1 | Quantum Mechanics

What is quantum mechanics? Quantum => in small/discrete steps

The Quantum of US Currency => $0.01

1.1 | Puzzle of the Blackbody Radiation

(”black” => opaque): from solid materials, liquids

The radiation from hot, solid materials looks samey (bright yellow) unlike every gas, however, had a spectral emission (think - neon lights.)

But!

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The light spectrum did depend on temperature, so what happened? Why is everything hot?

Max Plank => trying to model incoming light source from rays as basically all absorbed and not bounced back.

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Max Plank’s Model 1 in this manner matched well with observations at long wavelengths (red hot). But, it predicted infinite brightness (it will just ”keep bouncing”) as wavelength => 0, which is wrong. This is the ”ultraviolet catastrophie.”

So, he made it better.

Max Plank’s Model 2 is just Model 1, but an additional assumption that when Energy Transfers from e^- to EMWave, δE must be some constant * frequency of light.

So, to synthesize high frequencies, this cop out had the effect of supressing the infinite growth as δE would grow bigger and bigger to the point where all your energy would not go into the EMWave but to this transferring factor.

Which is like… Kind of a cop out. But it did fit medium frequencies better.

Einstein > `Light !` ”wave”; instead, light are photon particles moving through space.

Impontant Knowledges::

Energy of each photon is equal to the plank constant (h) times the frequency (f). $E = h * f$.

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$\lambda * f = c$

$E_{photon} = h \times f$

Instead of Hertz, however, the frequency of F could better be represented with ω, a unit of $\frac{radians}{sec}$ that is derived as $2\pi f(\frac{radians}{s})$

So to calculate energy with ω, simply use $\bar{h} = \frac{h}{2\pi}$ and so $E = \bar{h}\omega$

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1.2 | Heisenberg Uncertainty

$\Delta E \times \Delta t = \bar{h}$ => ”uncertainty of energy times uncertainty in time is the reduced plank’s contstant”

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Lifetime of the upper level => Δt

(Mean) lifetime of the "upper" energy level => Δt. So, $\Delta E = \frac{\bar{h}}{\Delta t}$.

If Δt is small, ΔE is large.

As long as the units of two deltas end up as $J \times s$, they would be related by the same way with $\bar{h}$

This ΔP has an actual effect on our vision

THIS IS IMPORTANT, TOO! $\Delta \vec{p} \times \Delta \vec{x} \approx \bar{h}$.

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Meaning, in the subatomic world, everything exists based on differening upper-energy-state-time based uncertainties.

"Diffraction through an apreture"

We could see a similar pattern in passing photons through a llit. $Slitlarge, \Delta P_x small\ Slitsmall, \Delta P_x large$.

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This limits the width of the lens of a camera because of the uncertanity in momentum.

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Taking the angle, and dividing it by 3000, which is $\frac{1}{60}$ degrees.

Even though Plank's constant is a tiny number, it effects how sharply you eyes could see b/c of this uncertainty.

There are three "flavor"s of Leptons, each with two variations — creating six different leptons.

Lepton => "small", but they are not actually that small as what their original namer had suggested.

1.3 | Famous Leptions

- The Electron
  - Dirac's equations predicted the existance of a certain "positiron" which would be the oppostite of an electron. After self-determination (the "equation was too perfect to be wrong"), he set out hard to try to prove it.

Interactions in the small scale world occur through the creation and annihilation of particles.

Neutrinos interact only by weak interactions, which is (bar gravity, which is the weakest physical interaction) a very weak physical interaction.

1.4 | A table of particles

Particle	Wat
Leptons	Fundimental one-half spin particles, experience strong interaction, have no quarks
Baryons	Componsite particles made of quarks + has 1/2, or 3/2, or 5/2 spin
Mesons	Composite particles made of quarks + has 0, 1, or any interger spin
Quarks	Fundimental strongly interacting particles that never appear singly
Hadrons	Bayrons and Mesons that strongnly interact
Nucleaons	Neutrons and protons that reside in the nucleai
Fermions	Leptons, quarks, and nucleans: all have 1/2 odd interger spin
Bosons	Force carriers, like mesons, have intergin spin

Positive pion decays into a positive muon, an *antimuon*, and a neutrino.

The negative pion decays into a negative muon and an antineutrino.

A pair of electrons could collide and form a pair of tou particles.

Three flavours of leptons cannot interchange or become each other, but they could interact.

2 | Photoelectric Effects

If you take a piece of conductor, for instance, a metal, and shine a EM radiation on it (a light), you will know that there is a possiblilty for electrons to escape the surface

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Most effective way of doing this: large Force, and shine for a long time.

Wrong but intuitive:

Large force => large electric field => bright light. Long wavelength light => long time => red light.

But! Long wavelength light, no matter how bright, ejected nothing. Short wavelength light, no mater how dim, ejected electron.

Kinetic energy of the ejected electrons was related to the frequency of the electron used. Higher frequencies gave electrons more frequency.

The brightness of light only had to do with electrons/sec. If you make the light brighter, you just get more of electrons, but they have the same energy.

this is because….

Light is a particle! A photon.

Each photon has an energy porportional to its frequency; that is, $E = hf$, where f is plank's constant and f the frequency.

So each e- in metal interacts with one photon at a time.

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A certain minimum amonut of energy is needed for electron to escape. The minimum escape energy is called the "**work function**" of the metal.

Electron will be ejected as long as your kinetic energy gets there.

Energy of yoru photons goes to two places => satisfying the work function + Kinetic energy of the ejected electron

Hence: $h \times f = WF + KE_{e^-}$, where WF is the work function of the material, and h, planks constant, f is the frequency