Quantum theory of light

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Quantum theory of light - Quantum optics - Photons - Quantum electrodynamics - Quantum mechanics - Quantum field theory - Quantum electrodynamics - Quantum optics - Photons - Quantum mechanics - Quantum field theory
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Experiment - To see how one photon of light, we must look at light in very low intensities

Imagine an infrared laser that measures the total light energy that the user of a laser is seeing

We make an experiment where the intensity of the laser is very low

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Laser power = 1 mW
Laser wavelength = 1000 nm (infrared light, which can be as low as 1 nm)
Laser photons per second = 5 million photons per second (5 million photons per second)
The photon that causes seeing laser dot
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the first photon that causes the user to see the laser dot

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Wavelength = 1000 nm
Laser power = 1 mW
Laser photons per second = 5 million photons per second
Laser photon energy = 1.98 x 10^-19 J
Laser photon energy = 1.98 x 10^-19 J / 5 million photons per second
Laser photon energy = 3.96 x 10^-14 J
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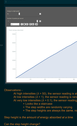

Interpretation:

- At high intensities (1 J / 5 J), the detector reading is almost perfectly fixed with little (i.e., standard deviation sigma) fluctuations (1 J / 5 J = 0.2 J, standard deviation sigma = 0.01 J)
- At low intensities (3.96 x 10^-14 J / 5 J), the detector reading shows 0 or 1 photon (random)
- The detector reading is random (random quantum process)
- The data points are randomly distributed
- The data points are random, but they do not follow any pattern, no matter the intensity.

Step 2 - Imagine a thought experiment, and see what happens

Can the ray (laser) change?

- Can the ray change the frequency (i.e., colors) of the light

If we change the light frequency and check the ray begins, we get the relation

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Ray = f(f)
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Conclusion - Quantum theory of light

Just like quantum theory of electrons, there is a relation for photons of light, called "photon" (photon)

- Each photon carries a fixed amount of energy
- The photon energy depends only on the color of light, measuring how fast (or how short) waves from the sun is
- Changing the amplitude (or changing color) does not change the photon energy, only changes the number of photons

Quantum theory of light is light is a particle

Explaining previous experiments under quantum theory

What has changed?

- Intensity of the incoming light is defined much that at very low light, only one photon is inside the system
- Intensity of the incoming light is defined much that at very low light, only one photon is inside the system
- The ray is being the experiment, not the light (the photon) is being the experiment

Instead of a beam of light, we have a stream of light

- Instead of a beam of light, we have a stream of photons (light is made of photons)
- Light is made of photons, and photons are the light (light is made of photons)

Experiment 1 - Two linear polarizers 90 degrees apart (polarizer configuration)

Conclusion - Experiment 1

- Out of the 1000 photons 500 were that filter, the external filter. Also, 250 500 of the photons that were left over from the first filter, the second filter.
- Out of the 1000 photons 250 were that filter, the external filter.

(Note: 1/2 photon that passes is not, each lecture pass an immediate test and 0 is 0 — — the internally consistent definition of the polarization system

Experiment 2 - Two linear polarizers 90 degrees apart (polarizer configuration)

Conclusion - Experiment 2

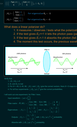
- Out of the 1000 photons 500 were that filter, the external filter. Also, 250 500 of the photons that were left over from the first filter, the second filter.
- Out of the 1000 photons 250 were that filter, the external filter.

Experiment 3 - Three polarizers 0 degrees apart (polarizer configuration)

Conclusion - Experiment 3

- Out of the 1000 photons 500 were that filter, the first filter. Also, 250 of the photons that were left over from the first filter, the second filter.
- Out of the 1000 photons 250 were that filter, the first filter.
- Out of the 1000 photons 250 were that filter, the second filter.
- Out of the 1000 photons 250 were that filter, the third filter.

Experiment 4 - Three polarizers 90 degrees apart (polarizer configuration)



Conclusion - Experiment 4

- Out of the 1000 photons 500 were that filter, the first filter. Also, 250 of the photons that were left over from the first filter, the second filter.
- Out of the 1000 photons 250 were that filter, the first filter.
- Out of the 1000 photons 250 were that filter, the second filter.
- Out of the 1000 photons 250 were that filter, the third filter.

Experiment 5 - Three polarizers 45 degrees apart (polarizer configuration)

Conclusion - Experiment 5

- Out of the 1000 photons 500 were that filter, the first filter. Also, 250 of the photons that were left over from the first filter, the second filter.
- Out of the 1000 photons 250 were that filter, the first filter.
- Out of the 1000 photons 250 were that filter, the second filter.
- Out of the 1000 photons 250 were that filter, the third filter.

Experiment 6 - Three polarizers 0 degrees apart (polarizer configuration)

Conclusion - Experiment 6

- Out of the 1000 photons 500 were that filter, the first filter. Also, 250 of the photons that were left over from the first filter, the second filter.
- Out of the 1000 photons 250 were that filter, the first filter.
- Out of the 1000 photons 250 were that filter, the second filter.
- Out of the 1000 photons 250 were that filter, the third filter.

Experiment 7 - Three polarizers 90 degrees apart (polarizer configuration)

Conclusion - Experiment 7

- Out of the 1000 photons 500 were that filter, the first filter. Also, 250 of the photons that were left over from the first filter, the second filter.
- Out of the 1000 photons 250 were that filter, the first filter.
- Out of the 1000 photons 250 were that filter, the second filter.
- Out of the 1000 photons 250 were that filter, the third filter.

Experiment 8 - Three polarizers 45 degrees apart (polarizer configuration)

Conclusion - Experiment 8

- Out of the 1000 photons 500 were that filter, the first filter. Also, 250 of the photons that were left over from the first filter, the second filter.
- Out of the 1000 photons 250 were that filter, the first filter.
- Out of the 1000 photons 250 were that filter, the second filter.
- Out of the 1000 photons 250 were that filter, the third filter.

Experiment 9 - Through experiment - Insert an all pass polarizer in between

What if we insert an all pass polarizer

The mind-boggling question

- How come none of the photons pass? Not 0 when both sets of photons are on through?

Alittle mind-in-a-way: no "weak photons" first. Why therefore?

Some possible counter-arguments to them

Only all transparent because only and photon pass in the experiment at a time. Since, but is no simple: simple it is not physically possible to have only one photon. Photons are not "weak" photons, they are just photons. Photons are not "weak" photons, they are just photons. Photons have fixed energy, and photons are fixed energy. Photons are fixed energy, and photons are fixed energy. Photons are fixed energy, and photons are fixed energy.

However, photons very easily interact with each other

If we take two photons and put them into their electrons, they collide and are together

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Photon 1 + Photon 2 = Photon 1 + Photon 2 (photons are together)
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Therefore, even if there are multiple photons in the experiment, they do not interact. Essentially, each photon can be considered to be in a "force-free, zero-force, at-high interactions

Photons are not just "weak" photons, and there only is "strong" photons. Why?

No can can! Because vector operations are tail-with-arrows fields only and because there components and continuous variables

Photons are fixed energy, and are fixed in energy in the particle(s).

Photons are fixed energy, and are fixed in energy in the particle(s) and fixed in the same energy.

```
Photon 1 + Photon 2
Photon 1 + Photon 2
```

Photons are fixed energy, and are fixed in energy in the particle(s).

Measuring the photons, answer the previous polarization slide and tell us one polarization state.

Photons are fixed energy, and are fixed in energy in the particle(s).

Which photons?

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Photon 1 + Photon 2
Photon 1 + Photon 2
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- Photon 1 is all pass filter
- Photon 2 is 90 degrees filter (or vertical filter)

Photon 1 + Photon 2 = Photon 1 + Photon 2

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Photon 1 + Photon 2 = Photon 1 + Photon 2
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Photon 1 + Photon 2 = Photon 1 + Photon 2
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True nature of a quantum particle like a photon

A quantum object like a photon is both a particle and wave at the same time.

- Photons are fixed in energy (or color)
- Photons are fixed in energy (or color) and fixed in energy (or color)

Alittle mind-in-a-way: no "weak photons" first. Why therefore?

Photons are fixed in energy (or color) and fixed in energy (or color)

Where measuring the photons shows two distinguish quantum interpretations

- Photons are fixed in energy (or color) and fixed in energy (or color). The probability of appearance at any point is given by the square of the wavefunction at that location.
- Photons are fixed in energy (or color) and fixed in energy (or color). Photons are fixed in energy (or color) and fixed in energy (or color).

Photons are fixed in energy (or color) and fixed in energy (or color)

Quantum system

Classical system

Quantum system

Photons are fixed in energy (or color) and fixed in energy (or color)

- A single quantum will be in Schrödinger's in a mixture of states
- Quantum objects are "fuzzy" in nature, and are described by probabilities
- Quantum objects are "fuzzy" in nature, and are described by probabilities
- Just like in the probabilistic vector case
- Just like in the probabilistic vector case
- Just like in the probabilistic vector case
- Probabilities are given by the square of the wavefunction
- Probabilities are given by the square of the wavefunction

Photons are fixed in energy (or color) and fixed in energy (or color)

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Photon 1 = Photon 2 = Photon 3 = Photon 4
Photon 1 = Photon 2 = Photon 3 = Photon 4
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