quantum mechanics (in five minutes)

brettkoonce.com/talks

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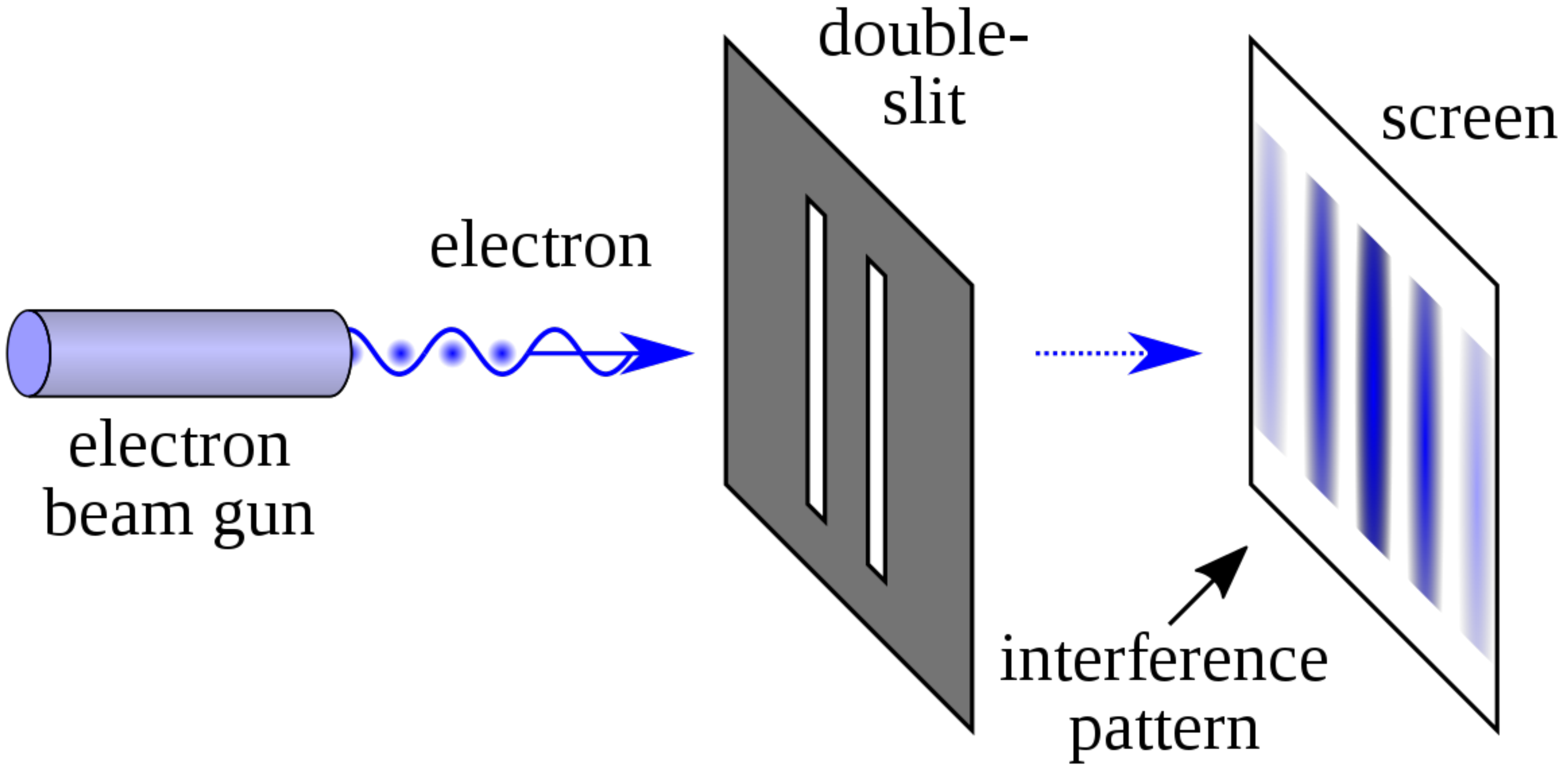

double-
slit
screen
electron
electron
beam gun
interference
pattern

schrodinger equation

$$\hat{H}\,\Psi = E\,\Psi$$

Hamiltonian Operator (Energy operator)

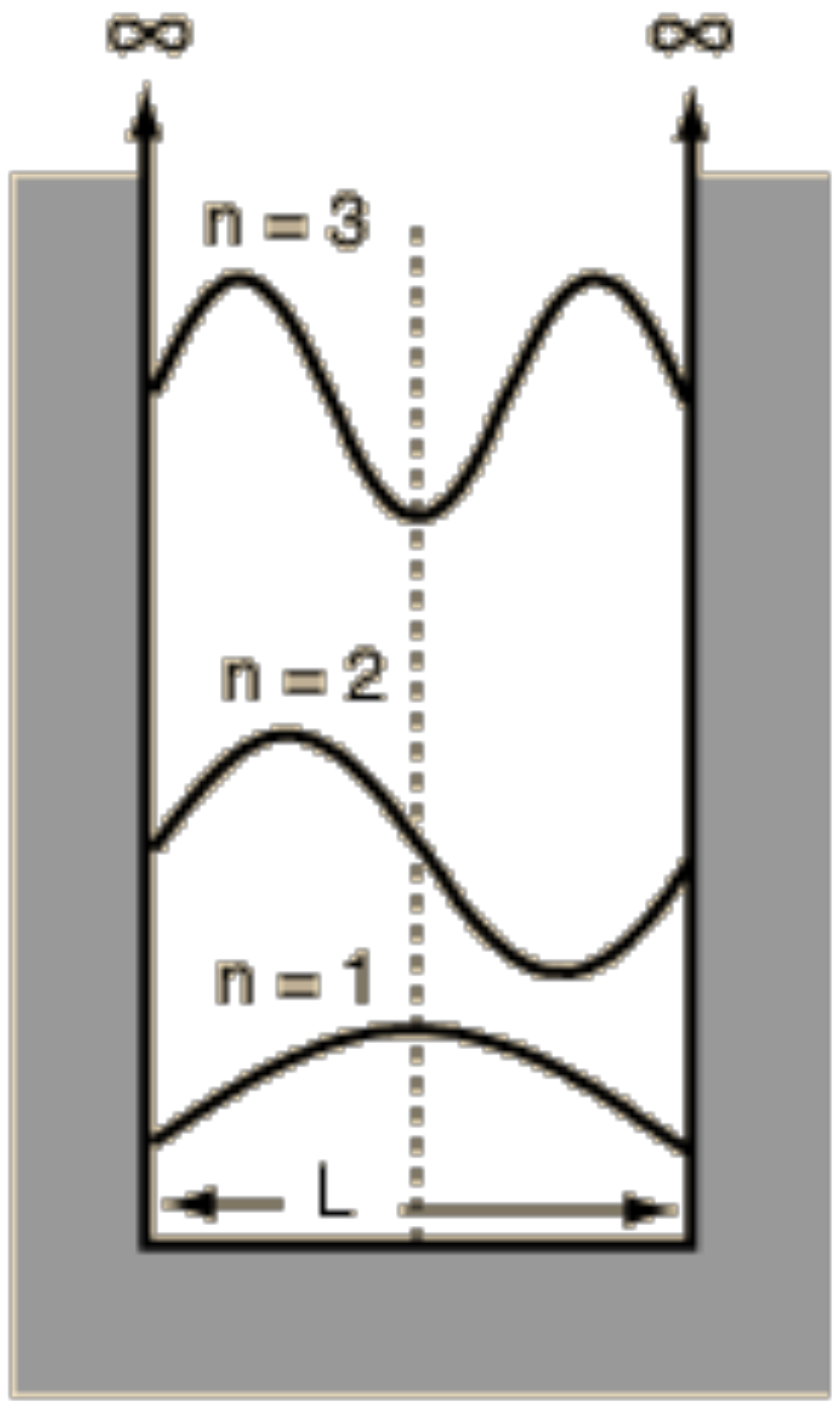
Energy eigenvalue

schrodinger equation

$$\frac{-\hbar^2}{2m}\nabla^2\Psi(\mathrm{r}) + V(r)\Psi(\mathrm{r}) = E\Psi(\mathrm{r})$$

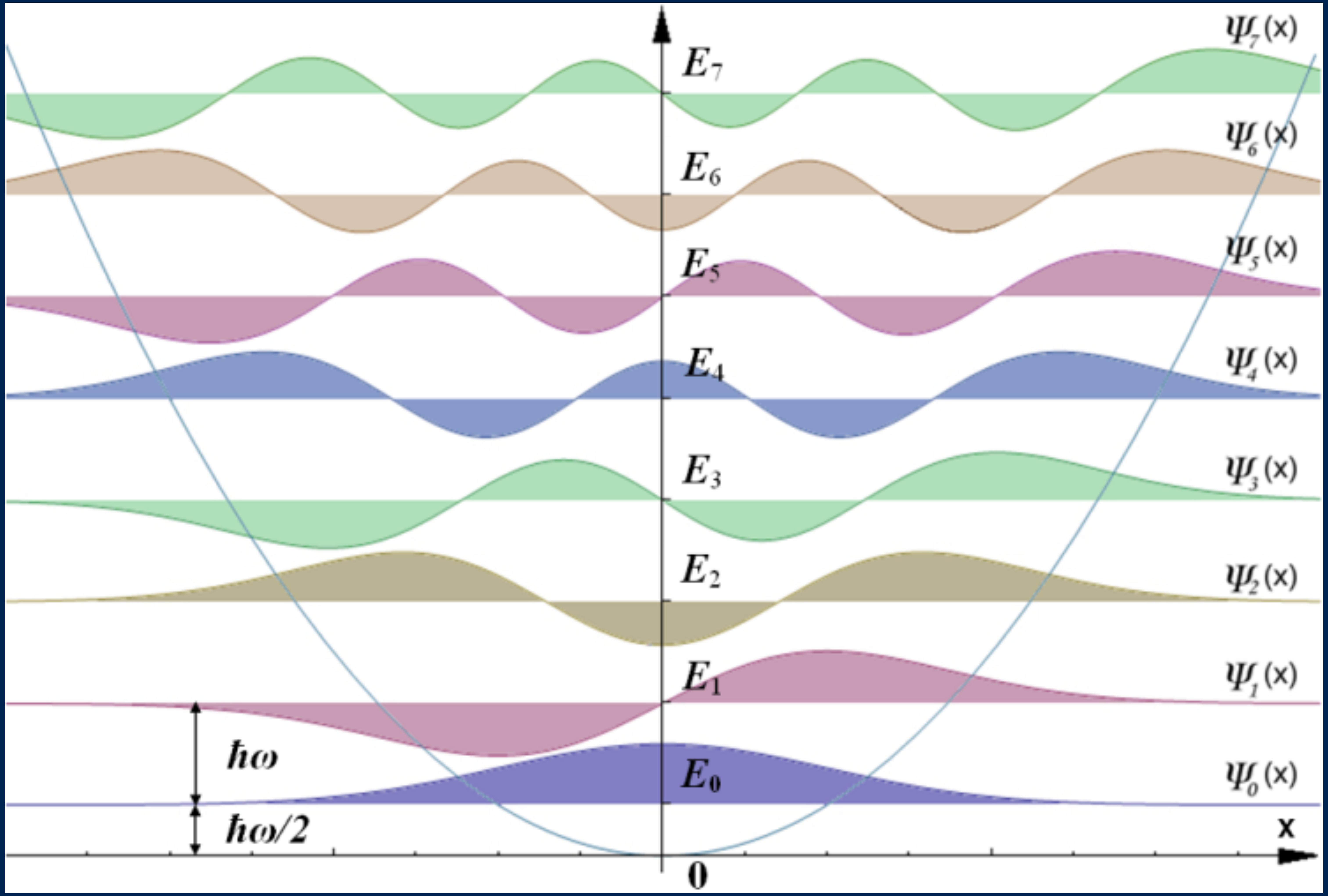
$$\textit{Kinetic Energy} + \textit{Potential Energy} = \textit{Total Energy}$$

particle in a box



x = 0 at left wall of box.

1d quantum harmonic



3d form

Second derivative
with respect to Z

Schrodinger wave
Function

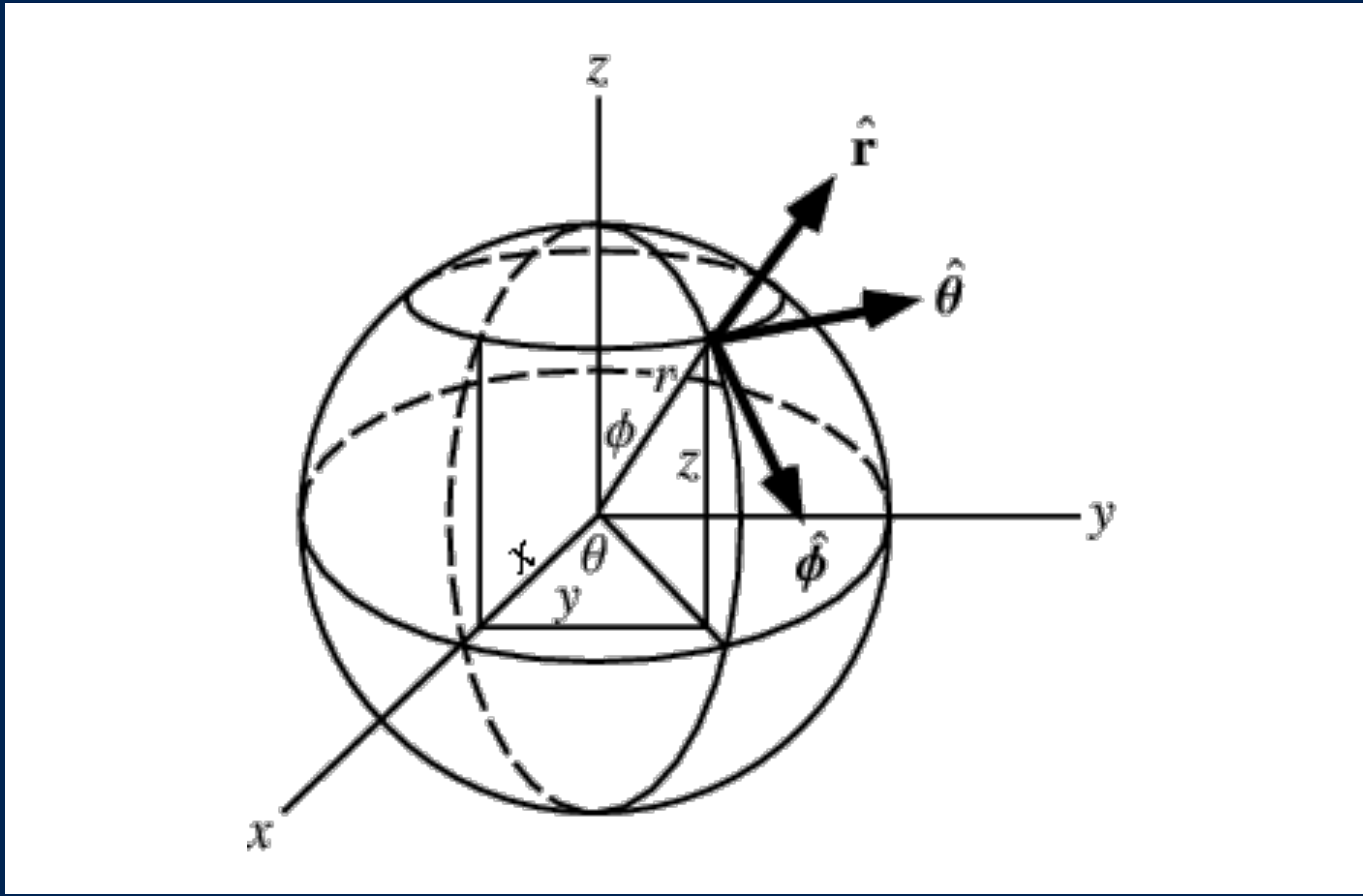
$$\frac{\partial^2\psi}{\partial x^2} + \frac{\partial^2\psi}{\partial y^2} + \frac{\partial^2\psi}{\partial z^2} + \frac{8\pi^2 m}{h^2}(E-V)\psi = 0$$

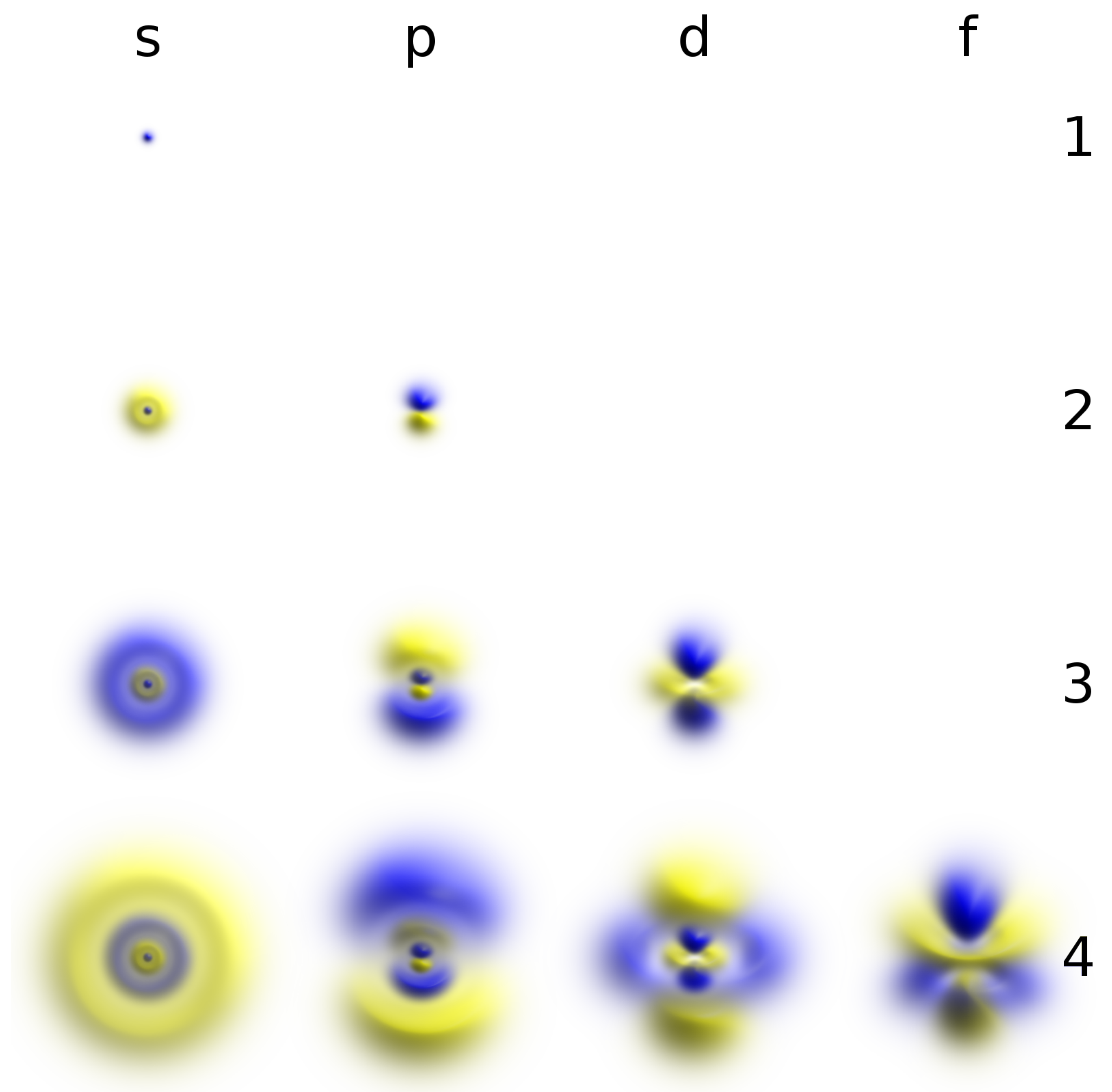
Position

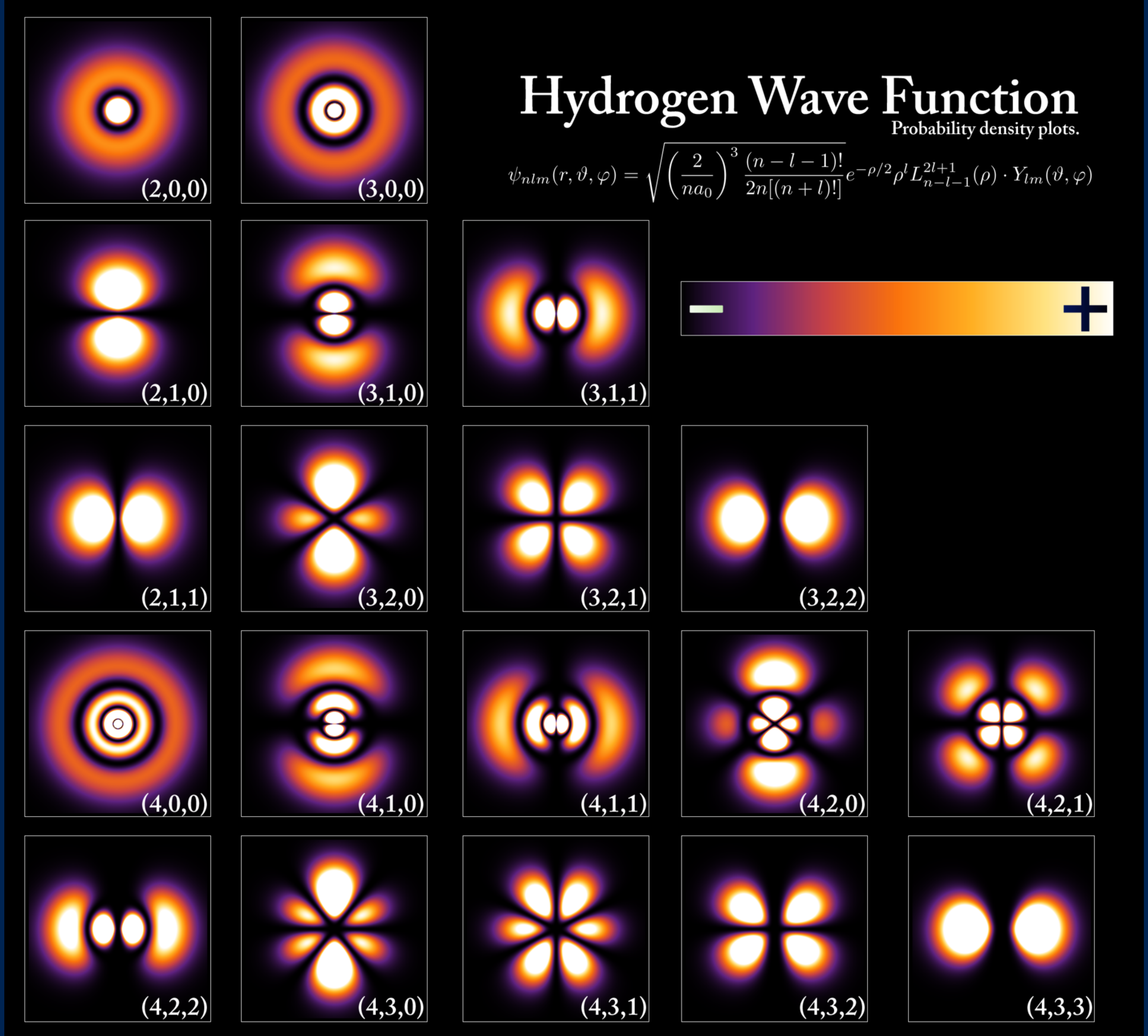
Energy

Potential
Energy

spherical coordinates




s
p
d
f
1
2
3
4

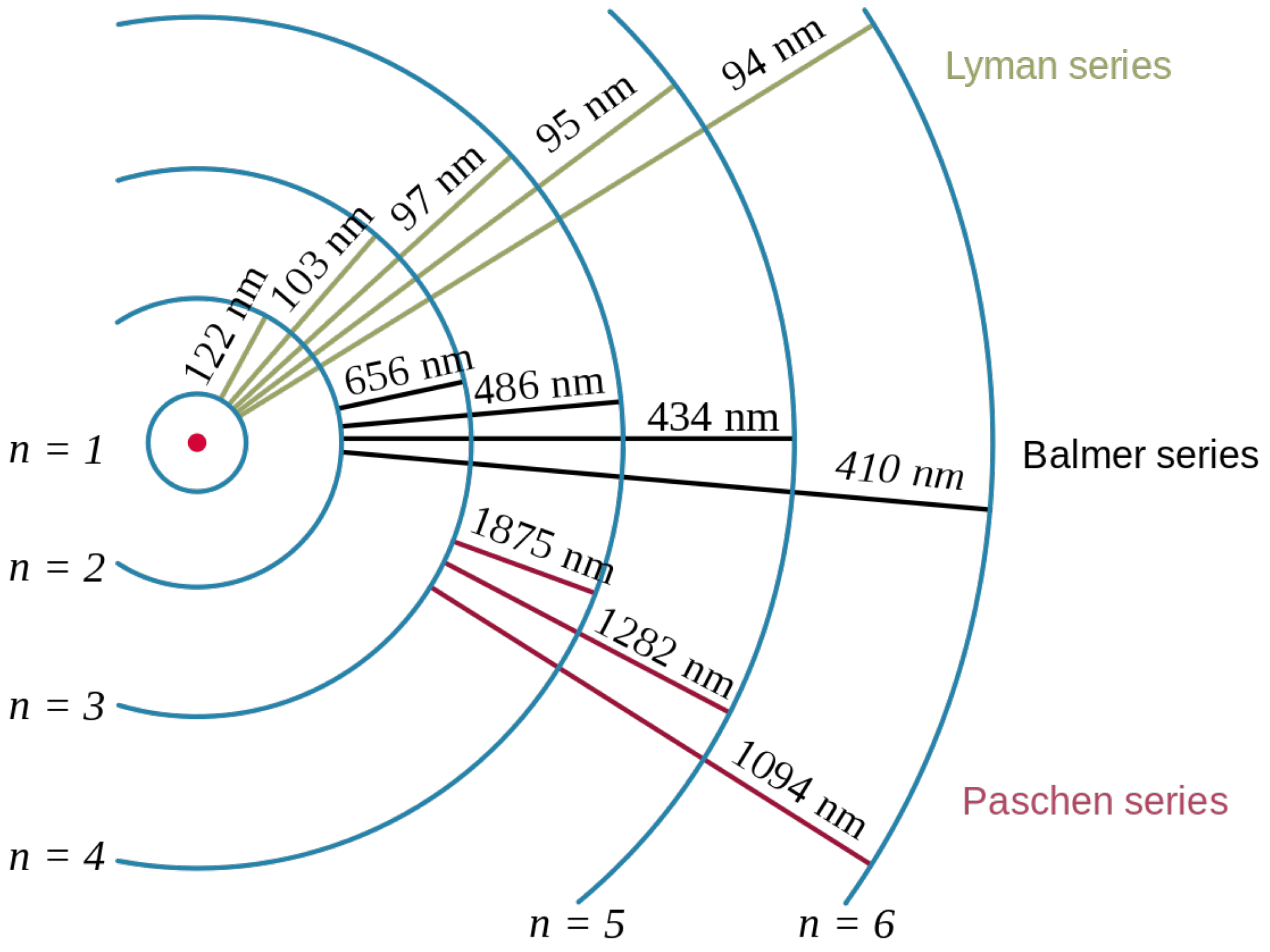

Hydrogen Wave Function
Probability density plots.
$\psi_{nlm}(r,\vartheta,\varphi)=\sqrt{\left(\frac{2}{na_0}\right)^3\frac{(n-l-1)!}{2n[(n+l)!]}}e^{-\rho/2}\rho^l L_{n-l-1}^{2l+1}(\rho)\cdot Y_{lm}(\vartheta,\varphi)$
−
+
(2,0,0)
(3,0,0)
(2,1,0)
(3,1,0)
(3,1,1)
(2,1,1)
(3,2,0)
(3,2,1)
(3,2,2)
(4,0,0)
(4,1,0)
(4,1,1)
(4,2,0)
(4,2,1)
(4,2,2)
(4,3,0)
(4,3,1)
(4,3,2)
(4,3,3)

einstein equation

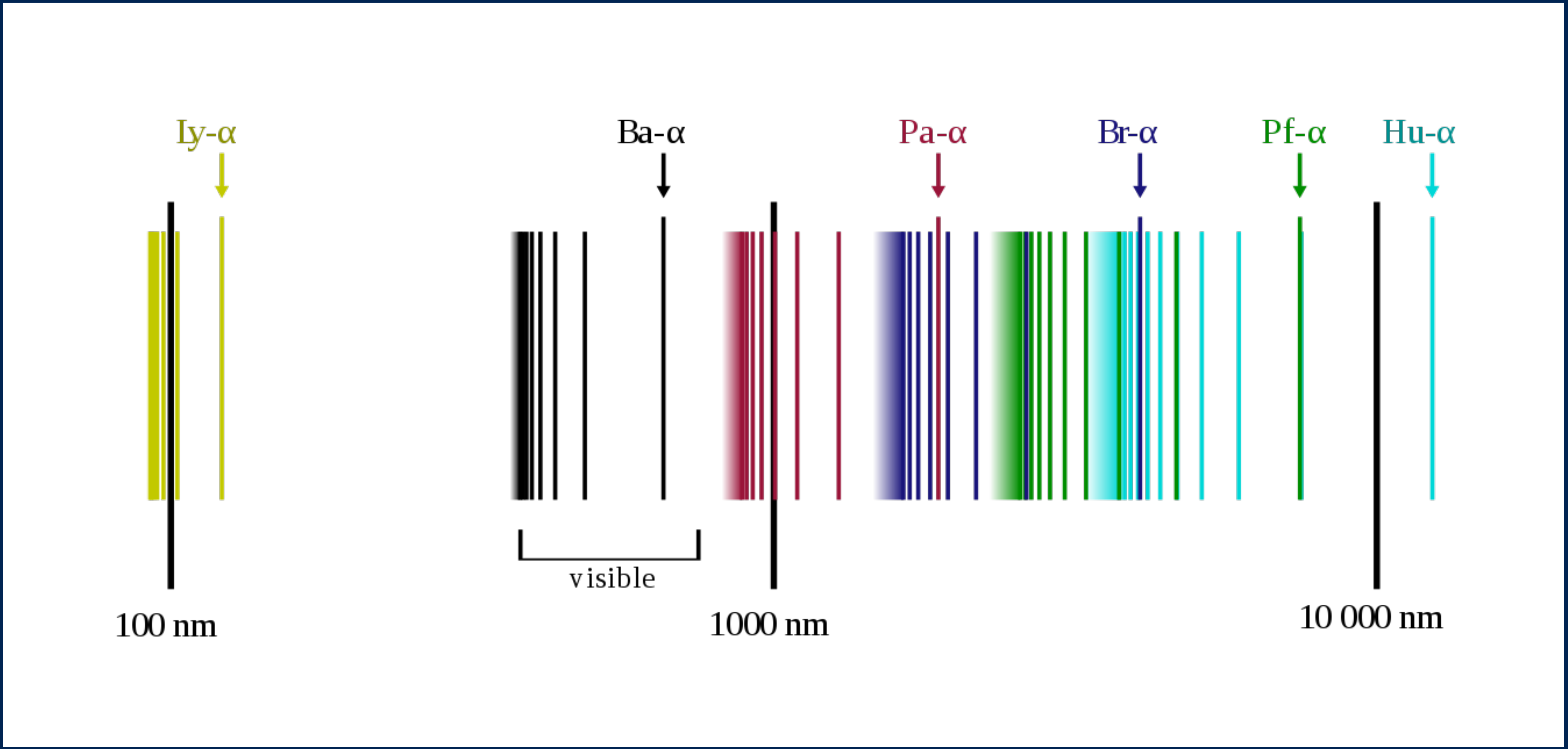
$$E = mc^2$$

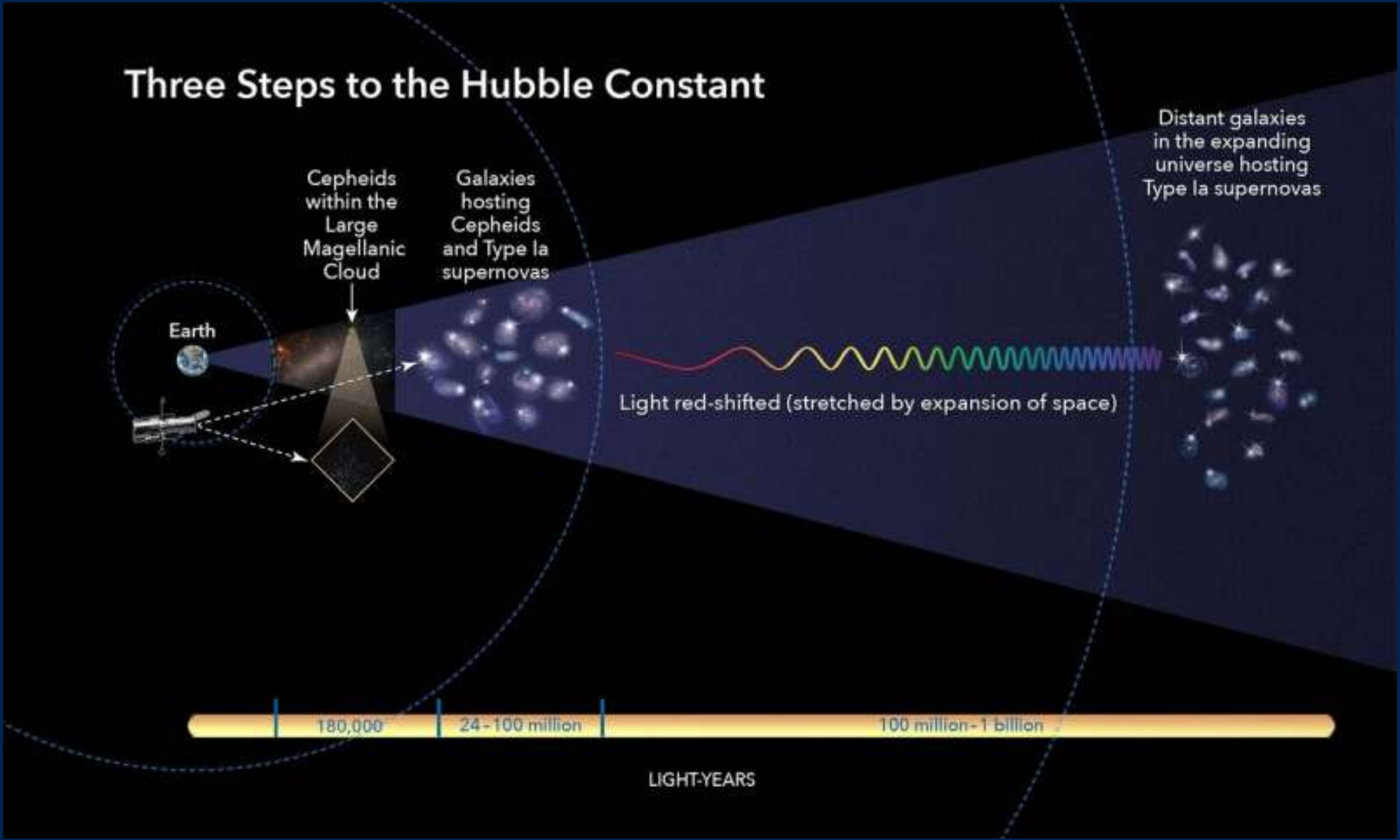
full hydrogen equation

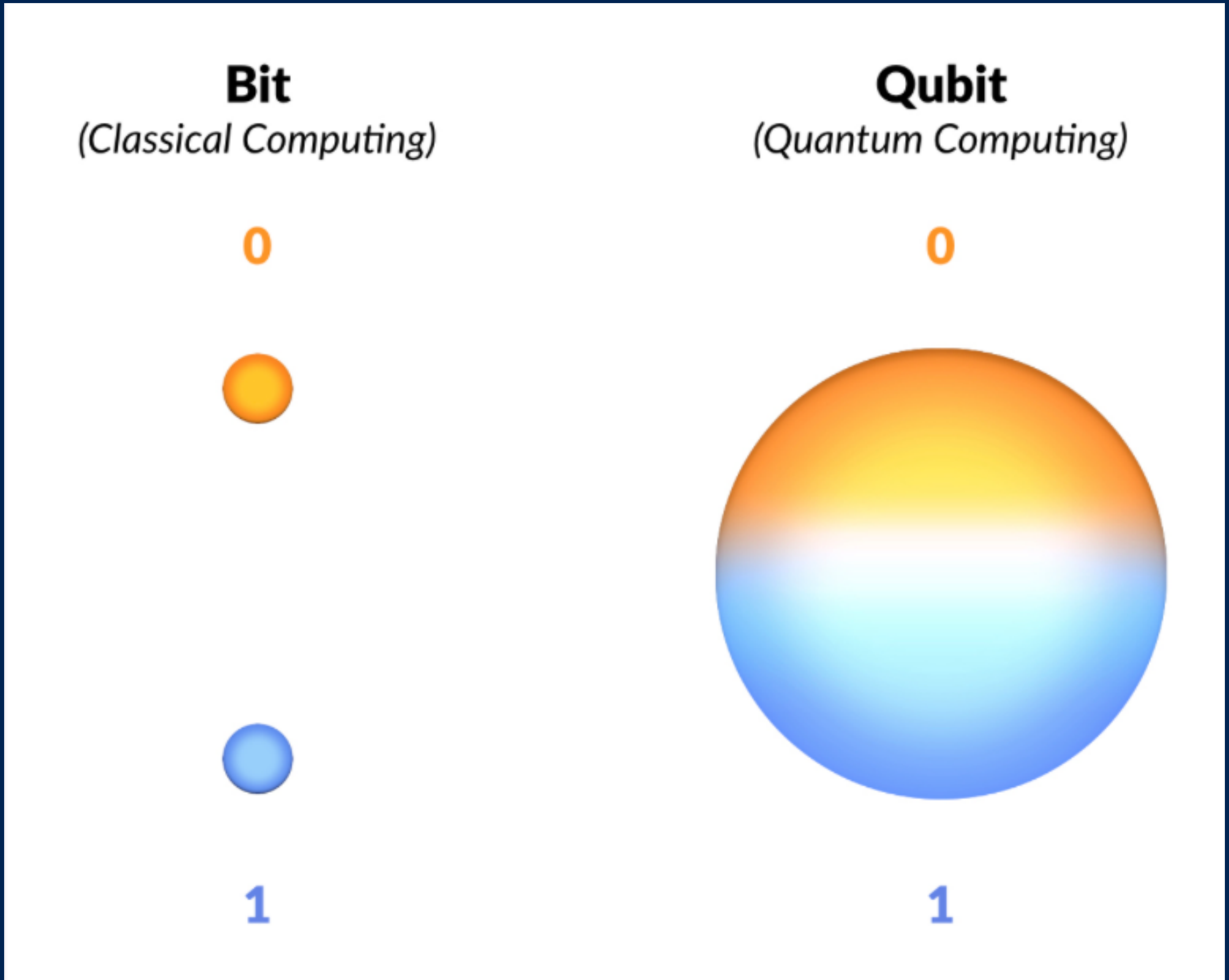
$$\left(\frac{p^2}{2m} - \frac{Ze^2}{4\pi r} - \frac{p^4}{8m^3c^2} + \frac{Ze^2\vec{L}\cdot\vec{S}}{8\pi m^2c^2r^3} + \frac{Ze^2\hbar^2}{8m^2c^2}\delta^3(\vec{r})\right)\psi \quad = \quad E^{(NR)}\psi$$

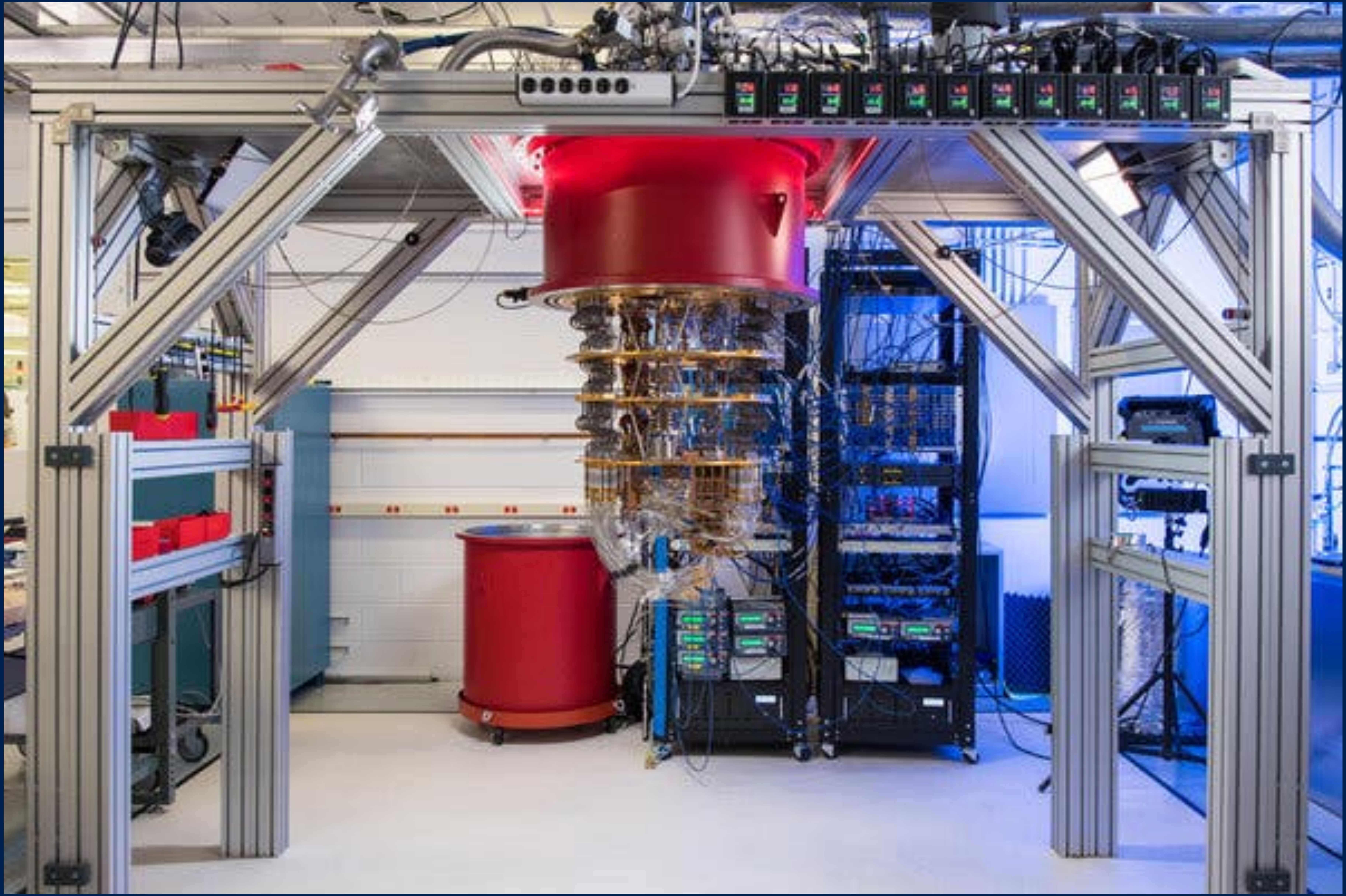

Lyman series
Balmer series
Paschen series
122 nm
103 nm
97 nm
95 nm
94 nm
656 nm
486 nm
434 nm
410 nm
1875 nm
1282 nm
1094 nm
n = 1
n = 2
n = 3
n = 4
n = 5
n = 6

hydrogen wavelengths

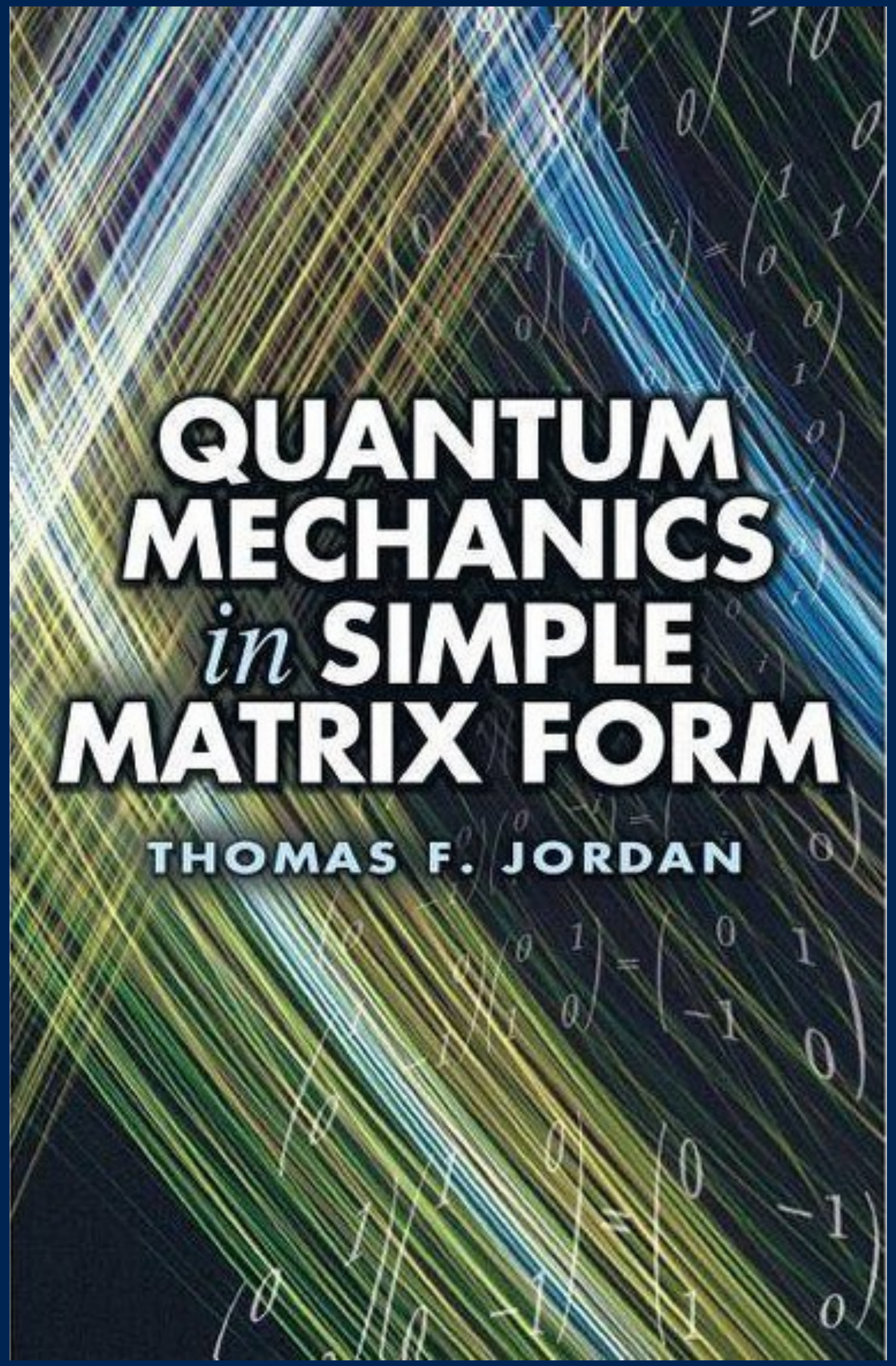



Three Steps to the Hubble Constant
Cepheids within the Large Magellanic Cloud
Galaxies hosting Cepheids and Type Ia supernovas
Distant galaxies in the expanding universe hosting Type Ia supernovas
Earth
Light red-shifted (stretched by expansion of space)
180,000
24 - 100 million
100 million - 1 billion
LIGHT-YEARS


Bit
(Classical Computing)
0
1
Qubit
(Quantum Computing)
0
1



thanks!



- https://quantummechanics.ucsd.edu/ph130a/130_notes/130_notes.html