Perfect Blackbody Spectrum
Quantum Mechanics in 20 min

① Many observables are quantized (i.e., cannot change by an arbitrarily small amount)
① Light waves: Energy for a specific frequency $f$ can only be absorbed or emitted in chunks (photons) of $E = hf$
② Possible energy for hydrogen atom can only assume values $E_n = -Ry/n^2$ (see next slide)
③ Angular momentum can only change by multiples of $\hbar = h/2\pi$
② All other observables are intrinsically uncertain
① Position: $x...x+\Delta x$
② Momentum: $p...p+\Delta p$
③ Heisenberg: $\Delta x \cdot \Delta p \geq \hbar/2$
③ Picture: particle motion described by waves ("wave function" $\psi$) that cannot be located precisely.
Quantization $\iff$ Standing Waves
Quantum Mechanics in 20 min

① Electron “motion” in hydrogen atom (nucleus = proton): standing wave described by wave function $\psi(r)$

② Schrödinger: Wave function is solution of the equation $H\psi(r) = E\psi(r)$, where $E$ is a possible energy “eigenvalue” and $H$ is a differential operator (“The Hamiltonian”)

③ Hydrogen atom: Only possible energies are $E_n = -Ry/n^2$ with $Ry = 13.6 \text{ eV}$ and $n = \text{integer}$. In general all atoms have a fixed series of possible energies $E_n$

Light can only be emitted with frequencies given by $hf = E_n - E_m$
Quantum Mechanics and Line Spectra

\[ \Delta E(n \rightarrow m) = Ry \left( \frac{1}{m^2} - \frac{1}{n^2} \right) \]

Lyman series

\[ \lambda = \frac{hc}{\Delta E} \]

Balmer series

Paschen series