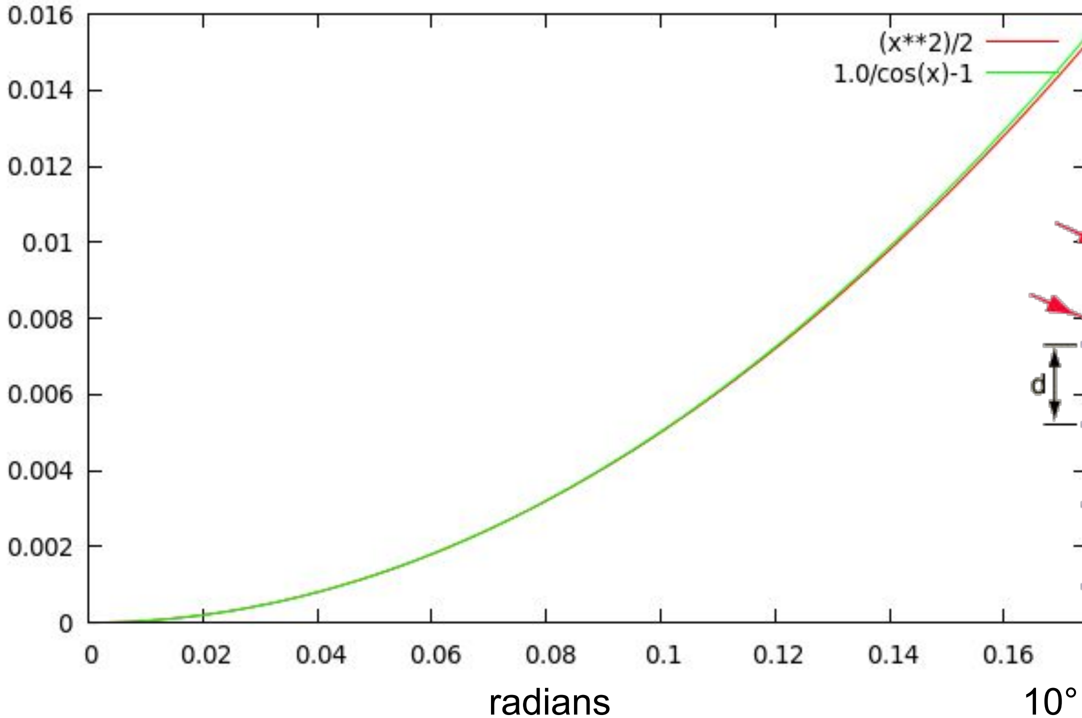
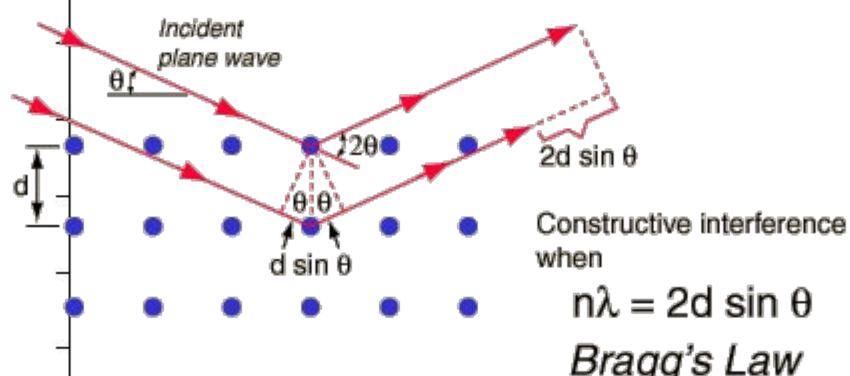
$$k = 2\sin(\Theta)/\lambda$$

If $\lambda = 0.02$Å and $k = 1/2$Å

$\Theta \sim= 0.29\ °$ or 0.005 rad

$a = c\ .\ \cos(2\Theta)$
$c = a\ /\ \cos(2\Theta)$





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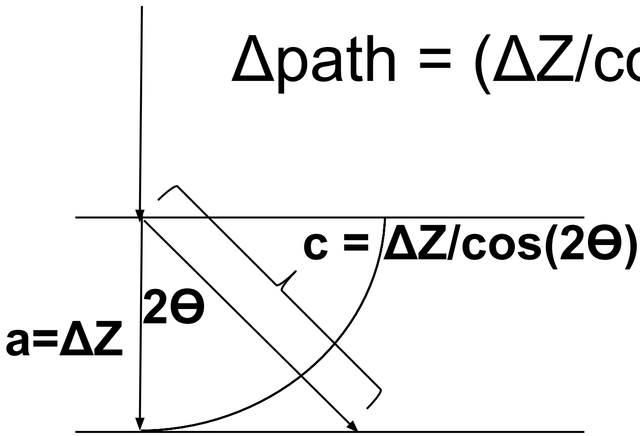

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Θ ~= 0.29 ° or 0.005 rad

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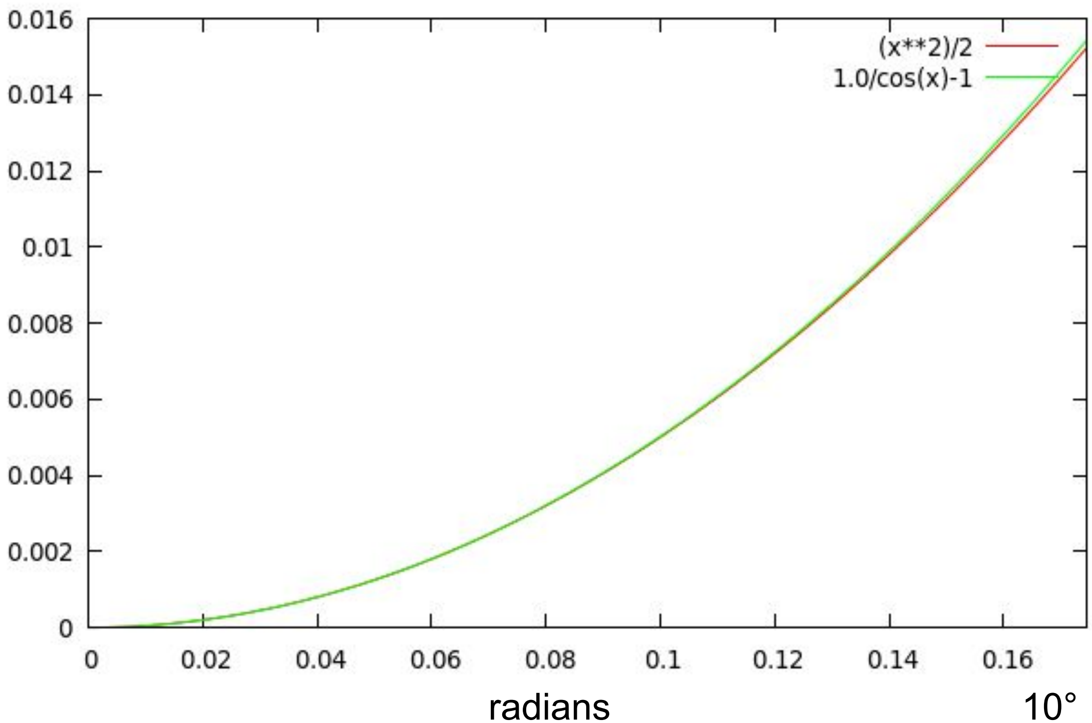

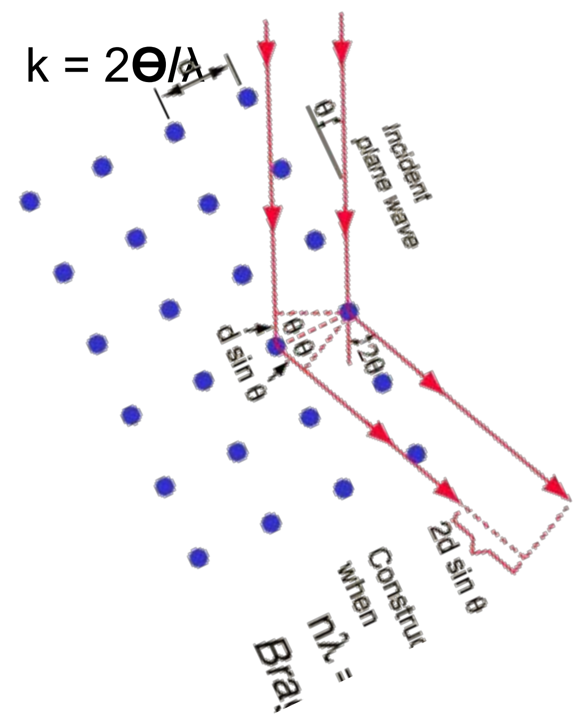

$$\chi = (2\pi/\lambda)\,\Delta Z\,(\boldsymbol{\theta}^2/2)$$

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$$I(\theta) = \delta(\theta) + \phi_0(\theta)\, \sin(\chi(\theta))$$

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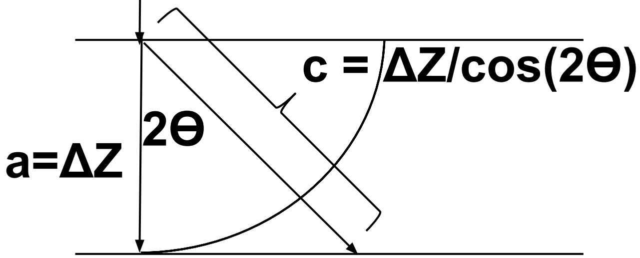

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