

# SINGLE EDGE CERTAINTY Copyright © Bill Alsept 3-16-2015

## A PARTICLE THEORY OF LIGHT

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**Abstract:** The nature of light has been questioned for hundreds of years. Is it a wave, a particle, or both? For those unwilling to accept the non-conclusive concept of duality, this paper offers a clear and simple particle-based solution. Contrary to scientific consensus, the fringe patterns observed in various slit, or edge experiments can be constructed from many individual photons. Not only do individual particles contribute to these patterns but the ideas behind **Single Edge Certainty** will do away with the approximations, assumptions, and uncertainties of the wave theory. This is a work in progress.

**Introduction:** The debate over the nature of light and matter goes back to the 17th century when Isaac Newton and Christian Huygens offered conflicting theories. Newton proposed that light was made of particles, while Huygens's theory consisted of waves.

For 350 years, these competing theories have continued to develop. Scientists such as Planck, Young, Einstein and many others have worked to compile the current scientific theory, that all particles have a wave nature. In other words, a wave-particle duality.

I never gave it much thought, and until recently, had never even considered the double slit experiment. As you know, there's a light source directed toward two narrow slits and a fringe pattern (interference pattern) forms on a distant screen. The pattern is made of equally spaced bright and dark fringes and the phenomenon has intrigued scientists for centuries. Often this concept is illustrated with overlapping semicircles representing waves as in **figure 1**.

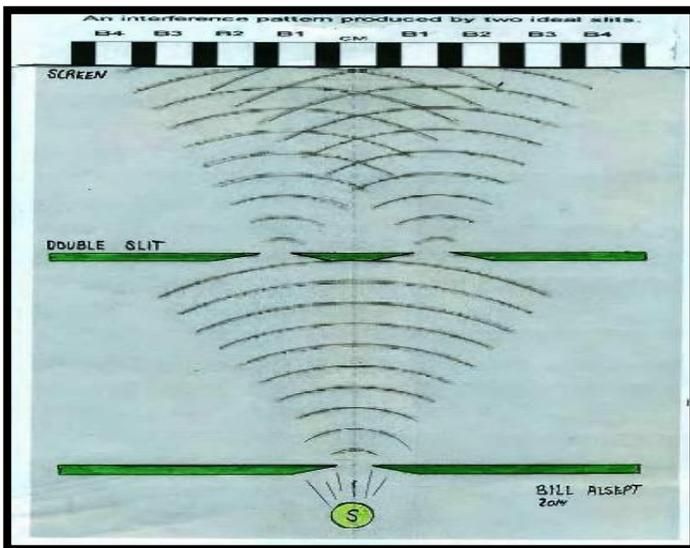


Figure 1

The wave theory is explained with sets of waves overlapping to form constructive and destructive interference. You can hardly find descriptions of light waves that do not include analogies of water or sound. It's easy to understand how water or sound form these waves because there are multiple forces and a medium involved. With water there is an initial force pushing against water molecules. A wave crest forms when displacement meets resistance and gravity pushes down on the crest countering the whole effect. There would not even be a water wave without the force of gravity or any one of the other forces involved. Sound waves also have multiple forces, including momentum, pressure, and density differences.

Light on the other hand has no medium to travel in or any of these countering forces. The wave theory of light doesn't even offer a physical explanation. The only descriptions attempted are Huygens's *wavelets*, or Heisenberg's *Uncertainty Principle* and neither are physical explanations.

The *Wave Theory* assumes only waves can explain the interference and implies the impossibility of a particle derivation. Everyone talks about duality, but particles of light are never seriously considered. I propose on the contrary, that light is only made of particles. Billions of individual photons, each one with real and physical properties including at the very least, speed, trajectory, polarization and a frequency that determines its energy.

## PHOTONS

In 1905 Einstein explained "Plank spectrum" by offering a hypothesis that the quantization of energy was a part of radiation itself, and common to all emissions and absorptions. He mathematically predicted the photoelectric effect which at the time was not so well measured.

Einstein's idea that radiation was universally emitted in packets of energy was radical, contradictory and not seriously considered. For years he was pressured to withdraw his crazy photon hypothesis. Even Seventeen years later in 1922 when he received his only Nobel Prize, it was not for his physical explanation of the photoelectric effect. It was for predicting the formula describing the phenomena.

100 years later the particle aspect of light is still not truly considered. In fact, its ignored when it comes to the derivation of interference fringe patterns. Even though there's abundant evidence that light comes in individual packets of energy, all attention seems to be on the wave. What is a light wave anyway if not billions of coherent photon particles? There is no experiment anywhere that determined, it had to be waves instead of particles, creating the fringe patterns we observe.

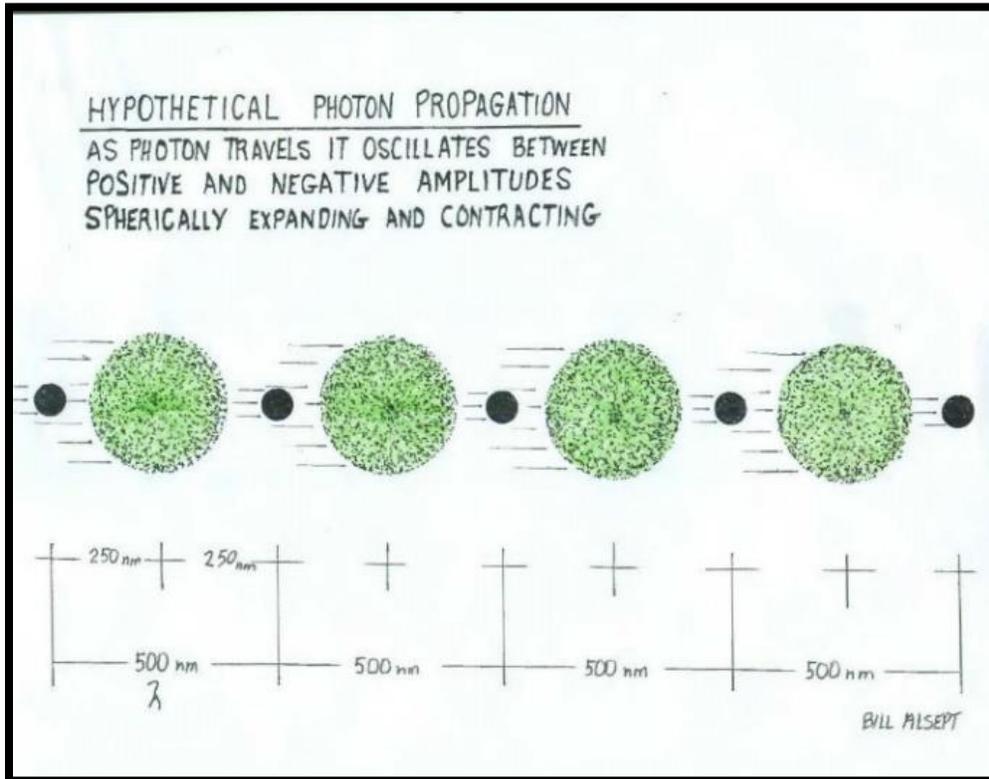
When it comes to particle theory of light, we have the photon. Everyone agrees photons are individual packets of energy but there's much disagreement as to what that means. Is a photon an excitation of some kind of field that somehow collapses to a point, or an individual packet of energy that travels an actual trajectory from one point to another?

To truly consider a particle aspect of light, we need specific physical properties to consider. Keep in mind that until now, no physical model to describe light as a wave or particle has ever been offered.

I could offer several models and the following photon hypothesis is just one that fits the derivations in this paper while explaining many of the light phenomena we observe.

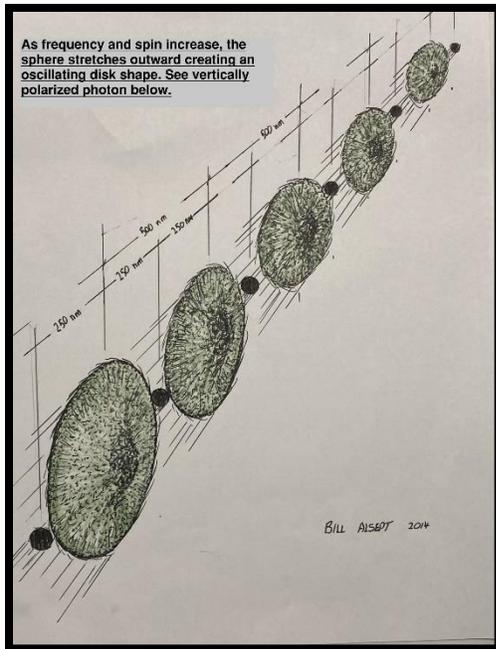
Like anything else in the universe, photons are not solid little balls. Instead imagine a spherically shaped packets of energy oscillating through cycles of expanding and collapsing, similar to the hypothesized model of our cyclical universe. A photon's oscillation rate is its frequency.

Picture a single  $500\text{nm}\lambda$  photon traveling along at 300,000 kilometers per second in a straight line. As the photon moves through space, it oscillates in and out through full cycles of expanding and collapsing. The image below represents a photon traveling left to right at the speed of light as it expands and collapses every 250 nanometers, completing a full cycle every 500nm. See **figure 2**.



**FIG 2**

Now imagine the photon sphere rotating as it oscillates. As the rotation increases, the sphere stretches outward at the equator giving the photon a definite polarization. And like any stringed instrument, the oscillating frequency increases with the tension. Together we have a spherical/disk shaped packet of energy oscillating and spinning as it propagates through space at the speed of light. **See Fig 3**



**Fig. 3**

Each photon is polarized to a specific degree about an axis in the direction of propagation. Most important, every photon can be counted or measured as an individual particle. There are many ways to theorize a packet of energy oscillating or propagating through space, but whatever photons are doing, they do it a lot. The energy of a photon is labeled by its wavelength, but wavelength is only a convenient unit of measurement. Really, it's the frequency that matters.

A photon with a 500-nanometer wavelength has an extreme oscillating frequency of more than 600 terahertz per second. That's 600,000,000,000,000 or (600 trillion) oscillations per second! Think about that and convince yourself. In a typical slit experiment, a photon travels about one meter, or one billion nanometers ( $L=1,000,000,000$  nm). During that short trip to the detection screen, the photon will oscillate 2,000,000 times. Now if you divide the meter ( $L$ ) by the number of oscillations you'll get an extremely small distance of 500 nanometers. ( $1,000,000,000/2,000,000=500\lambda$ ). 500nm is the distance a photon travels as it oscillates through one cycle. We call this a wavelength, **but it has nothing to do with waves.**

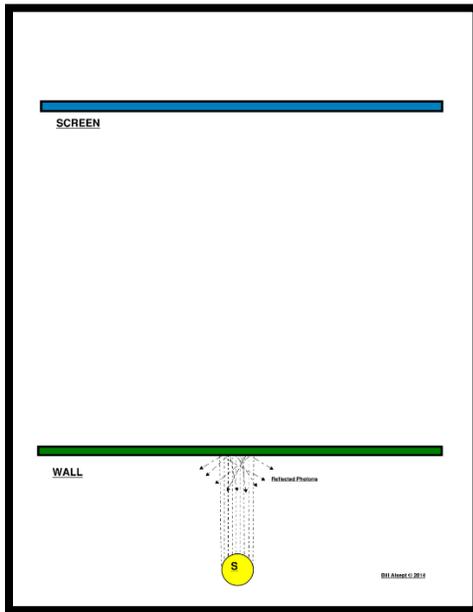
We may not know everything about photons, but each one does have a certain frequency and travels close to 300,000 kilometers per second. Every photon has a polarization that can be changed, and a trajectory that can be diverted. Photons can diffract around corners and scatter off edges. We also know that photon energy which can be transferred is directly related to its frequency.

Someday more photon properties could be discovered, but just applying the few properties listed above, it can be shown that light made of particles can account for any light phenomena, especially the fringe patterns we observe.

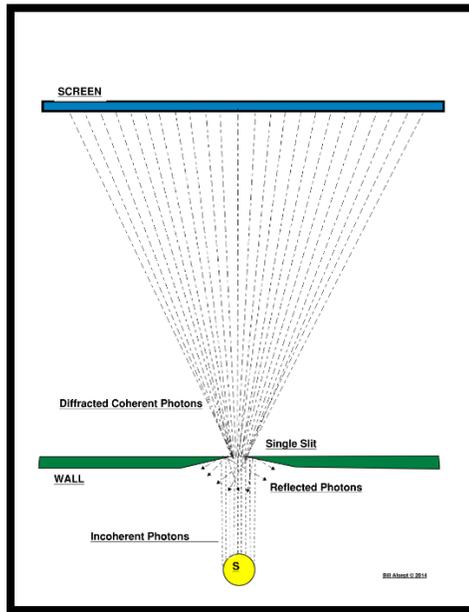
Step by step I'll show how the fringes are physically and mathematically constructed from the buildup of individual photons. The convolution of these photons at a detection screen can be all at once or one at a time.

## PHOTON PATHS

When a visible photon is emitted toward an opaque wall, it travels a straight line (if not disturbed) until it impacts an atom on that wall. The photon's energy will be absorbed, and a new photon may or may not be emitted in some random direction from that spot. **Figure 4**



**Figure 4**



**Figure 5**

If the wall has an opening or slit, then some photons will make it through and continue on their way. Their trajectories will be diverted left or right proportional to their proximity to the edges. The closer a photon gets to an edge the more its path will be diverted. See **Fig 5**.

As a photon passes close to an edge, it's oscillating may be expanding or collapsing. This will determine if the photons trajectory scatters away from the edge or diffracts around and behind the edge. Photons making full contact with the edge can be absorbed and randomly emitted from that spot. Randomly polarized photons passing through, will become polarized parallel to the edge.

Eventually billions of photons are diverted left and right along the plane to spread across every part of the detection screen **including the dark areas**. To understand this better let's take a closer look at a **single edge**.

## THE SINGLE EDGE

The most popular experiment is the double **slit** experiment. Obviously, it has two single **slits** but take a closer look at the left side of the left slit. We'll call this **Edge 1**. See **figure 6**

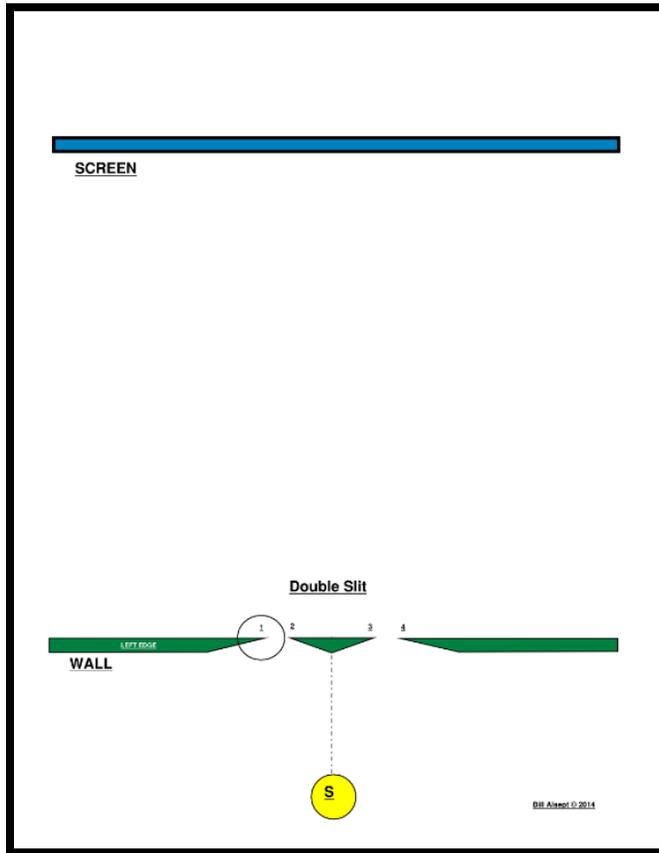


Figure 6

In **FIG. 7** there's a light source, a single edge and a detection screen. Photons traveling close to the edge will scatter at different angles depending on their proximity to the edge. In other words, they are linear dependent, based on what their frequency and oscillating phases are, as they're passing the edge. Keep in mind that they go to every area of the screen and not just the bright areas.

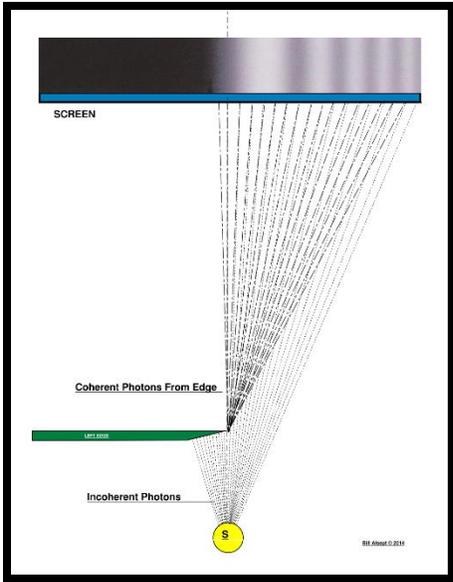


Figure 7

In **figure-8** I've added more photon trajectories with a few details. There's a monochromatic light source emitting 500nm wavelength photons. On their way to the detection screen some photons travel close to the **Edge**. The distance ( $L$ ) equals one meter but for these calculations I have labeled it one billion nanometers. (1,000,000,000nm).

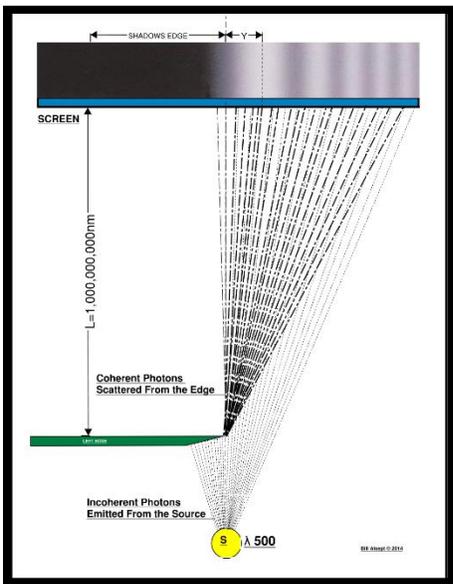


Figure 8

Photons are emitted from a source where some hit the first wall with edge, and the others continue on to the detection screen. As a result, a shadow forms on the left side of the detection screen and the right side is illuminated with a fringe pattern.

If you look closely, you'll see that the pattern is not like any slit diffraction pattern. The spacing between fringes is not equal, and the farther away from the shadows edge the smaller these spacings get. This diminishing pattern continues reducing until it blurs and is typical of all single edge diffraction patterns. This is better known as Fresnel diffraction.

These unique patterns are always present behind single edges. If the light frequency or distance  $L$  were to change, the overall pattern size would increase or decrease, but maintains the unique diminishing pattern.

Single edge patterns don't have a far and near field that look different. They are consistent and guaranteed to be there, hence the term "Single Edge Certainty". These patterns are the foundation of all fringe patterns and important to any theory of light. To understand any slit or multiple slit interference pattern, you need to understand the single edge **diffraction** pattern first.

**Fig. 9** shows a small flux of photons traveling from an incoherent source to the detection screen, with each one oscillating as it passes close to an edge. Although the source is incoherent, some photons are the ones that reach the edge while at a positive (expanding) amplitude. These photons scatter off the edge at angles proportional to the timing and proximity of the edge as they pass. There are no specific or preferred angles and after thousands of photons have been scattered, the screen to the right of the edge will be covered left to right along the plane.

As photons travel to the screen, they all continue oscillating between positive and negative amplitudes (Large and Small Dashes). Because proximity to the edge affects how much a photon is diverted, the total distance traveled for each photon will be different. The photon's oscillating frequency and the total distance it travels determines if the impact will be positive or negative when it reaches the screen. Positive impacts are detected as they transfer energy. Negative impacts on the detection screen take energy away and are **not detected as light**.

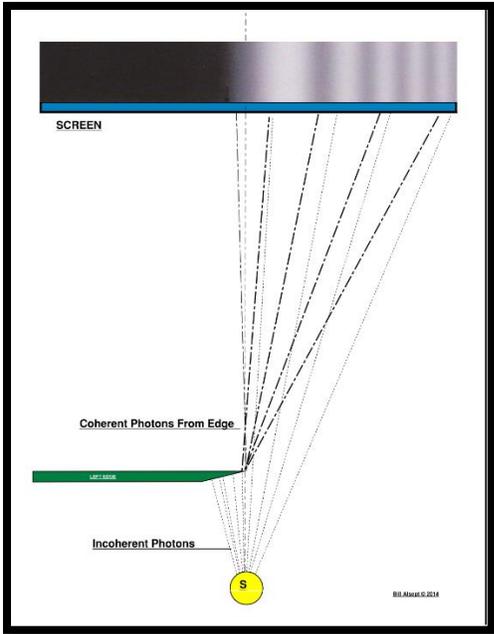
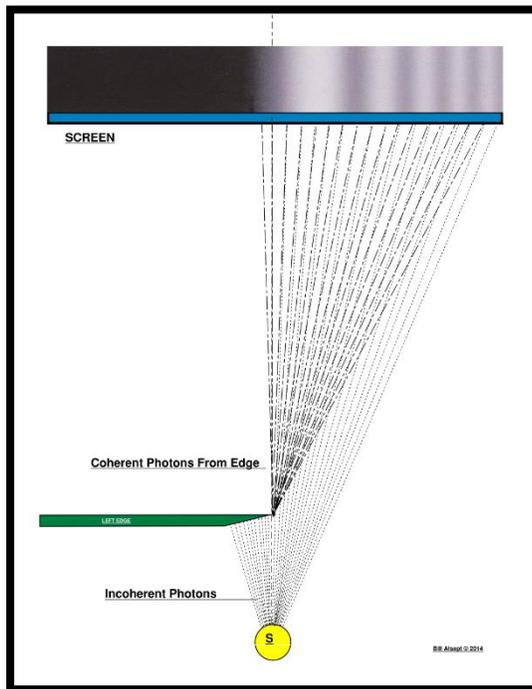
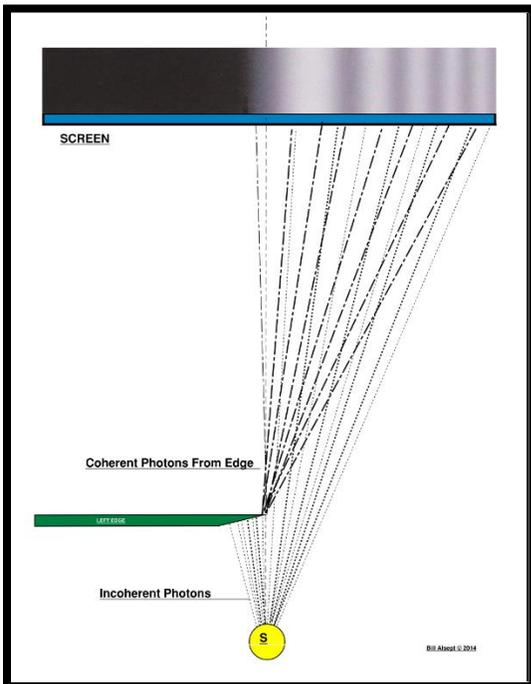


Figure 9

As more and more coherent photons scatter from the edge, a pattern develops on the screen. With increased intensity, notice how billions of **individual** coherent photons, all in phase, traveling from the edge, resemble a wave. This is more analogous to a wave of marching soldiers, than it is to a wave of water. See figures 9 and 10.



**Figure 10**

**Figure 11**

Fig. 12 also has a small flux of photons traveling from an incoherent source to the detection screen, with each one oscillating as it passes close to the edge. Again, the source is incoherent, but this illustration only shows photons that reach the edge in a negative (contracting) amplitude. These photons don't scatter the way positive impacting photons do, but instead diffract around and behind the edge at angles proportional to the timing and proximity of the edge as they pass. There are no specific or preferred angles and after thousands of photons have diffracted, the screen behind the edge will be covered across the plane.

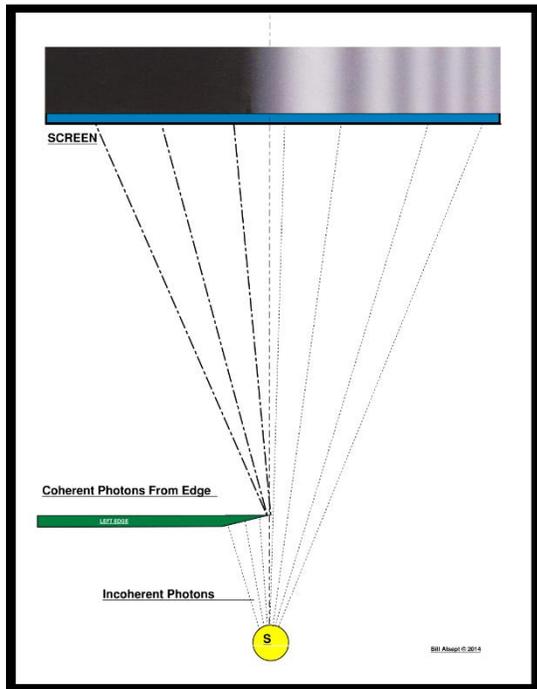


Figure 12

Photons traveling to the screen continue oscillating between positive and negative amplitudes (Small and Large Dashes). Because proximity to the edge affects how much a photon is diverted, the total distance traveled for each photon will be different. The photon's oscillating frequency and the total distance it travels determines if the impact will be positive or negative when it reaches the screen.

Figs 13 and 14 show how a pattern resembling a wave develops as more and more photons are added.

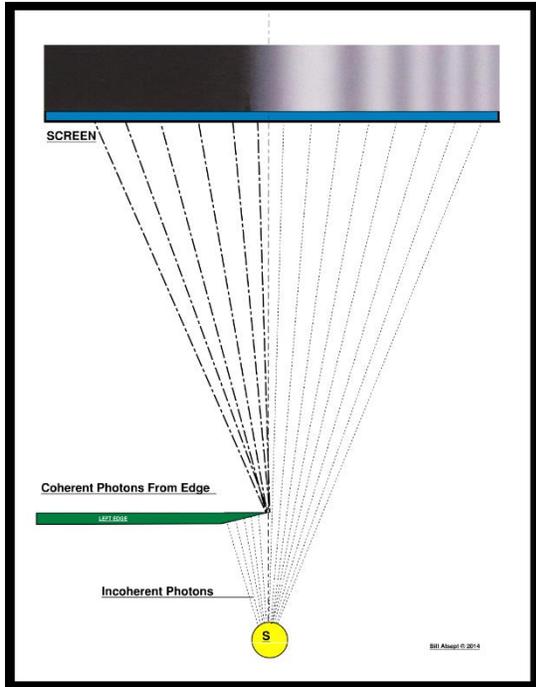


Figure 13

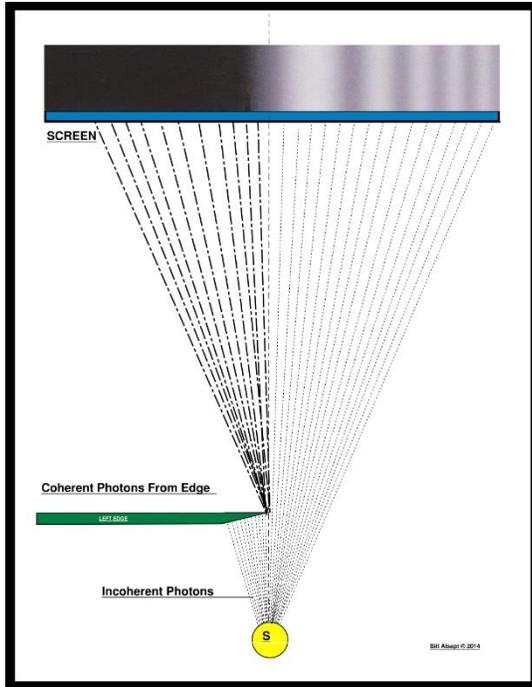
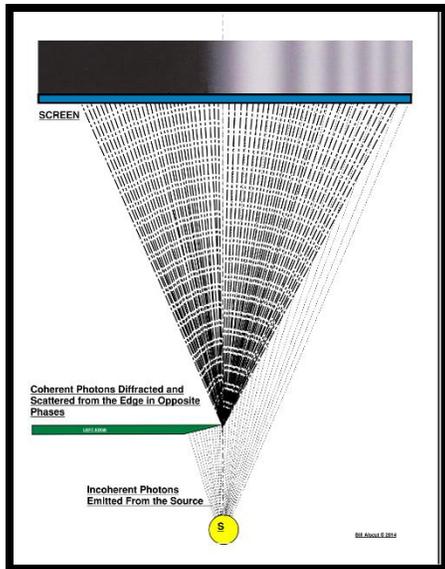


Figure 14

It's important to notice that the positive and negative phasing is reversed for the scattered and diffracted photons. Each side still forms wave patterns, but the amplitudes are opposite. Where a positive bright fringe forms on the scattered side, a negative dark fringe forms on the diffracted side. This is important later when we look at scattered patterns overlapping diffracted patterns.

In **figure 15** a heavy flux of coherent photons scatters right and diffract left, from the edge. As the photons travel to the screen their negative and positive amplitudes are aligned in perfect radiuses. Note that the left and right sides are illustrated in opposite phases. Also as explained before, positive impacting photons on the shadow side are hard to notice for two reasons. The brightness from the scattered side overwhelms the shadow side making it harder to see, but also notice that the first large fringe in the shadow area is a negative one.



**Figure 15**

As mentioned before, the distance from edge to detection screen ( $L$ ) is  $1,000,000,000\text{nm}$ . A photon traveling directly and perpendicular to the screen with a  $500\text{nm}$  wavelength will oscillate exactly  $2,000,000$  times before hitting the screen. Whether a photon impacts the screen negatively or positively depends on its frequency and the total distance it travels. You can see that the angle of the photon's trajectory determines the total length it travels. It also determines the total number of oscillations. Keep in mind these illustrations are not to scale, where  $L$  would be much longer for illustrations this size.

## SINGLE EDGE DERIVATION

We can now use Pythagorean's theorem to calculate the locations of these individual fringes such as (B1) the first bright spot, (D1) the first dark spot or (B2), (D2), (B3) etc. See **Fig-16**

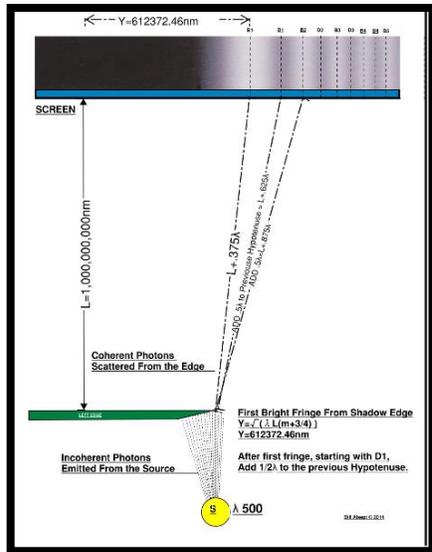


FIG 16

Fig-16 above shows the Y locations of the bright fringes B1, B2, B3 and the dark fringes D1, D2 etc. To calculate for the Y distance from the shadows edge to the center of the 1st bright fringe B1), I tried adding  $\frac{1}{2} \lambda$  (250nm) to L to create a hypotenuse for my Pythagorean equation, which I calculated as:

$$Y = \sqrt{(L + 250\text{nm})^2 - (L)^2} \quad \text{or}$$

$$Y = \sqrt{(1,000,000,000\text{nm} + 250\text{nm})^2 - (1,000,000,000\text{nm})^2} \quad \text{or}$$

$$Y = 707,106.82\text{nm} \quad \text{but this was incorrect.}$$

I had nothing to compare my calculation to, and the only equations I could find for single edge fringe patterns were extremely complicated. One day I came across this site about lunar occultation's <http://spiff.rit.edu/richmond/occult/bessel/bessel.html> and discovered another way to look at single edge fringe patterns.

This was the first time I had read about occultations. By chance I recognized a sequence of numbers similar to my calculations and realized I was on the right track. As described in the link above, a lunar occultation is when the moon comes between the Earth and some other heavenly body such as a star. Just before the moon covers the star, the star light scatters off the edge of the moon in the same way light scatters off all edges.

Based on what I'd learned about lunar occultations I could now relate to the diminishing fringe pattern cast on the Earth by the lunar occultation. The creator of this web site had already measured these distances, so I finally had something to compare my calculations to. All I had to do was convert his (L) distance of 184,000 kilometers between the Earth and the moon's edge to my (L) distance of 1 meter between the screen and edge.

Using Pythagorean Theorem and calculating backwards, I converted the Y and L measurements of the occultation to my experiment and calculated for the hypotenuse. What I discovered was, no matter what wavelength of light or distance you input (when calculating for the 1<sup>st</sup> bright fringe B1) the hypotenuse will always be  $L + 3/4 * 1/2\lambda$  or  $L + 3/8\lambda$ . As you can see, this is Not quite  $1/2\lambda$  as I had first guessed.

This told me that the photons were coherent or in phase and adding  $3/8\lambda$  to (L) would predict the exact length the hypotenuse needed to be to complete an oscillation just as the photon was impacting the screen with a positive amplitude. The distance Y from the shadows edge to the center of first bright fringe is calculated as:

$$Y = \sqrt{(L + .75 * .5\lambda)^2 - (L)^2} \text{ or}$$

$$Y = \sqrt{(L + .75 * .5 * 500)^2 - (L)^2} \text{ or}$$

$$Y = \sqrt{(1,000,000,000 \text{ nm} + 187.5 \text{ nm})^2 - (1,000,000,000 \text{ nm})^2} \text{ or}$$

$$Y = 612372.46 \text{ nm}$$

See Fig 17 below

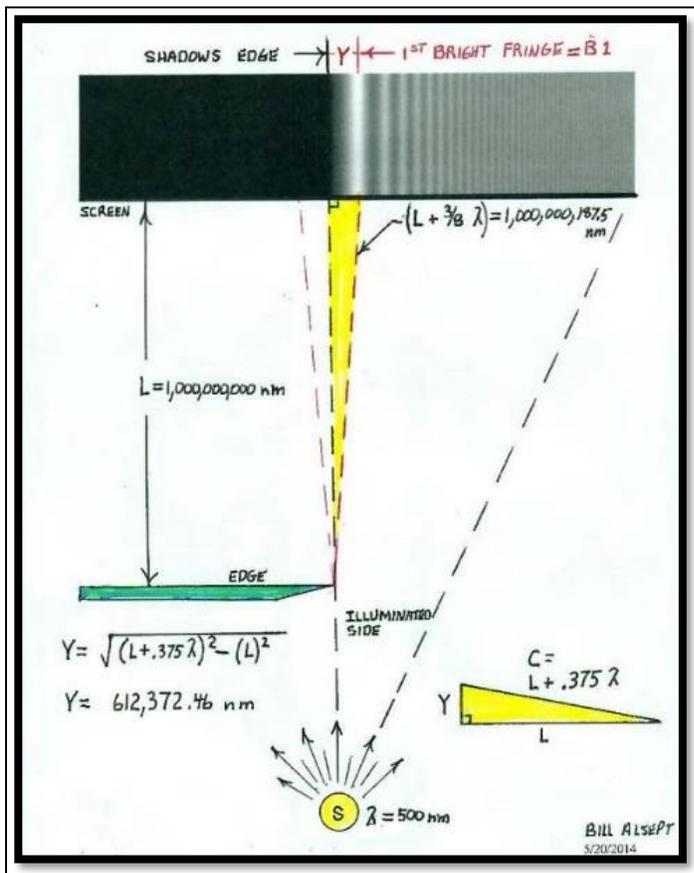


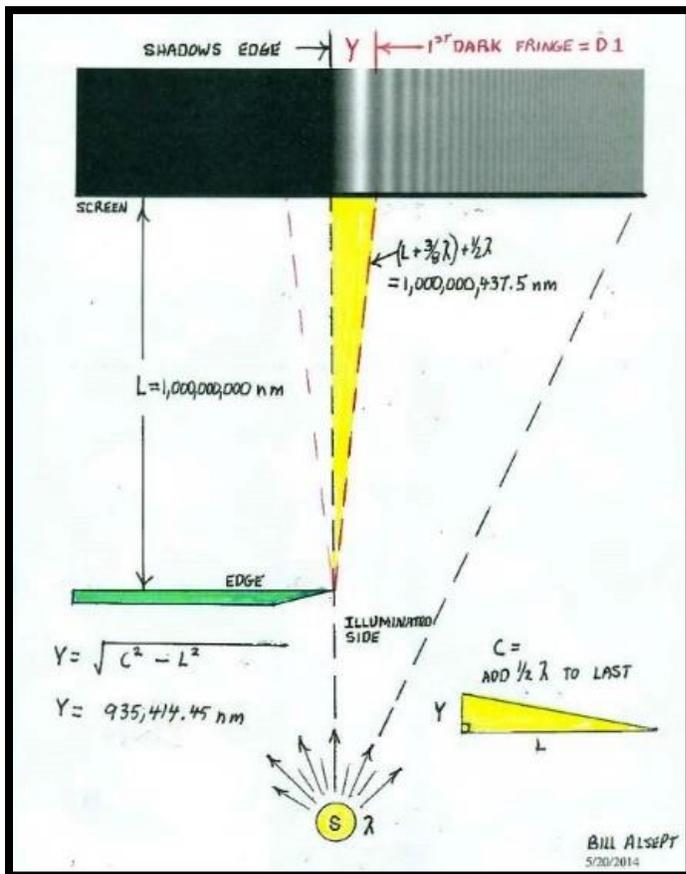
Figure 17

Figure 17 shows  $3/8$ ths of a wavelength added to (L) to create a hypotenuse with the perfect length to derive the first maximum. You can also calculate the 1st bright fringe directly using  $Y = \sqrt{\lambda L(m + \frac{3}{4})}$

For every fringe after that, we add  $1/2\lambda$  (like I originally thought) to the previous hypotenuse to create a new hypotenuse for calculating (Y). The 2nd fringe is a dark spot (D1) and to calculate it I would add  $1/2\lambda$  (250nm) to the previous hypotenuse which was 1,000,000,187.5nm Now it would look like this:

$$Y = \sqrt{(1,000,000,187.5\text{nm} + 250\text{nm})^2 - (1,000,000,000\text{nm})^2} \text{ or } Y = \sqrt{(1,000,000,437.5\text{nm})^2 - (1,000,000,000\text{nm})^2} \text{ or}$$

$$Y = 935,414.45 \text{ nm distance to (D1)}$$



See Fig 18

Every other bright or dark fringe can be confirmed at any Y distance no matter how far out you calculate. The patterns are a buildup of individual coherent photons impacting the screen and there are no waves involved. Billions of oscillating photons and straight-line Pythagorean geometry is all you need to derive these patterns.

The 3<sup>rd</sup> fringe (B2) again is bright. With 250nm added to the previous hypotenuse we calculate:

$$Y = \sqrt{(1,000,000,437.5\text{nm} + 250\text{nm})^2 - (1,000,000,000\text{nm})^2} \quad \text{or}$$

$$Y = 1172604.142\text{nm} \quad \text{distance to (B2)}$$

See Fig 19

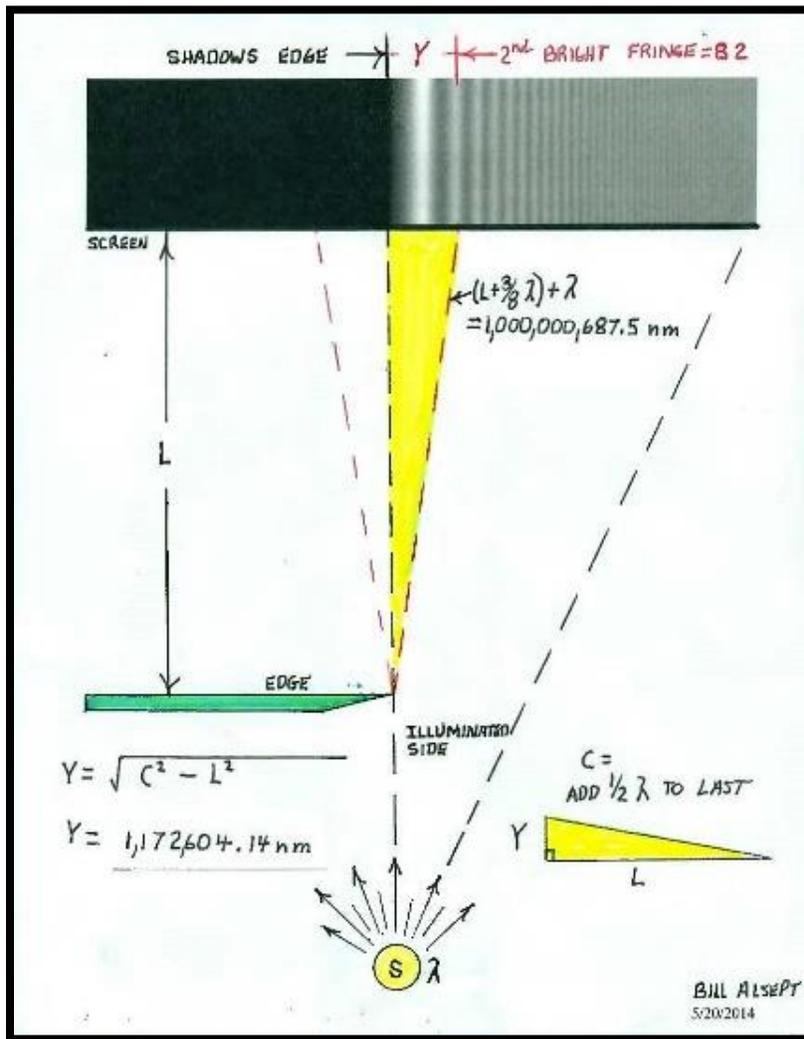


Figure 19 Second bright fringe B2

The 4th fringe (D2) is dark and calculated as follows:

$$Y = \sqrt{(1,000,000,687.5 \text{ nm} + 250 \text{ nm})^2 - (1,000,000,000 \text{ nm})^2} \quad \text{or}$$

$$Y = 1541103.958 \text{ nm} \quad \text{distance to (D2) See Fig 20}$$

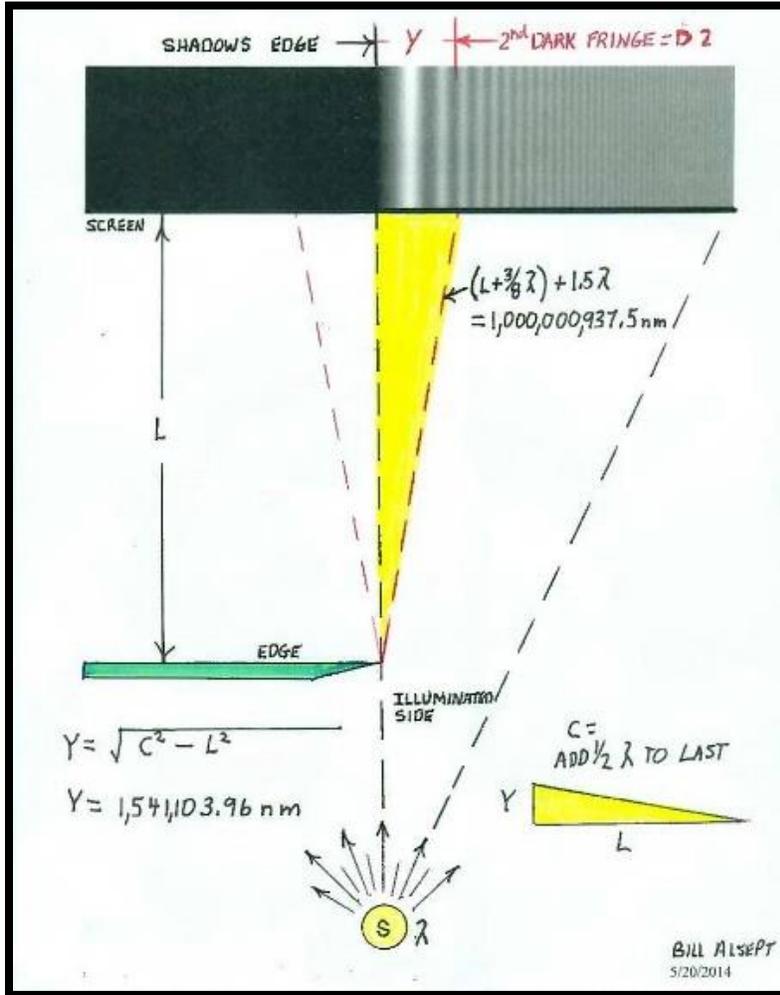


Figure 20 Second dark fringe D2

The 5th fringe (B3) is bright and calculated as follows:

$$Y = \sqrt{(1,000,000,937.5 \text{ nm} + 250 \text{ nm})^2 - (1,000,000,000 \text{ nm})^2} \quad \text{or}$$

$$Y = 1695583.105 \text{ nm} \quad \text{distance to (B3) See Fig 21}$$

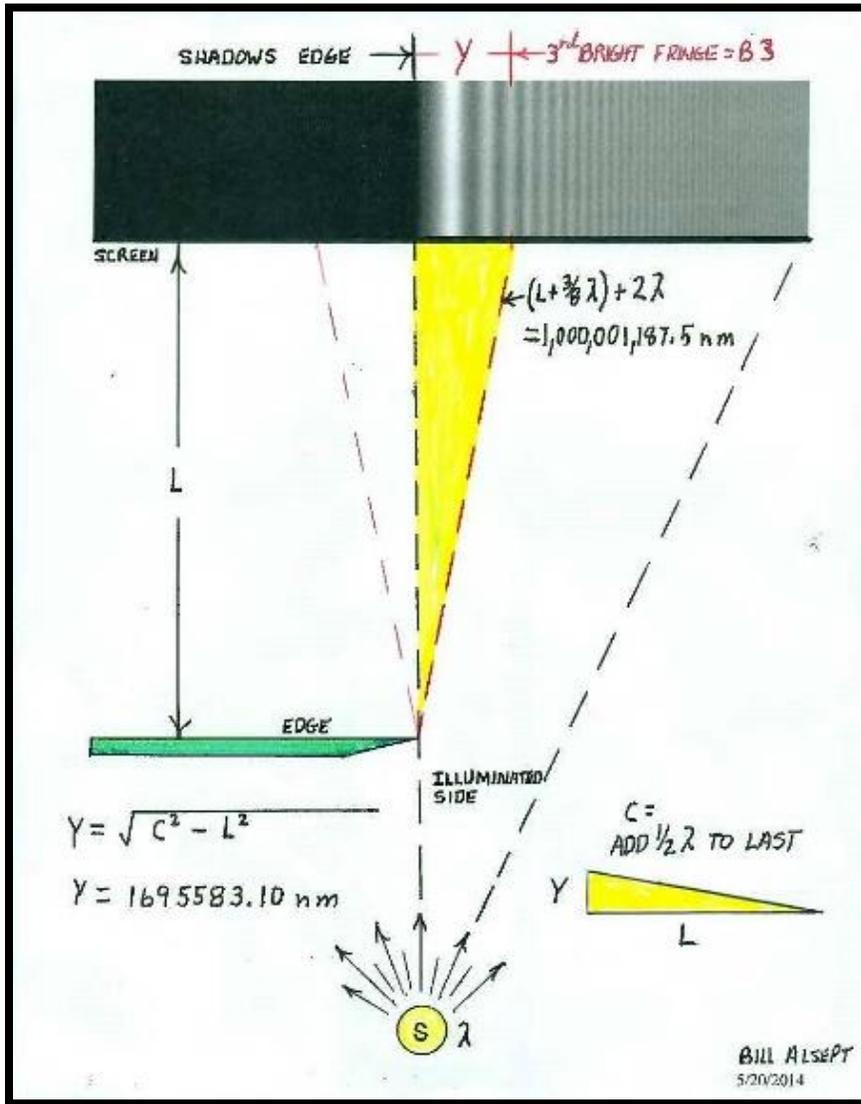


Figure 21 The third bright fringe

Incoherent photons coming directly from the source completely illuminate the right side of the screen, while coherent photons scattered from the edge impact positively and negatively (depending on the length of their trajectory) to form the single edge fringe pattern. Negative impacts subtract locally from the already illuminated side making it darker than average at those points. Positive impacts add to the already illuminated side making it brighter than average at those points. A pattern is formed by darker than average and brighter than average fringes.

## IN THE SHADOW

We can clearly see on the illuminated side of the detection screen; a fringe pattern forms as coherent photons scatter from the edge to every part of the screen. Photons also diffract around and behind the edge into the shadow area. The same Pythagorean principle applies forming a single edge pattern in an opposite mirror image. The pattern is hard to see because the brightness of the illuminated side is overwhelming.

Just like the illuminated side, photons impact positively and negatively forming the same unique pattern. Photons impacting in a negative phase will subtract from the already dark screen, so the location remains dark. Photons impacting in a positive phase do add energy but it's extremely hard to see with the illuminated side overexposing the screen. Other than the first  $\frac{1}{2}$  fringe most of the pattern in the shadow would not be noticed.

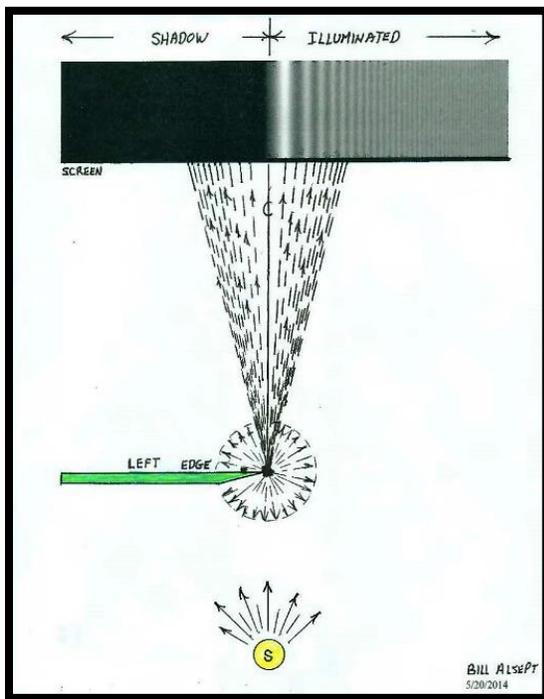


Figure 22

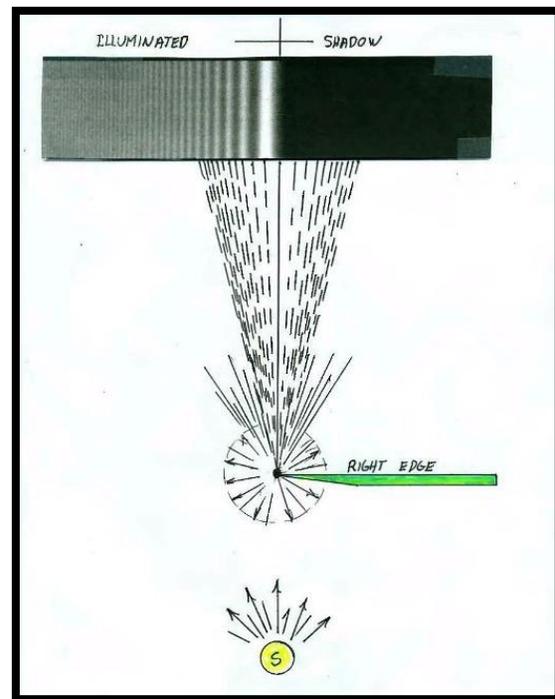


Figure 23

My premise is that a photon's energy oscillates between positive and negative amplitudes, and we only detect the positive amplitudes on impact. For example, when a photon positively impacts an electron, some or all the photon's oscillating energy is transferred to the electron and the photon's linear momentum is not considered. The premise assumes a photon's energy is divided into two parts. Vibrational and Translational energies should be considered for a theory of everything.

The higher a photon's oscillating frequency is, the higher its energy. A positive impact will raise an electron to a higher energy level. If the photon's frequency is too high, the oscillation can completely knock the electron away from the atom. This is known as the photoelectric effect.

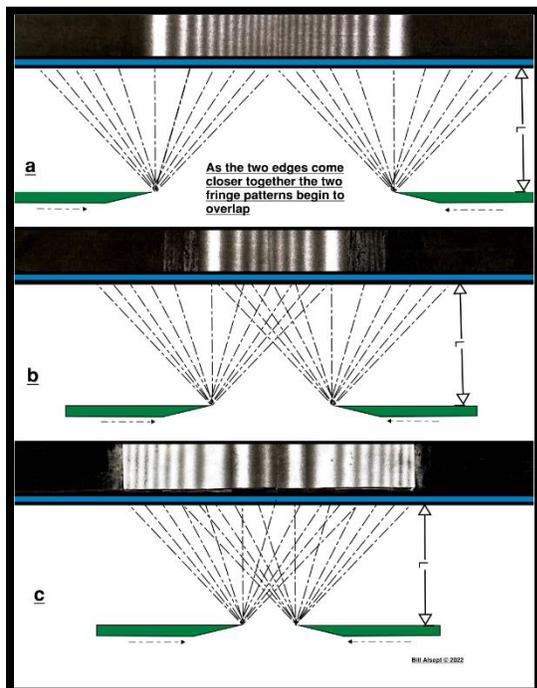
If a photon is in a negative amplitude when it interacts with an electron, usually nothing happens. If the electron was already raised to a higher energy level when the negative photon passes through, it will absorb some or all of the electron's energy and carry it away in the same direction it was already going.

In that process, the photon's frequency changes proportionately to the amount of energy it absorbed from the electron as it was passing through. As the photon passes through, it appears to have been emitted from the electron, but the photon never slowed down or sped up. It just passed through and absorbed the extra energy. I realize this is backwards from the expected theory, where photons are created and emitted as the electron falls from a higher to lower energy level.

Overall, a physical derivation of oscillating photons (as particles) will produce all the different interference patterns we observe in any slit or edge experiment. Billions of individual photons diffracting and scattering coherently from single or multiple edges, will superimpose across a detection screen, negatively and positively to form these convoluted patterns.

## OVERLAPPING PATTERNS

Now slowly bring the left and right edges closer together keeping the detection screen at the same distance ( $L$ ) beyond. As the two edges move parallel to the screen their unique patterns remain intact and move along the screen toward each other. See Fig 24 a, b, c



## Figure 24

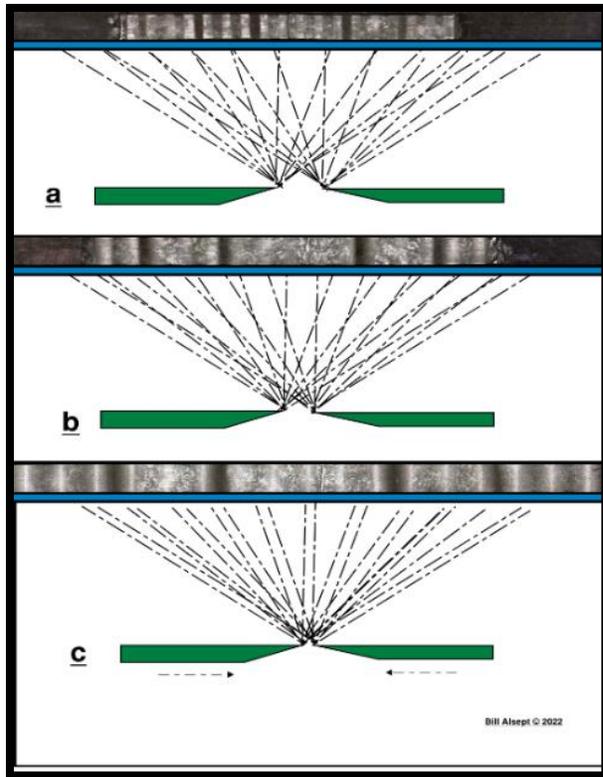
Each edge produces a pair of Fresnel patterns going opposite directions. A single slit has two edges, and the four patterns project and overlap on the screen. When the slit narrows, the overlapping patterns shifts, and the fringe pattern changes like any [Moire Patterns](#).

Every point on the detection screen receives photons from both edges. Depending on the distance they travel and their frequency, the photons will impact Positive/Positive, Negative/Negative, Positive/negative or some combination in-between.

In Fig. **24a** the two inward opposing patterns are beginning to overlap. The convoluted pattern is unique and bright enough to overwhelm the outer left and right areas. In **24b, c** the two patterns have not yet fully overlapped so in the outer areas you still only see the original diminishing Fresnel patterns.

At first the light going through the slit has no obvious pattern but as the slit gets smaller and the patterns overlap, the fringe spacing becomes more consistent. In figure 24b and c we watch the convoluted pattern slowly evolve as the scattered and diffracted patterns overlap in the outer areas, becoming Fraunhofer diffraction.

In **fig 25a, b and c** as the slit narrows, the outer areas overlap, and the fringes become evenly spaced. It's important to remember that all four single edge patterns are still the same, and exactly where they are supposed to be. If you could remove three of them, you would see the one remaining single edge fringe pattern all by itself, as in **Fig 7**. The fringes on the right come from two sources. Photons scattering from the left edge mixing with photons diffracting around the right edge. The fringes on the left also come from two sources. Photons scattering from the right edge mixing with photons diffracting around the left edge. See **Fig 25**. And convince yourself.



**Figure 25**

As the slit narrows, it appears the photon trajectories are bending more and spreading out but they're not. The photons are still scattering and diffracting from the two edges to every part of the screen just like they did before. The original patterns are still there and do not spread or change.

Every time the slit narrows, both scattered patterns overlap the diffracted patterns a little more. Every adjustment is a different superimposed Moire pattern, creating a different spacing. As you narrow the slit the two patterns overlap more and more and the fringe spacing gets larger and larger, giving us the illusion of spreading waves.

## **LEFT EDGE**

**Figure 26** A yellow highlighted light source is directed at a dark green edge and a pattern, with about thirty fringes' forms on a distant screen. Although photons scatter at all angles from the edge, the dashed lines only show the trajectories of coherent photons impacting the screen during positive or negative amplitudes. A green triangle wave highlights the amplitudes by aligning the crests with the bright spots and the troughs with the dark. Note fringe B27 (the 27<sup>th</sup> bright fringe) is labeled so that later we can compare it to D27 (the 27<sup>th</sup> dark fringe of the right edge) diffraction pattern illustrated next in **Figure 27**.

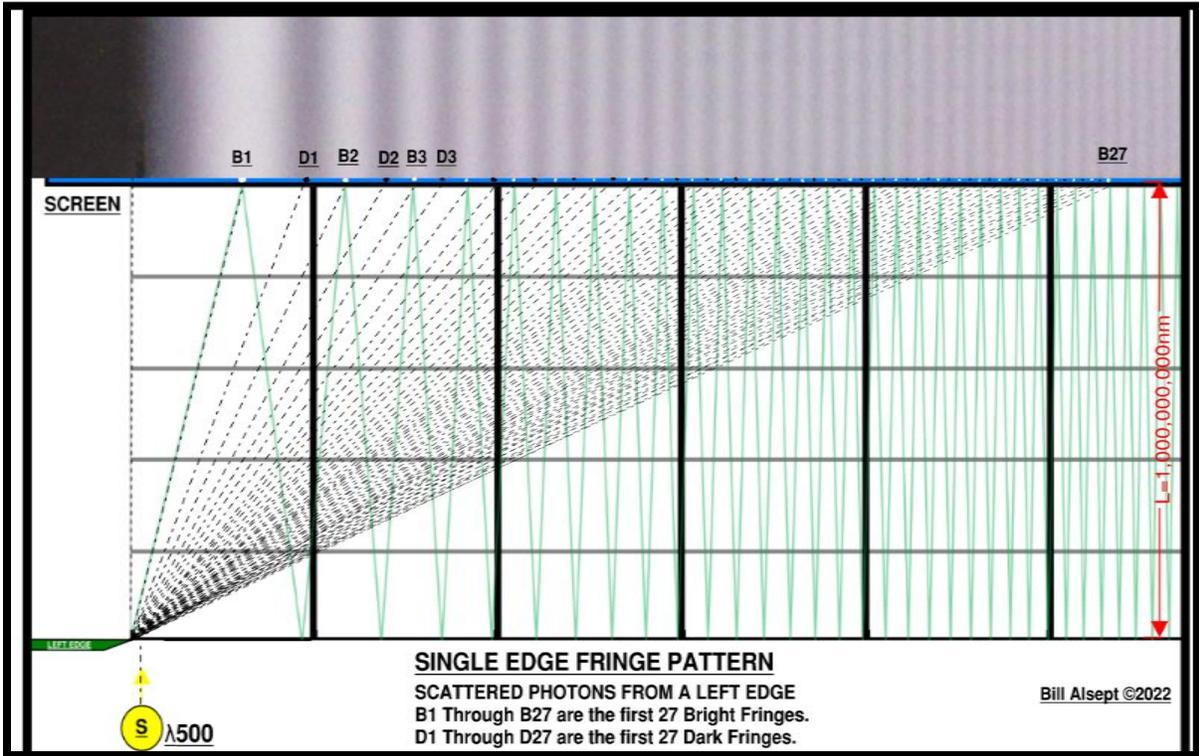


FIG 26

RIGHT EDGE

**Figure 27** A light source highlighted yellow is directed at a dark green right edge and a pattern, with about thirty fringes' forms on a distant screen. Although photons diffract at all angles around and behind the edge, the dashed lines only show the trajectories of coherent photons impacting the screen with positive or negative amplitudes. Again, a green triangle wave highlights the amplitudes, but this time aligning the crests with the dark spots and the troughs with the bright, because the phasing for diffracted

photons is opposite of scattered photons. Note fringe D27 (the 27<sup>th</sup> dark fringe) is labeled so that later we can compare it to B27 (the 27<sup>th</sup> bright fringe of the left edge) scattered pattern illustrated before.

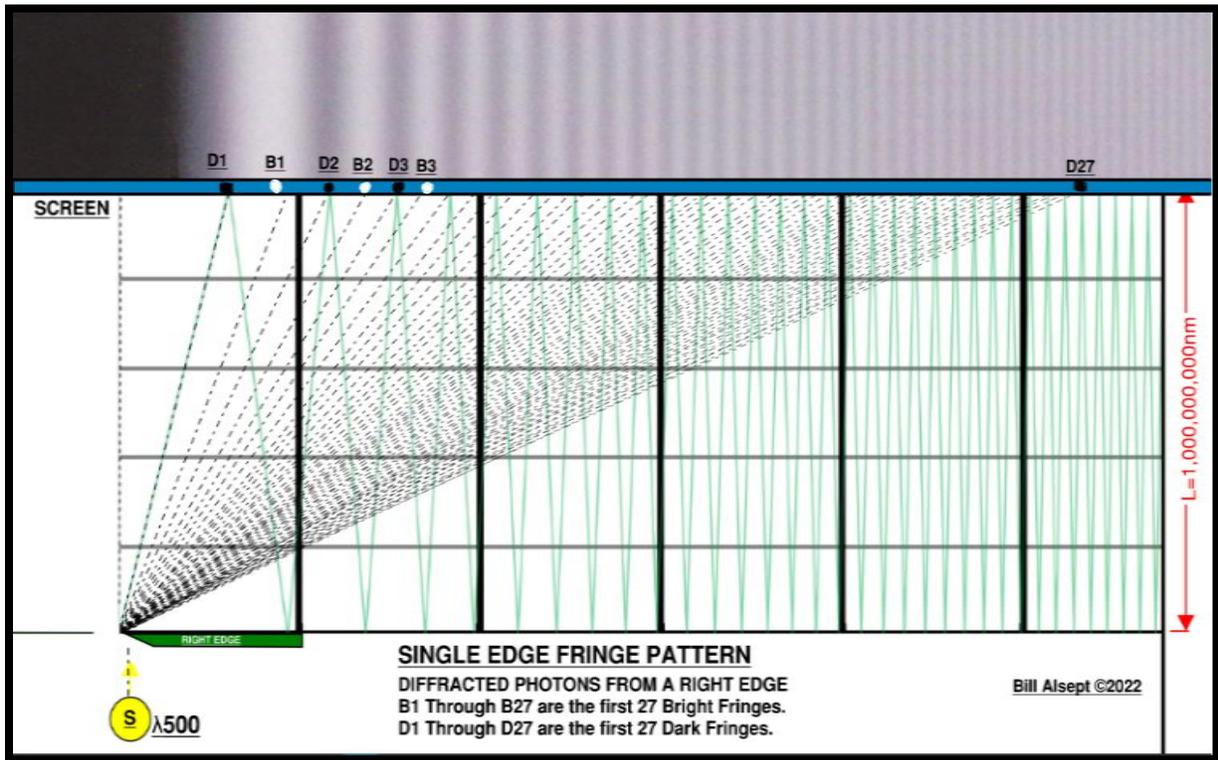


FIG 27

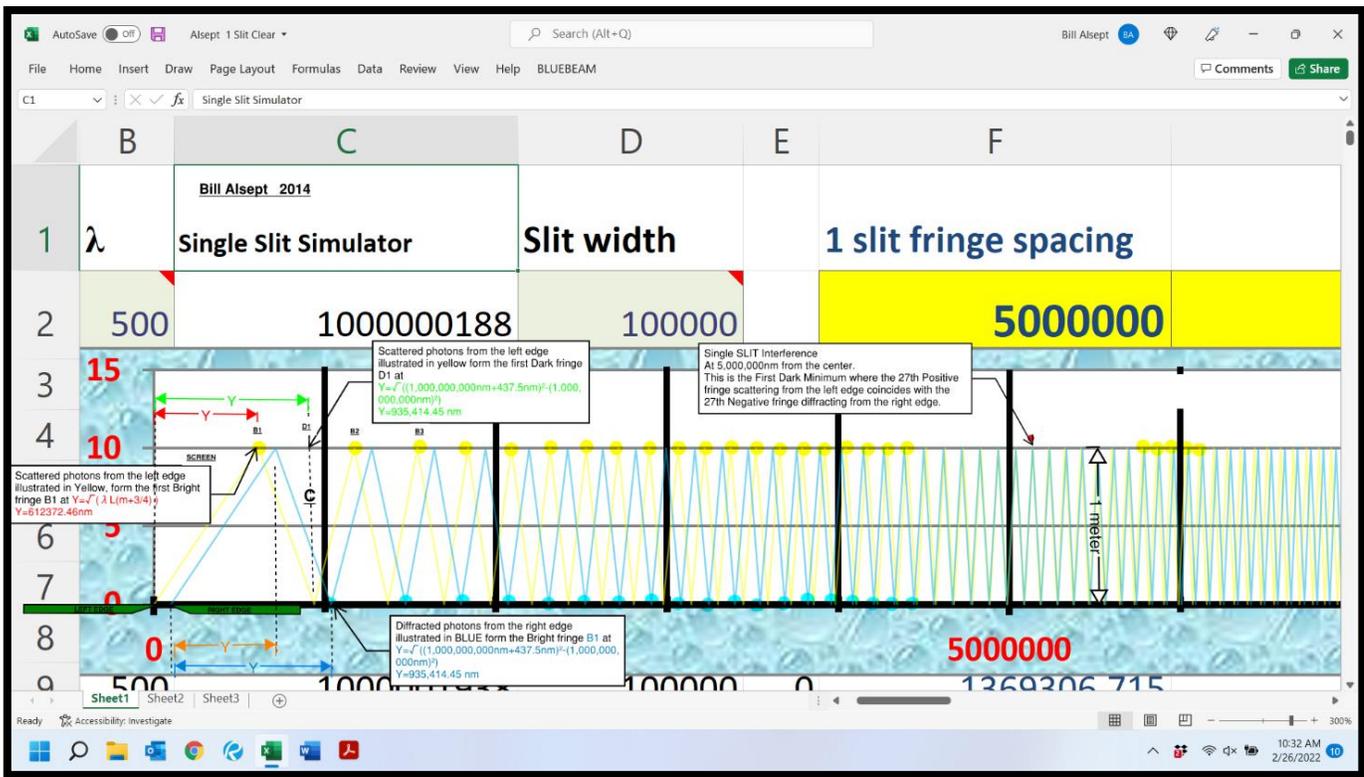
## A SINGLE SLIT

When two edges come close together, we have a **slit**. FIG 28 illustrates the superimposed patterns originating from the two dark green edges, labeled Left and Right. The patterns are highlighted with yellow and blue triangle waves. Both diminishing patterns are accurately simulated for a 500nm wavelength light source, a 100,000nm wide slit and a detection screen that's 1,000,000,000nm beyond.

The simulation derives about 47 fringes in YELLOW scattered from the left edge toward the right, and about 47 fringes in BLUE diffracting around the right edge also to the right. This illustration does not show patterns diffracting or scattering toward the left. The Blue and Green patterns are identical (same

frequency) other than they start in opposite phases, from two different edges that are 100,000nm apart. See the left edge and the right edge illustrated in dark green in **Figure 28**.

Notice that opposite phased impacts (yellow and blue) are coinciding the closer they get to the 27<sup>th</sup> fringes and completely cancel each other where  $Y=5,050,000\text{nm}$ . The extra 50,000nm is counting half of the slit width.  $Y=5,050,000$  and every 5,000,000nm after, will be dark from the deconstructive interference. The opposite phases are illustrated yellow and blue to help emphasize destructive interference as the colors blend to green. These fringes also develop in a “One Photon at A time” experiment.



**FIG 28**

This works the same for any slit. In **Fig 28** there there’s a 500nm  $\lambda$  light source and a detection screen 1,000,000,000nm away. The two edges are 100,000nm apart and destructive interference is calculated to be every 5,000,000nm. This can be derived using real oscillating particles and straight-line Pythagorean geometry for any slit.

When the two edges are 90,000nm apart the destructive interference will be every 5555555.556nm. With an 80,000nm slit the destructive interference is every 6,250,000nm. With a 70,000nm slit its every

7,142,857.143nm. With a 60,000nm slit is every 8333333.333nm and finally, when the two edges come together to form a 50,000nm slit, the destructive interference is every 10,000,000nm.

As the slit gets smaller the overlapping Fresnel patterns shift and keep forming convoluted or superimposed patterns with larger and larger spacing's. This is no different than any Moire Pattern where two set patterns are overlaid. As you move the two patterns closer to each other, the combined pattern changes.

When you overlay two diminishing patterns (like single edges have), you get a combined pattern that is equally spaced. The distance between areas of destructive interference gets larger as the two starting points (edges) get closer. This gives the appearance that the light is spreading, but it's not. The same diffraction and scattering from the edges is still happening and has not changed. The only thing that changed is one of the patterns moved sideways overlapping the other pattern a little bit more, changing the combined pattern like any Moire Pattern would do.

## PARTICLE / FRINGE SIMULATION Copyright © Bill Alsept

Most of the illustrations used in this paper are screen shots from a [fringe pattern simulator](#) I designed with an Excel program. On the website [billalsept.com](http://billalsept.com) or below you will find links to several of these slit simulators. Making these simulators was a very interesting journey in itself.

At first, I graphed the fringe patterns with a straight edge, pencil, and **lots of calculating**. I decided on a chart-based triangle wave and calculated for a diminishing pattern, with the crests representing positive amplitudes (bright fringes) and the troughs represented negative amplitudes (dark fringes). In **Fig 29** you will find a diminishing triangle wave, illustrated below the photo of a real single edge diffraction pattern. The crest and troughs of the triangle wave align with each bright and dark fringes respectively as the spacings get smaller and smaller.

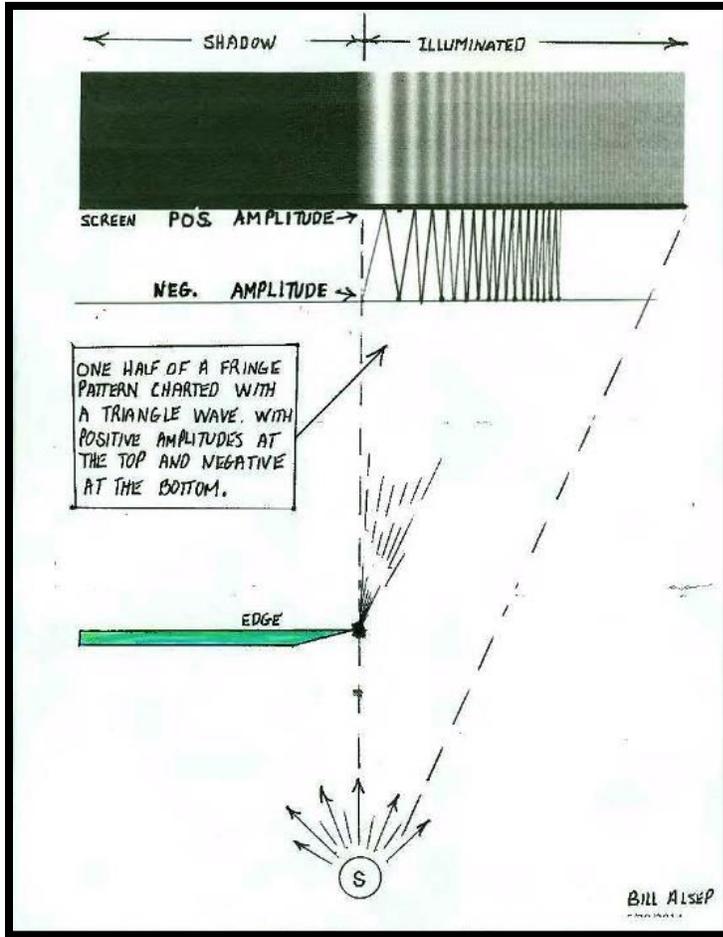


Figure 29

Calculating and charting these diminishing (Fresnel) patterns is not the same nor as easy as charting a repeating sine wave. The spacing's consistently get smaller and smaller and simulating them is much harder. **Fig. 30 and 31** illustrate diffracting and scattering patterns (which are oppositely phased) going in opposite directions from each edge. In **Fig 30** I have highlighted the scattered pattern on the right in yellow and the opposite phases diffracted pattern in blue. In **Fig 31** the diffracted pattern on the right is blue and the scattered pattern is yellow.

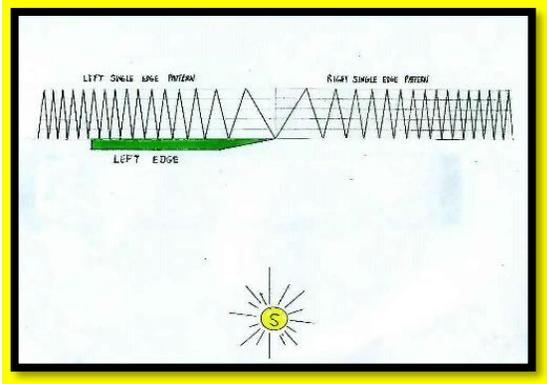


Figure 30

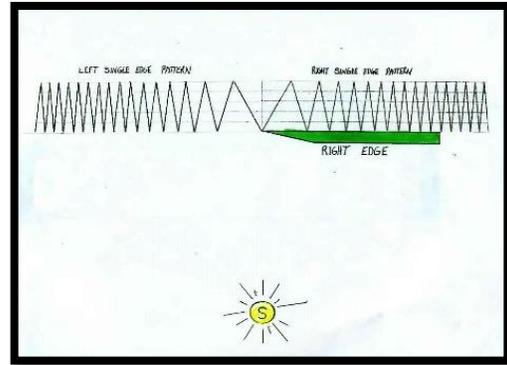


Figure 31

In Fig 32 as the two edges come together, the patterns mix with two opposite phased patterns to the left and two opposite phased patterns to the right. The overlaid patterns reveal a combined fringe pattern (or Miore Pattern) with equal spacing. If you follow the scattered yellow lines, you'll see where they catch up with the diffracted blue lines and eventually cancel each other. The simulator combines yellow and blue to illustrate the destructive interference with green but real patterns have dark fringes. All other areas in the pattern never have 50/50 negative and positive impacts canceling each other, so they are brighter. Some areas combine different mixtures of positive and negative impacts as the brightness varies.

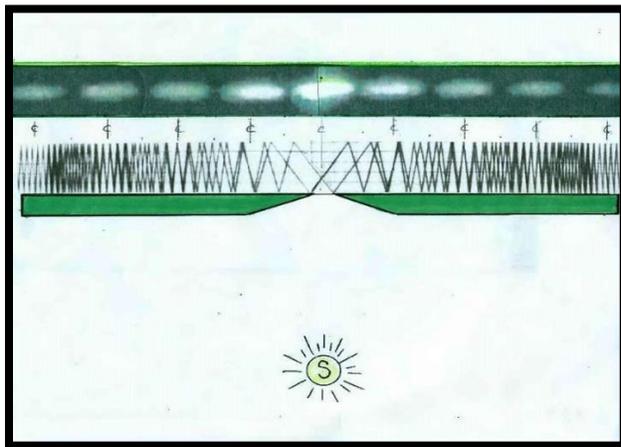


Figure 32 This is WRONG, needs to show single slit diffraction with large center fringe

# Simulator

At first, I tried many wavelengths and distances but couldn't get multiple edges to produce obvious patterns. After setting up a laser and viewing real single edge patterns I realized the fringes were much more numerous than a **slit** would produce. For instance, in **Fig 28** it required 27 single edge fringes to produce the first dark fringe. I would need to calculate and draw these patterns a lot farther out to even begin to derive a **slit** pattern. I couldn't draw that many amplitudes, so I looked for a way to simulate it.

I knew that Excel could chart equally spaced patterns but could not find anything about diminishing patterns. After several attempts I realized Excel was perfect for this. Maybe someone somewhere has already calculated these unique patterns with a program like Excel, but I couldn't find one. Other simulators that I found could only do equally spaced patterns and not the diminishing spacing's you find in the single edge fringe patterns.

It turned out to be easier than I thought, and I'm still surprised that no one has done this before. Not only can Excel accurately chart the diminishing patterns but it also does the calculations as I showed them earlier. You can separate the edges 1, 2, 3, 4 ... into columns with calculations specific to each. The simulator is set to calculate 2000 bright and dark fringes along the right side of the fringe pattern.

Because the simulator overlays multiple patterns, originating from multiple edges, I decided to chart only the right sides of the patterns. This made programing much simpler to calculate. The left sides are mirrored images anyway. **Fig 33** below is a snapshot from my **single edge** simulator showing a **scattered** pattern from a **left edge**. As you can see there is no cancelation in the pattern. Just the diminishing positive and negative amplitudes. A single edge pattern goes until it blurs with no interference anywhere.

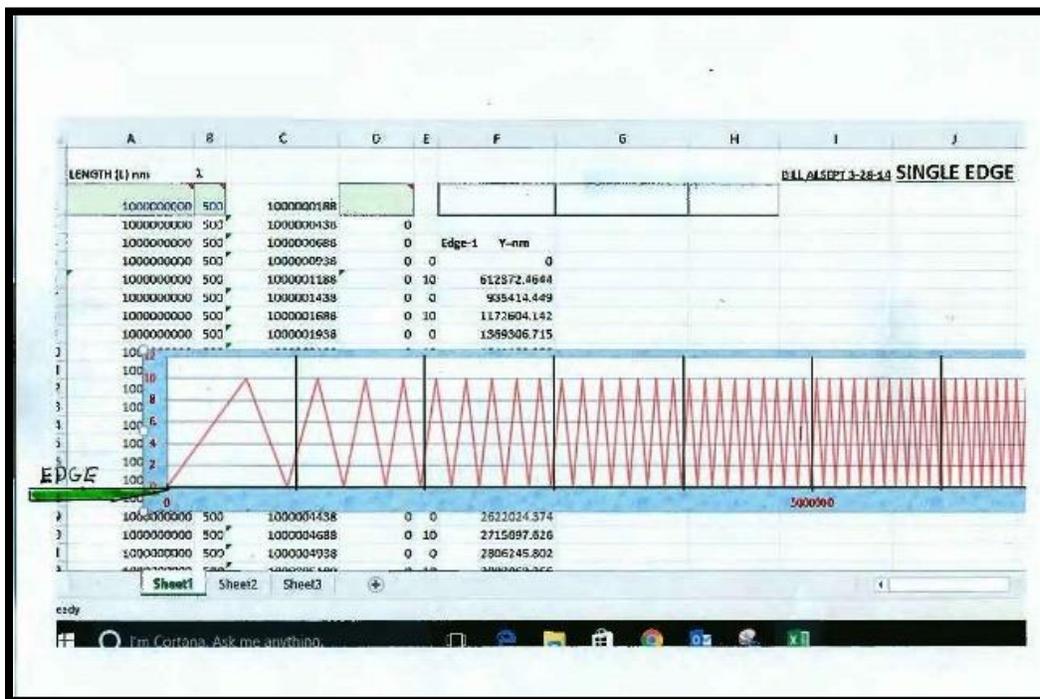


Figure 33 Change to yellow

Fig 34 and 35 show screen shots from my 1 SLIT and 2 SLIT simulators. Remember single slits have two edges and double slits have four edges. The edges are illustrated in dark green.

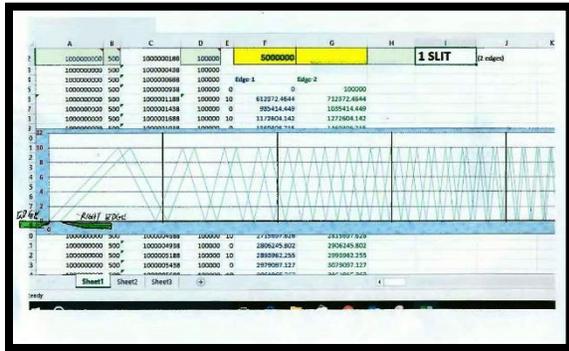


Figure 34 1 SLIT (two edge) Pattern

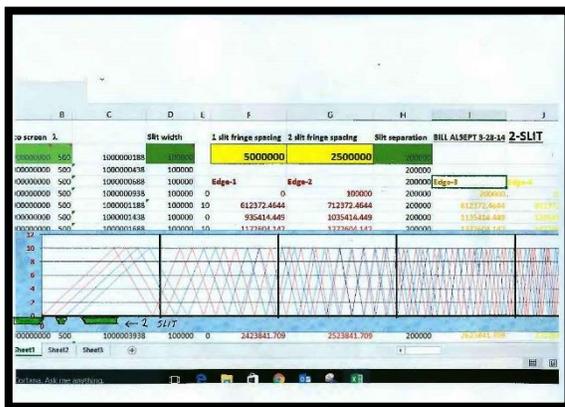


Figure 35 2 Slit Pattern (four Edges), Right side only

The simulators calculate single edge, single slit, and multiple slit fringes. You can input wavelength, distance, or any number of slits. You can mix fringe patterns and see exactly how the overlapping patterns form the equally spaced patterns we observe in nature. Fig 36 shows my 4-slit simulator, and you can see exactly where all 8 edges (Four negative and four positive) come together at 5,000,000nm, canceling out to form the first dark spot. And as you scroll to the right you will see that every 5,000,000nm the lines coincide to cancel each out. Remember you are only looking at the right half of a complete diffraction pattern.

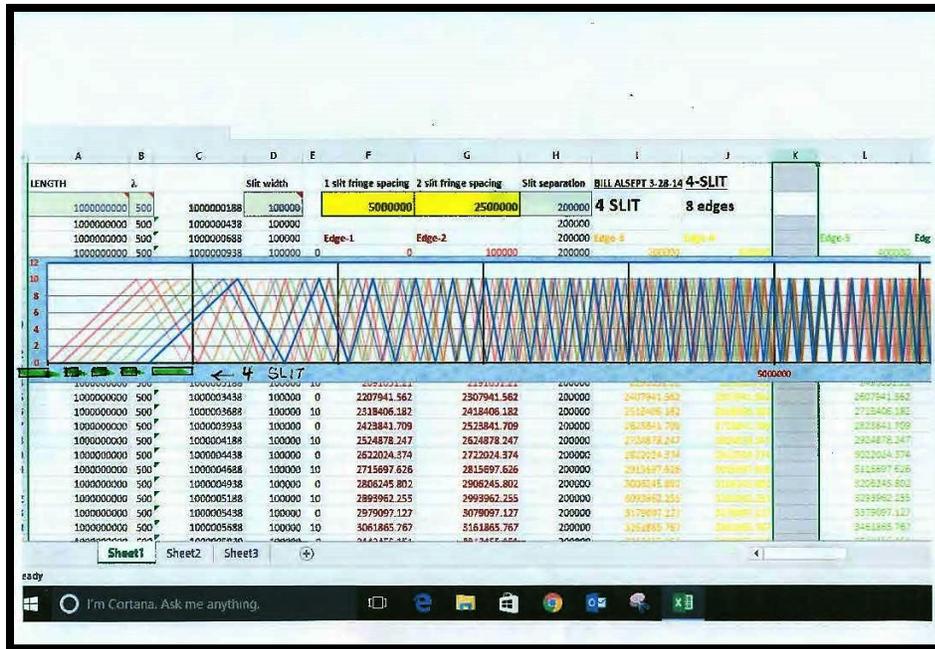


Figure 36 Screen shot of 4 slit (8 edges) simulator showing the right-side calculations and chartings of all eight edges.

These simulators calculate every positive and negative amplitude, for more than 2000 oscillations along the right half of the fringe pattern. Below are five of my simulators. You can upload them below, but it will be quicker and easier from my website at [billalsept.com](http://billalsept.com)

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[Single Edge Pattern Simulator](#) (one edge)

[Single Slit Pattern Simulator](#) (two edges)

[Double Slit Pattern Simulator](#) (four edge)

[Triple Slit Pattern Simulator](#) (six edge)

[Four Slit Pattern Simulator](#) (eight edge)

## ELECTRON SLIT EXPERIMENT

Not all slit experiments use photons. Sometimes heavier particles like electrons are used. Richard Feynman popularized and clearly describes the experiment in his lecture:

<http://physicsworld.com/cws/article/news/2013/mar/14/feynmans-double-slit-experiment-gets-a-makeover> The results are nicely explained but how the electrons do what they do is not. Again, we see the same equally spaced fringe pattern that the photons produced, but why?

As I developed Single Edge Certainty I wondered about electrons and this phenomenon they displayed. The electrons appear to be going through both slits and interfering with themselves to form the pattern on the screen. Electrons unlike photons are not absorbed or emitted by atoms. How then do they form this so-called interference pattern?

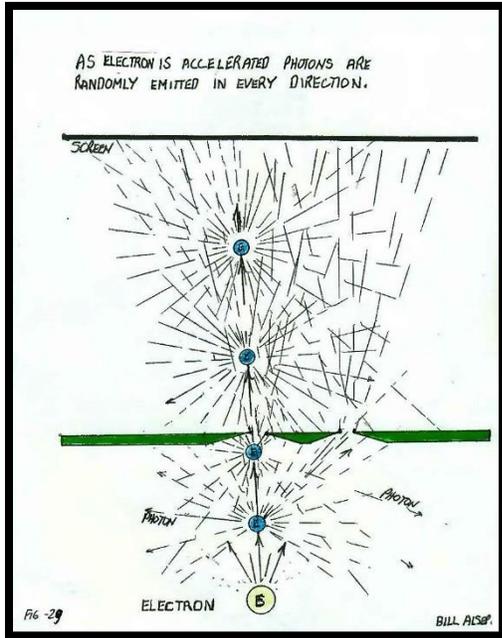
Many articles make a big deal of this, turning it into some impossible miracle of the quantum world. Some articles imply the system is consciously altering the paths of the electrons just because we observed it. They never mention that detectors or any additional light may be affecting the experimental results by blocking or deflecting the electron trajectories. The idea that reality can be changed by our perceptions, has never been proven. This silly concept, sensationalized in many popular science books, has no supporting evidence.

These self-interfering or self-aware electrons act as a straw man to set the premise of a wave function and the uncertainty principle. Unfortunately, the consensus seems to be that patterns formed by these electrons are dictated by a wave function that has no physical explanation. Ironically, it's the wave function they consider real, and not the photons.

When electrons are accelerated, they emit photons. You see this put to use with X-rays or synchrotron experiments. A double slit experiment is no different and when you fire electrons at a slit, photons are emitted by the millions. The photons impact and re-emit from every exposed surface in the experiment. The double slit has four edges for the photons to interact with, producing an actual fringe pattern equivalent to a virtual wave function or pilot wave.

The photons reflecting back and forth between the slit wall and detection screen form an actual grid, similar to a quantum field. As an electron travels through a slit experiment, toward a detection screen it would be guided and corralled continuously, conforming to the photon pattern already on the screen.

These patterns can be calculated and offer a physical solution to the wave function. **Figure 37** shows an accelerated electron passing through one slit of a double slit experiment and randomly emitting photons in all direction as it propagates.



**Figure 37**

The radiating photons form the familiar double slit fringe pattern, and billions of reflecting photons interact with the still propagating electron. The photons influence the trajectory of the electron more and more as it moves closer to the screen. Billions of photons deflect the electron left and right eventually corralling them into certain locations. The resulting fringe pattern is no different than the pattern you would expect, even when one electron at a time is sent through.

**Fig-38** represents a snapshot of an electron accelerated through a slit and emitting synchrotron radiation as its influenced by the reflected photon field.



## ONE PHOTON AT A TIME

So often we hear about the “one photon at a time” experiments. For the most part these experiments are designed to demonstrate the particle-wave duality of light. Some interpret the results as proof of the wave theory, but never do you hear arguments for the particle only theory.

Next, I will use a homemade simulator to illustrate how two Fresnel patterns overlap to form a pattern, even if it's one photon at a time.

With Single Edge Certainty I have described two particle-based theories to account for all the fringe patterns we observe in nature. Oscillating photon particles diffracting and scattering from edges produce the fringe patterns for both photon or electron slit experiments.

This is a work in progress by Bill Alsept [b\\_alsept@yahoo.com](mailto:b_alsept@yahoo.com) or [billalsept.com](http://billalsept.com)

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