Physical Chemistry III

2022.03.21

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Quantum Physics for Poets (시인을 위한 양자물리학)

Book by Christopher T. Hill and Leon M. Lederman

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알라딘	교보문고	고객센터 - 옥션

Did you like this book?

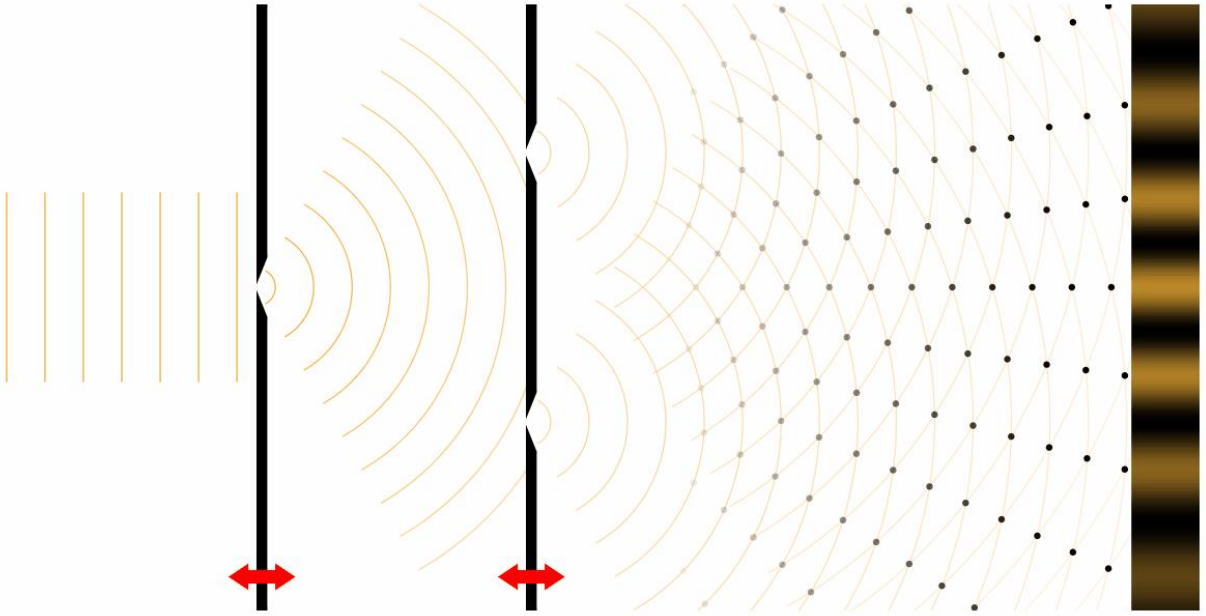
The Times Literary Supplement called their previous book, Symmetry and the Beautiful Universe: [A] tour de force of physics made simple.Quantum theory is the bedrock of contemporary physics and the basis of understanding matter in its tiniest dimensions and the vast universe as a whole. ... Google Books

Originally published: September 11, 2010

Authors: Christopher T. Hill, Leon M. Lederman

Double slit experiment

In 1801, Thomas Young



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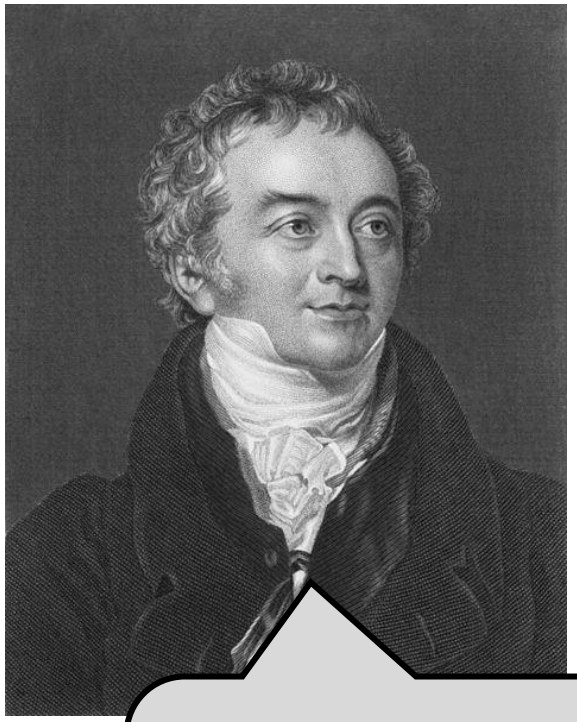
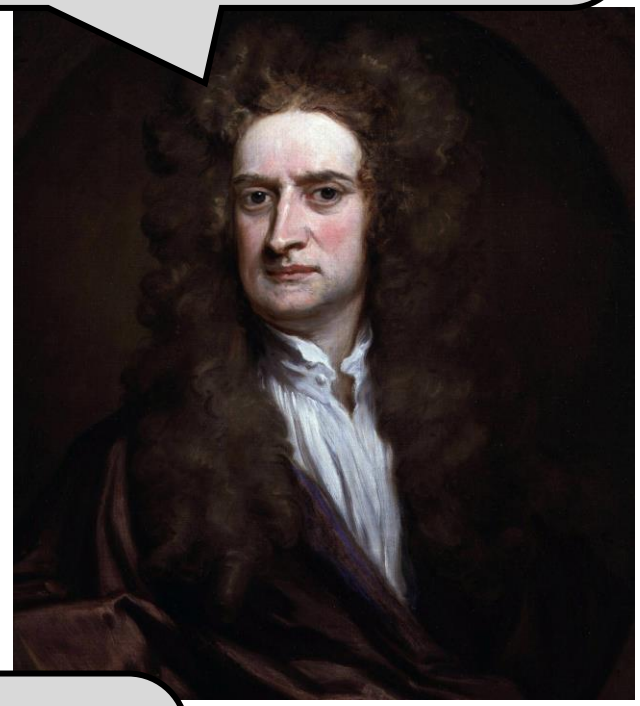


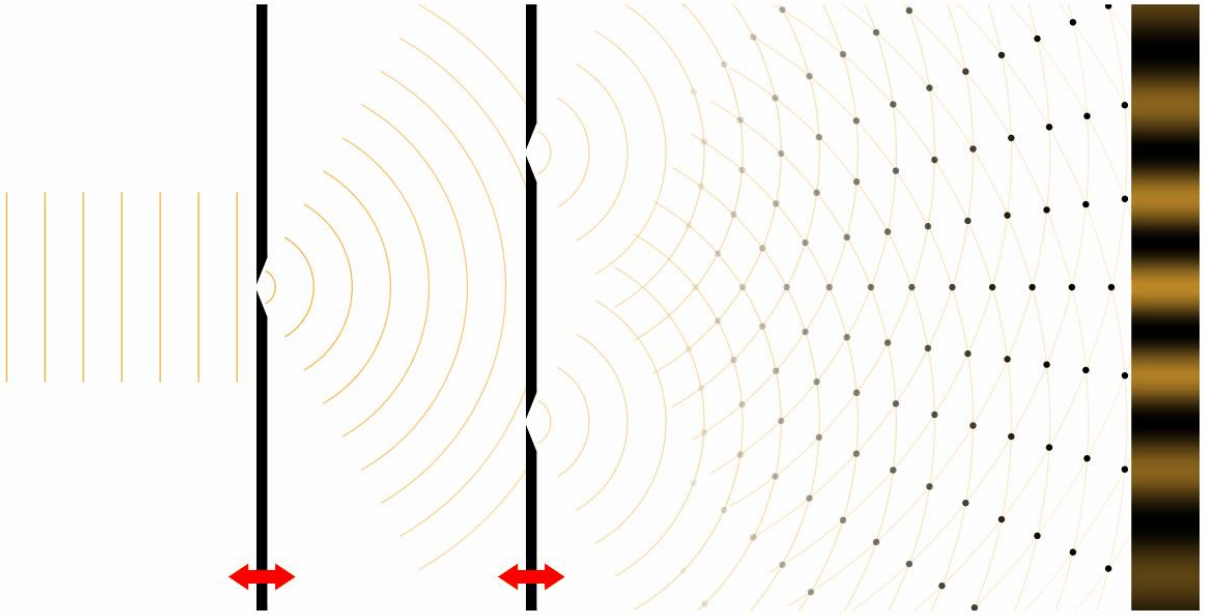


Light is made up of small discrete particles!

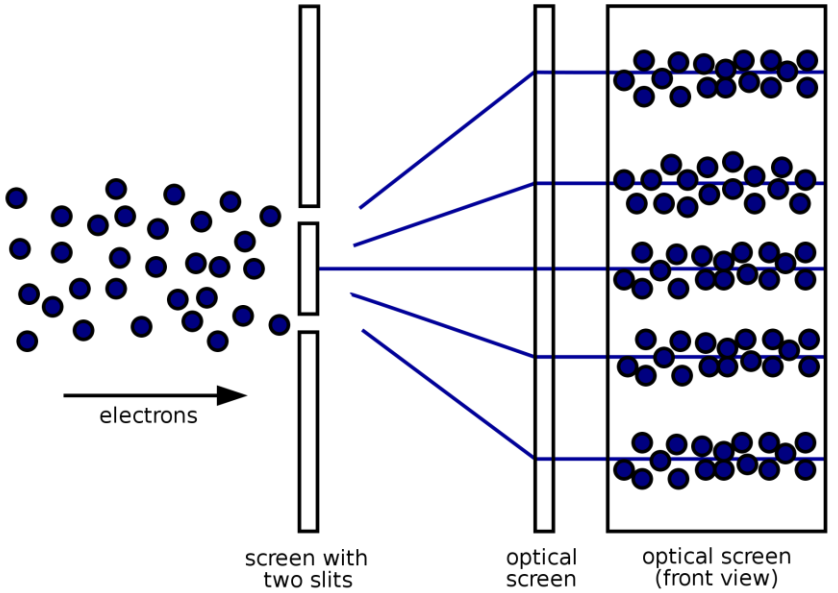
No. You wrong. Light is wave.

Double slit experiment

In 1801, Thomas Young



In 1927 at Bell Labs, Clinton Davisson and Lester Germer

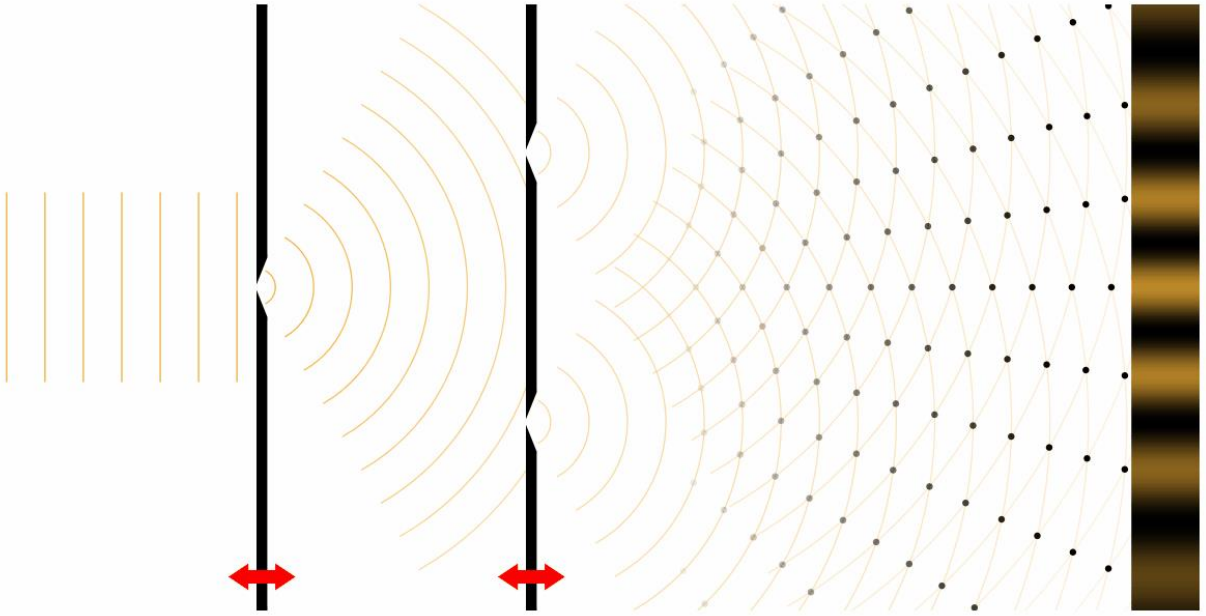


https://javalab.org/en/youngs_double_slit_en/

Electron is wave..?

Double slit experiment

In 1801, Thomas Young



https://javalab.org/en/youngs_double_slit_en/

letters to nature

Wave–particle duality of C_{60} molecules

Markus Arndt, Olaf Nairz, Julian Vos-Andreae, Claudia Keller, Gerbrand van der Zouw & Anton Zeilinger

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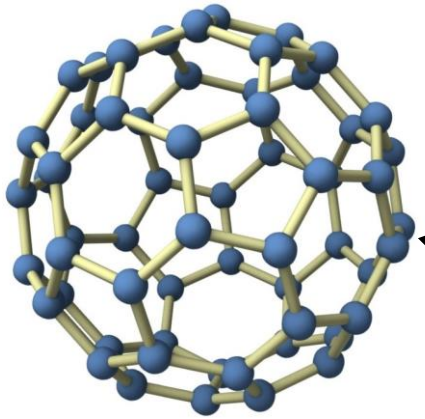


Am I wave?

Matter wave

In 1924, De Broglie (Ph.D student)

De Broglie hypothesis

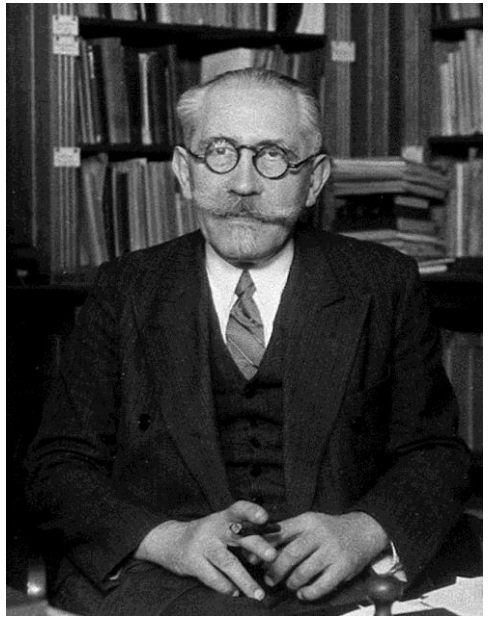
$$\lambda = \frac{h}{p}$$

λ: wavelength of matter wave

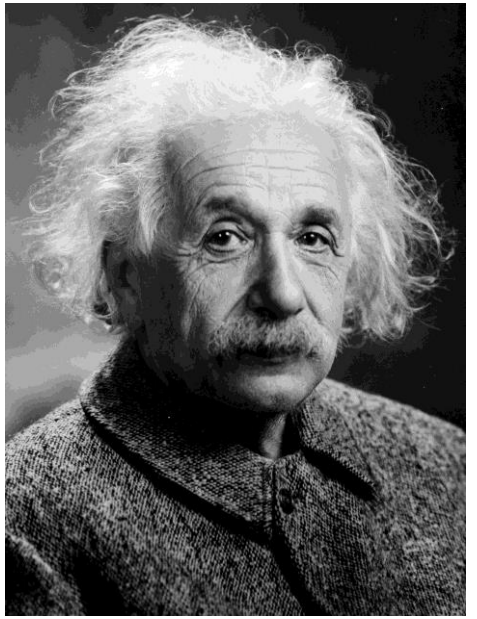
h: Planck constant

p: momentum

Matter wave



Paul Langevin (Professor of Broglie)



Albert Einstein (Friend of Langevin)

De Broglie (Ph.D student)

Erwin Schrödinger (Research assistant of Einstein)

Schrödinger Equation

In 1925, (published in 1926)

If De Broglie hypothesis is correct,

then it can be described by

Hamiltonian mechanics!

(a.k.a. King of classical mechanics)

$$\hat{H}|\psi\rangle = \left(-\frac{\hbar^2}{2m}\nabla^2 + V_0\right)|\psi\rangle = i\hbar\frac{\partial}{\partial t}|\psi\rangle = E|\psi\rangle$$

It is clear!

But I don't know the meaning of $|\psi\rangle$

After Schrödinger Equation

In 1926,

Werner Heisenberg

Uncertainty principle

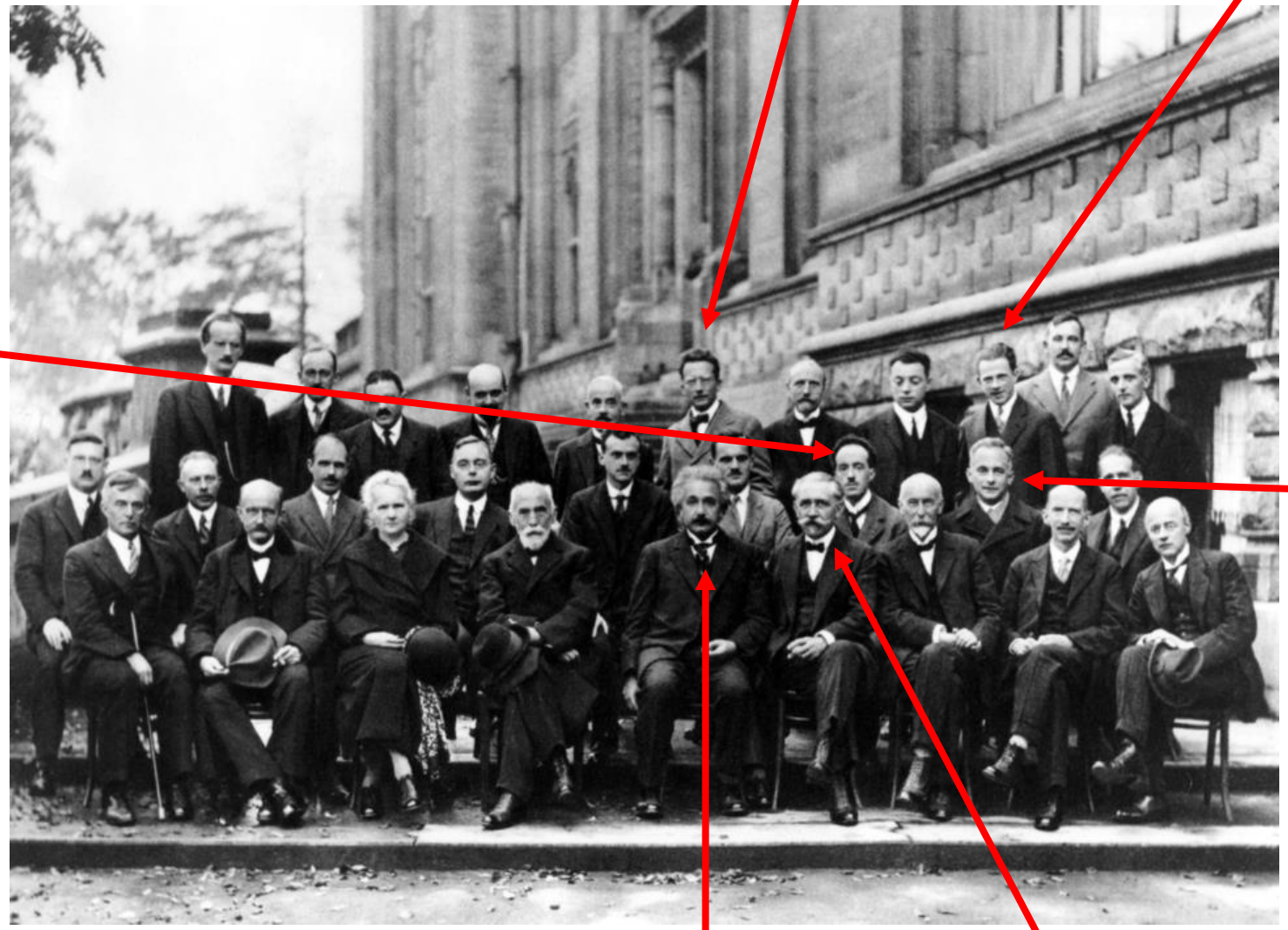
$$\Delta r \, \Delta p \geq h$$

$|\psi|^2 =$ Probability density function!

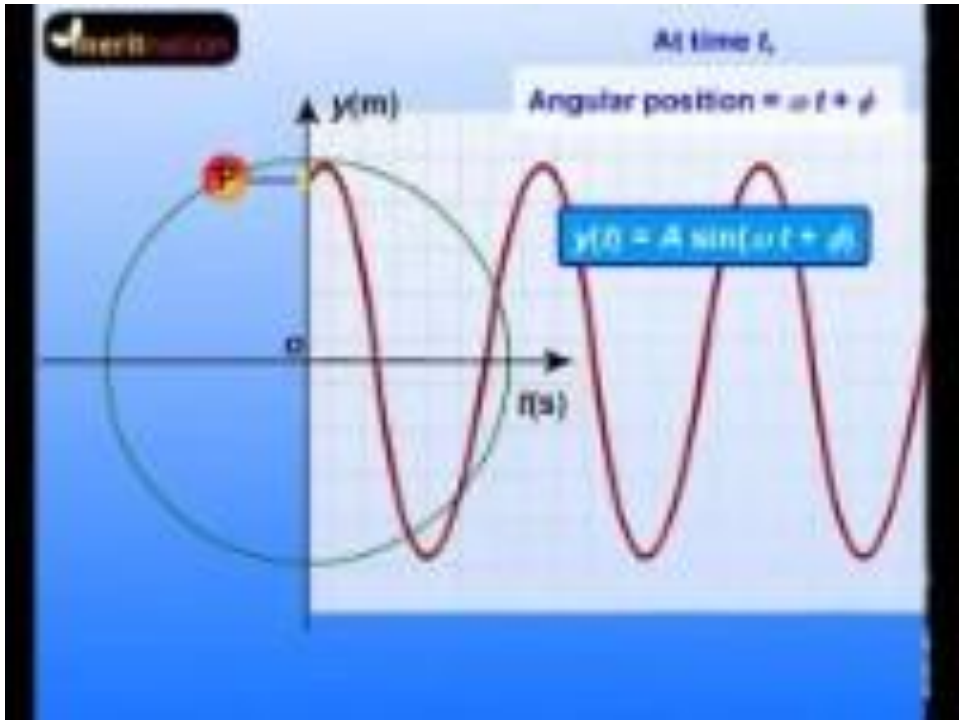
Max Born

After Schrödinger Equation

In 1927 Brussels conference..



$\langle x|$ $|\psi\rangle$ $\langle x|\psi\rangle = \psi(x)$



$$Let, |\psi\rangle = a_1|\varphi_1\rangle + a_2|\varphi_2\rangle + a_3|\varphi_3\rangle$$

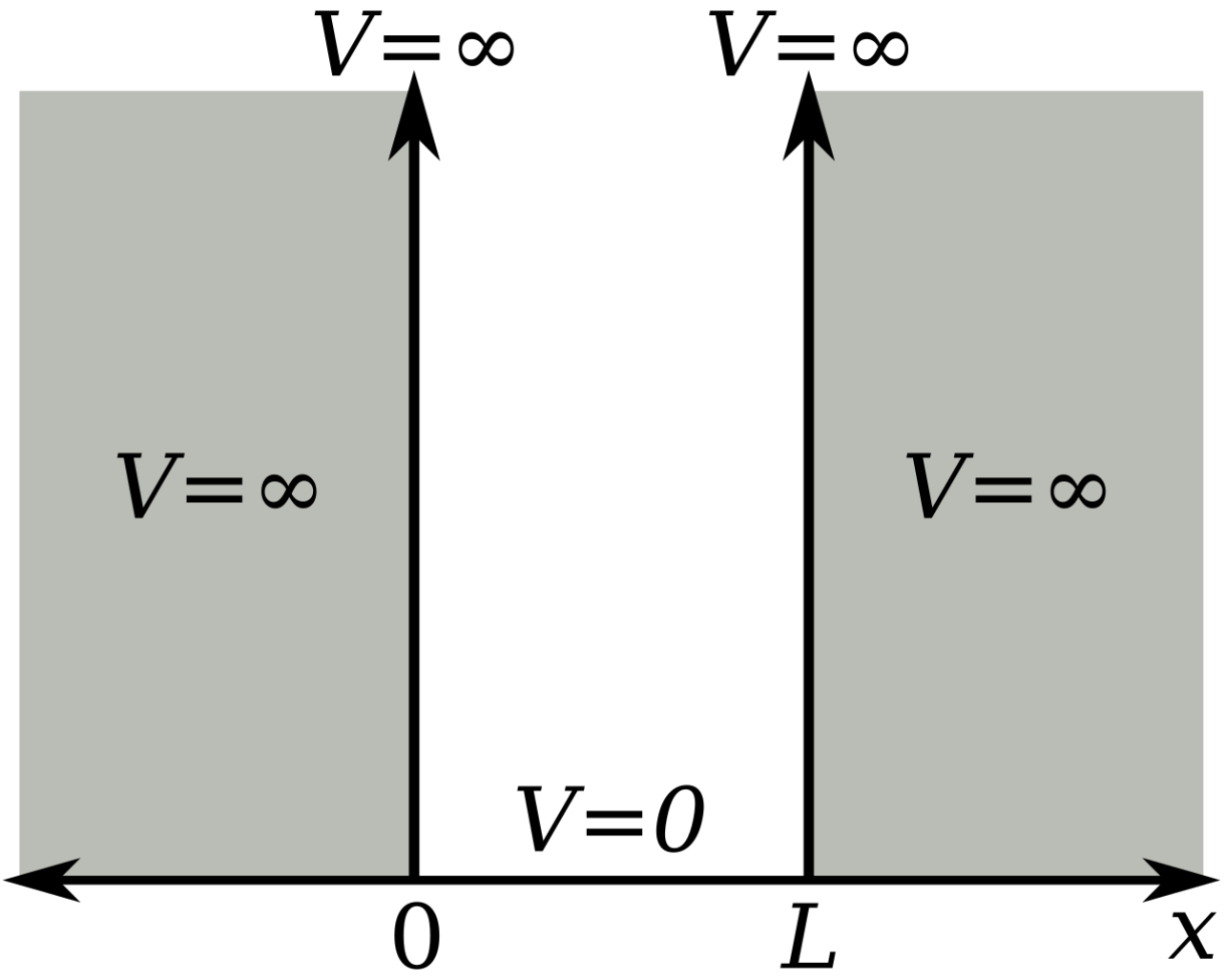
$$|\varphi_1\rangle = \begin{pmatrix}1\\0\\0\end{pmatrix} \qquad |\varphi_2\rangle = \begin{pmatrix}0\\1\\0\end{pmatrix} \qquad |\varphi_3\rangle = \begin{pmatrix}0\\0\\1\end{pmatrix}$$ Orthonormal basis

$$|\psi\rangle = \begin{pmatrix}a_1\\a_2\\a_3\end{pmatrix} \qquad {a_1}^2 + {a_2}^2 + {a_3}^2 = 1 \qquad \langle\varphi_1| = |\varphi_1\rangle^\dagger = \begin{pmatrix}1\\0\\0\end{pmatrix}^\dagger = (1 \quad 0 \quad 0)$$

$$\langle\varphi_1|\psi\rangle = (1 \quad 0 \quad 0)\begin{pmatrix}a_1\\a_2\\a_3\end{pmatrix} = a_1 : \text{component(weight factor) of } |\varphi_1\rangle$$

$$|\psi\rangle = \sum_{i=1}^{3} a_i|\varphi_i\rangle = \sum_{i=1}^{3} |\varphi_i\rangle\langle\varphi_i|\psi\rangle = \mathbf{I}|\psi\rangle$$

Particle in a box



$$\hat{H}\psi(x) = E\psi(x)$$

$$\hat{H} = \frac{\hat{p}^2}{2m} + V(\hat{x}) = -\frac{\hbar^2}{2m}\frac{\partial^2}{\partial x^2} + V(x)$$

$$V(x) = \begin{cases} 0 & \text{for } 0 < x < L \\ \infty & \text{otherwise} \end{cases}$$

$$\psi(x) = \sum_{n=1}^{\infty} a_n \psi_n(x)$$

$$\psi_n(x) = \sqrt{\frac{2}{L}} \sin\left(\frac{n\pi}{L}x\right), E_n = \frac{h^2}{8mL^2}n^2$$

https://github.com/thereexist/Physical_chemistry_3/blob/main/Particle_in_a_box/particle_in_a_box.ipynb