Abolishing the Wave-Particle Duality Non-Sense

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This paper shall describe how to account for the observed particulate nature of waves, without requiring any particle to be involved. Using geometry and known facts about electromagnetic radiation, facts about the ghost particle otherwise known as the photon, and hence the true nature of light, will be explored.

The debate about the true nature of light and matter dates back to the 1600s. Christiaan Huygens proposed light was waves, whilst Isaac Newton came up with his own corpuscle (particle) theory. Since then, preference has flipped to and fro between these two opposing views. Currently, the scientific community cannot properly resolve this debate, and it holds that all waves also have a particle nature, and vice versa.

Particle or Wave?
In 1905, Einstein published a tentative attempt to describe light quanta as particles. After over forty-five years of struggling with the rejection of the idea by prominent scientists and his own persistent meditations, he gave up hope of either discovering the true nature of light himself or expecting anybody else to. Just a few years before his death, his frustration was clearly evident in the following comments:

All my attempts to adapt the theoretical foundation of physics to this new type of knowledge (quantum theory) failed completely. It was as if the ground had been pulled out from under one, with no firm foundation to be seen anywhere, upon which one could have built. (1949)

All these fifty years of conscious brooding have brought me no nearer to the answer to the question, "What are light quanta?" Nowadays, every Tom, Dick and Harry thinks he knows it, but he is mistaken. (1951)

Sixty more years have passed, theories have been revised and updated, new technologies have surfaced, and yet it seems nobody has had the guts to tackle this challenging issue again. Scientists seem satisfied enough reciting wave-particle duality rhetoric. Is it following the scientific method to do the same and accept this paradox as part of science, just because Einstein failed and gave up?

How can it be known whether or not a source is sending out matter or waves? No matter can travel at the speed of light, but waves can. So, theoretically, this question can be answered by simply measuring the speed of the flying entity. Also, if one sends out a wave, it ripples across space with a spherical wavefront, so its intensity at the detector would be inversely proportional to the square of the distance traveled. On the other hand, if one throws out a particle of matter, it would be expected that even if it is too small to be seen, the momentum exchanged at the target would be the same or very close to the momentum gained as it left the source. However, detecting momentum does not tell us if the thing which hit our target is a wave or a particle, since a particle would have momentum \( p = mv \) due to its mass being in motion, and a wave would have momentum due to its Poynting vector (the cross product of the E-field and B-field vectors) of magnitude \( p = E/c \). Light offers a challenge to the scientist because its properties are neither fully described by an all-particle model, nor by an all-wave model – or are they?

The problem with light, and other high-frequency radiation, is that the momentum of individual wave packets does not spread out, so it seems to behave like matter or waves which are confined in a special container. However, all matter has mass, so this would restrict light to a speed below that of light itself.

For this reason, a special, fictitious force-carrying particle, the photon, was hypothesized and declared to have zero mass. To date, not a single photon has been detected in flight. Photon detection is always the result of energy-momentum exchanges at a target location. There is absolutely no experimental evidence.
indicating photons have the ability to propagate. Light also undergoes interference, diffraction, refraction, and all other classical wave phenomena. Matter does not. So, when these phenomena are occurring, light is considered to be a classical EM wave. For these reasons, the concept of duality evolved.

In practice, not all EM waves are known to behave as particles. Radio waves never seem to demonstrate particle behavior, or wave-collapse, while visible light, which is of wavelengths not much smaller than radio waves, is said to exhibit particulate behavior. Some speculate this is because radio photons would be ridiculously large, others suppose there must be some frequency at which photons are not formed, others may have other theories, but the majority has no clue at all.

Validity of the Inverse-Square Law

The inverse-square relationship between radiation intensity and distance exists because light from a point-like source propagates in a continuum of expanding concentric spherical waves. Since energy must be conserved from one surface to the next, the intensity per unit area diminishes. Figure 1 shows the intensity $I$ from an isotropic source radiating power $P$ is equal to the radiated power per unit surface area. Since the surface area of a sphere is given by $A=4\pi r^2$, the intensity is given by $I=P/(4\pi r^2)$.

How does the intensity of radiation emanating from a planar source vary with distance? The inverse-square law is true as long as it is applied to the correct geometrical configuration. If a wave were to keep the same cross-sectional area during propagation, then the inverse-square law will clearly no longer apply. In fact, the intensity of planewaves is invariant with distance. In general, it can be stated that radiation from any source subject to beam shaping cannot comply with basic inverse-square-law assumptions. Figure 2 shows a few examples of common directional EM wave sources that generate fields to which the inverse-square law cannot be applied directly.

Correct Application of the Inverse-Square Law to High-Gain EMR Sources

Planewave sources do not obey the inverse-square law for the simple reason that the propagating surface is no longer spherical. A beam with a $2\text{cm} \times 2\text{cm}$ cross-sectional area will still have the same shape and size after traveling 1km. But how can a planewave be produced if a simple isotropic radiator generates spherical waves? The answer lies in modifying the source so that it can no longer be modeled as a point source. This can be done by creating an array of many sources configured so as to provide a more or less flat emitting/radiating surface with a preferred beam direction. Waves emanating from a surface with a curvature flattened to the extent that its radiation demonstrates the most significant properties of planewaves will be referred to as quasi-planewaves. When using such a configuration, all sources need not be active. They could be parasitic (passive) elements interacting with a single active source, as in the case of TV antennas. Remember, a spherical wave will look like a planewave over a small area very distant from the source.

![Figure 1](image1.png) **FIGURE 1.** The geometrical origin of the inverse-square law. Energy is conserved from one spherical shell to the next.

![Figure 2](image2.png) **FIGURE 2.** Examples of high-gain EM radiators.
The trick of modeling a planewave source as the near-equivalent of the composite of many spherical generators is accomplished theoretically by substituting a far-distant, virtual (fake) source behind the real EM source, which is modeled merely as an aperture. (See Figures 3 and 4.) Waves passing from a far-distant source through an intermediately-located aperture would have essentially the same orientation, and their wavefront would have minimal curvature. This is exactly what happens with high-gain EM sources. The source can no longer be modeled as a point source at the center of the radiating or emitting cross section, but it can be modeled as an equivalent source a kilometer behind an aperture with the same position and dimensions as the real source. The distance of the virtual point from the aperture can be easily calculated from the aperture cross section and beamwidth (gain).

Applying the inverse-square law to directional sources requires that the virtual distance be included in the calculations. If one measures how the intensity varies with distance from any such device, a discrepancy from the inverse-square law, with distance being measured from the physical device, would be evident in the readings. One can easily confirm this by plotting light intensity vs. distance for the output of a flashlight or laser pointer. The higher the source gain, or the greater the effective aperture relative to the wavelength, the further the virtual point source moves behind the physical source location, and the flatter the corresponding wavefront. Extremely high-gain sources can be modeled as pure planewave emitters. The extent to which the wave shows its “particle-like” behavior depends only on the gain of the source and the detector. The net gain of a system comprising both a directional source and a directional target is equal to the product of the components’ individual gain values. In addition, polarization won’t make any difference in the surface curvature or gain. Polarization affects only the kind of momentum the wave imparts to the target. Linear polarization imparts linear momentum, while circular polarization imparts angular momentum. Today, circularly-polarized beams are called “chiral photons.”

**Argument Logic**
The logic of the argument can be briefly summarized as follows:

- Matter cannot travel at the speed of light.
- Particle motion does not obey the inverse-square law.
- Particles are classically defined in two ways: either as matter or force carriers.
• Particles do not undergo interference.
• Particles propagate their momentum \( p = mv \) (where \( v < c \)) from one point to another without spreading out.

• “Photons” travel at the speed of light.
• “Photons” do not obey the inverse-square law.
• “Photons” have no rest mass.
• “Photons” carry energy and are force carriers.
• “Photons” transfer momentum \( p = h\nu/c \).
• “Photons” undergo interference.

• Electromagnetic waves travel at the speed of light.
• Electromagnetic waves have no rest mass.
• Electromagnetic waves undergo interference.
• Electromagnetic waves carry energy and momentum \( p = E/c = h\nu/c \) and are force carriers.
• Spherical EM waves spread their energy and momentum over shells of increasing spherical area.
• Spherical EM waves approximate planewaves only at very large distances, but still propagate spherically.
• Plane EM waves do not spread out, so they do not obey the inverse-square law.
• Plane EM waves travel at the speed of light.
• High-gain emitters convert one or more spherical wave sources into a narrow beam, simulating a planewave.

From the above statements, one can clearly see that “photons,” and all other force carrier particles traveling at the speed of light, can be replaced in all statements by the term “planewaves.” These waves can be generated by simply beam-shaping a spherical wave source.

### Packet-Like Behavior of Highly-Directional Waves

In order to understand how quasi-plane EM waves can manifest all properties attributed to the classic photon, a simple numeric example will be provided. Consider the ratio of intensities of radiation at 2m and 1m from a highly-directional source. Neglecting the fact that the source is directional, and treating it as a point source, the ratio would be calculated using the inverse-square law:

\[
\frac{I_2}{I_1} = (\frac{R_1}{R_2})^2 = (1/2)^2 = 25%.
\]

On the other hand, taking into account the gain, the virtual point source may be located. Knowing the divergence of the field and the size of the effective aperture of the source is sufficient to calculate the source-aperture displacement. For the sake of keeping the argument simple, assume the virtual point source is determined to be 1000m behind the physical source. By applying the inverse-square law for this point, the expected intensity ratio is found to be

\[
\frac{I_2}{I_1} = (\frac{R_1}{R_2})^2 = (1001/1002)^2 = 99.8%.
\]

This gives virtually the same intensity and momentum transfer at twice the distance from the source. The higher the gain, the smaller the difference. It is as if the packet of energy thrown out from the source is intercepted by the receiver almost in its entirety. Using a simple parabolic reflector, where gain would be frequency-dependent, a narrower beam would be reflected for higher frequencies. This would cause higher-frequency waves to show more “packet-like” behavior than lower-frequency waves. Using highly-directional sources, a packet of electromagnetic momentum may be radiated from the source, and virtually the same amount of momentum would be received at the target, all at the speed of light. Does this sound like something familiar?

It can thus be seen that certain source configurations can make a wave act more like a particle without any physical particle or box to contain the radiation. No box or packet is required because the beam is able to restrict its own path in space, allowing the receiver to intercept the whole amount of energy that was sent by the transmitter without the need for the wave to “collapse” as it has to do in the wave-particle duality concept. What’s more, the beam does not break any fundamental law by traveling at the speed of light, because that’s what EM waves are supposed to do. This abolishes the need for the special massless particle that has come to be known as the photon. Photons simply do not exist. Their behavior has just been fully explained in terms of quasi-planewaves.

### Intensity Calculations for High-Gain Radiators

Note in Figure 5 that the isotropic source waves (dashed lines) would eventually flatten out to a planewavefront at large distances (See dashed wavefronts at B.), but still spread out spherically. The directional waves (solid lines) are quasi-planewaves from the instant they exit the aperture (See solid wavefronts at A.), and the spreading out is minimal. The larger the distance \( f \), the less the spreading out.
which is distance-invariant and gives the intensity for planewaves.

**Application to Aperture Antennas**

Aperture antennas, such as microwave dishes, are high-gain radiators. For radiation from these, $f$ is usually unknown, but it can be found if the corresponding diameter and operating frequency are known. In practice, an efficiency factor $\mu$ would make the effective antenna aperture area $A_{\text{eff}}$ somewhat smaller than its physical aperture, usually in the range of 50-70%. Using the equations below, one may find the antenna gain in order to estimate the beamwidth $\theta$ and source-aperture separation $f$:

$$A_{\text{eff}} = \mu A_{\text{ph}} = \mu \pi D^2 / 4;$$

where $A_{\text{ph}}$ is the physical aperture area; $\mu$ is the efficiency factor, which is about 70%; and $D$ is the aperture diameter.
Antenna efficiency $\mu$ is not due to a single factor, but accounts for several types of losses including RF losses, mismatch losses, illumination inefficiencies, spillover (edge spilling and back lobes), and phase error losses. The relationships among gain, effective aperture area, beamwidth, and wavelength may be derived as follows:

\[
G = \frac{A_{\text{sphere}}}{A_{\text{eff}}} = \frac{4\pi f^2}{A_{\text{eff}}},
\]

where

\[
A_{\text{eff}} = xy = (f \sin \theta)(f \sin \phi) \approx f^2 (\theta \phi).
\]

So,

\[
G = \frac{4\pi}{\theta \phi}.
\]

Assuming equal horizontal and vertical beamwidth $(\theta = \phi)$,

\[
G = \frac{4\pi}{\theta^2} \quad \text{and} \quad \theta = \sqrt{\frac{4\pi}{G}}.
\]

(See Figure 6.) Beamwidth is related to wavelength by

\[
\theta = \frac{\lambda}{\sqrt{A_{\text{eff}}}}, \quad \text{so} \quad G = \frac{4\pi A_{\text{eff}}}{\lambda^2}.
\]

Therefore, for aperture antennas, one may note that:

- Doubling the frequency quadruples the antenna gain.
- Doubling the frequency reduces the beamwidth by half.
- Doubling the antenna diameter quadruples the antenna gain.
- Doubling the antenna diameter reduces the beamwidth by half.

It is important to be careful with these generalizations and, as always, assess whether the particular equation or assumption fits the situation being analyzed. The above assertions are definitely not true for all antennas, since many antennas are only effective for a relatively narrow bandwidth, usually having a particular frequency band for which they are meant to be used. Doubling the frequency in such cases would effectively increase the mismatch losses.

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**FIGURE 7.** Poynting vector field lines around an antenna showing how effective capture area becomes larger than the antenna’s physical aperture.

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**Nomenclature**

- $A$ = surface area
- $A_{\text{eff}}$ = area of effective aperture
- $B$ = magnetic field strength
- $c$ = speed of light
- $D$ = aperture diameter
- $d$ = distance between source and target
- $E, E_0$ = electric field strength
- $f$ = distance between virtual source and (aperture) source
- $G$ = gain
- $h$ = Planck’s constant
- $I$ = intensity (of radiation)
- $m$ = mass
- $n$ = principal quantum number
- $P$ = power
- $p$ = momentum
- $R$ = radius of sphere
- $r$ = radial distance (from source)
- $v$ = velocity
- $x$ = distance between detectors
- $y, z$ = length, width of aperture
- $\lambda$ = wavelength
- $\mu$ = efficiency factor
- $\nu$ = frequency
- $\theta, \phi$ = beamwidth or divergence
and drastically reduce the effective aperture area and gain. Fractal antennas go around this problem by having stepped-size or nested layers of effective aperture areas, so that a much larger bandwidth can be accommodated. A common log periodic TV antenna (See Figure 2.) used to receive the whole UHF band is one example. It is also possible for an antenna to have an effective aperture which is much greater than its physical aperture. (See Figure 7.)

**Modeling an X-Ray “Photon”**

**Emission as a High-Gain EM Wave Source**

There are good reasons for treating the atom as a directional high-gain antenna with an effective aperture area much greater than its physical cross-sectional area. In the abstract of the paper, “How Can a Particle Absorb More than the Light Incident on It?” (Craig F. Bohren, *Am J Phys*, 51:4, April 1983, p. 323), the author states:

A particle can indeed absorb more than the light incident on it. Metallic particles at ultraviolet frequencies are one class of such particles, and insulating particles at infrared frequencies are another. . . . In both instances, the target area a particle presents to incident light can be much greater than its geometrical cross-sectional area. This is strikingly evident from the field lines of the Poynting vector in the vicinity of a small sphere illuminated by a planewave.

In another article entitled “Light Absorption by a Dipole,” (H. Paul and R. Fischer, *Sov. Phys. USP*, 26:10, October 1983, pp. 923-926), it is claimed:

In semi-classical radiation theory, the electric dipole moment induced on an atom by a strong incident field absorbs much more energy, per second, than is flowing through its geometrical cross section. This means that the atom has the capability to “suck up” electromagnetic radiation from a spatial region that is by far larger than its own volume.

Figure 7 shows the Poynting vector lines of a directional antenna at its resonant frequency, which at a glance explains observations like these. With reference to nuclear physics, it is very clear that what today are called “absorption curves” are nothing but the frequency response curves of atoms. An absorption peak means that part of the atom’s antenna has reached a resonant condition with the incoming radiation. In other words, the atom has matched its impedance to its external environment to efficiently absorb the incoming radiation. At each of these absorption peaks, the effective aperture dynamically expands to a value exceeding by far its physical cross section. Therefore, the peaks of a plot of effective aperture or gain vs. frequency should coincide with those on a corresponding absorption vs. energy curve. (See Figure 8.)

**Simultaneous Reception Prediction**

A classical “photon” emission assumes the photon leaves one place and hits another unique location. Classically, the wave function is said to “collapse” at a single location. If the classic photon is replaced with the planewave model, momentum and energy would still propagate in a localized packet-like manner, but the small divergence of the quasi-planewave might be detectable if the wave packet is found to be shared on two very close but separate targets. This is something that is not possible with the present quantum theory.

The proposed quasi-planewave theory predicts an x-ray wavefront will spread out from its source at a particular beamwidth, which at some distance from the source should be able to hit two detectors simultaneously. A particular scenario will be considered because some variables must be defined to prevent equations from being indeterminate:

- The atomic aperture efficiency is 100%.
- The azimuth and elevation beam widths are equal.
- The source aperture is selected to correspond to a tungsten source (atomic radius = 139pm).
- The target aperture is selected to correspond to a silicon detector (atomic radius = 111pm).
- The typical x-ray wavelength is about 60pm.
FIGURE 9. Thought experiment for showing photons are quasi-planewaves. Will the same "photon" be simultaneously received by two separate detectors?

FIGURE 10. Multiple planewave sources can mimic a point source. The net intensity over the spherical surface obeys the inverse-square law, even if the intensity of each individual beam is invariant with distance d.

Considering the tungsten and silicon atoms to be physical antennas, the gain would be

\[ G_{\text{total}} = G_{\text{source}}G_{\text{target}} = \frac{4\pi A_{\text{eff (source)}}}{\lambda^2} \frac{4\pi A_{\text{eff (target)}}}{\lambda^2} \]

\[ G_{\text{total}} = \frac{4\pi (\pi 139^2)}{60^2} \frac{4\pi (\pi 111^2)}{60^2} = 28,628 \text{ or } 44.6\text{dB}. \]

Gain may be calculated even though nothing is known about the internal structure of the atoms. The effective 3dB beamwidth in radians is given by

\[ \theta = \sqrt{\frac{4\pi}{G}}, \]

so the beamwidth \( \theta = 0.21 \text{ radians} = 1.2^\circ \). This means the virtual point source distance is

\[ f = \frac{\text{atomic radius}}{\tan \theta} = \frac{139}{\tan (1.2/2)} = 13,273\text{pm} \]

behind the atom, which might not seem like much, but when compared to a wavelength of 60pm, its impact is not negligible, as is confirmed by the small beamwidth.

The probability that the same x-ray event will hit both detectors simultaneously increases with the distance of the detectors from the source, and decreases with the distance \( y \) between the two detectors. Let’s assume a distance of 50cm from the source to the detectors. If one detector is on the peak of the main radiation lobe, and the other is at the 3dB beamwidth angle \( \theta/2 \), there will be a 50% coincidence rate. The separation distance of the detectors required for a 50% chance of observing the desired phenomenon is

\[ y = (50\text{cm})\tan (1.2/2) = 5.2\text{mm}. \]

The first null is located at about twice this distance or \( y \geq 1\text{cm} \), where the chances of simultaneous detection would fall to zero. An appropriate detector would have to be used to obtain positive results. Such an experiment will enable simultaneous detection of the same event at two independent detectors separated by a few cm. A detection rate in excess of 50% will directly contradict theories of wave-particle duality. Figure 9 shows a conceptual setup for a gedanken experiment.

If Nuclear Decay Emits Highly Directional Waves, Shouldn’t the Count Rate Contradict the Inverse-Square Law?

As has been previously explained, planewaves do not spread out like spherical waves. However, there are particular examples in which the source is made up of a plurality of these directional sources, which are spread over a surface area or perhaps within some volume. The stars and radioactive materials are two such examples.

Figure 10 illustrates an example in which a spherical object is covered with high-gain radiators. For the
sake of clarity, we are observing a small part of the surface area containing only nine directional radiators. In reality, in most cases, the whole surface would be densely populated with a large number of these radiators. The sources could be optical beams, microwave beams, pulses of gamma rays, or any number of directional radiators stacked together onto the same object. Each beam acts as a planewave with an individual intensity that is invariant with distance from the center of the object. It is clear that the net intensity of radiation, which spreads spherically outward, now depends, at a given distance, on the number of beams per unit area. On the surface area covered at distance \( d \), we have all nine sources radiating through one unit square, whilst at a distance \( 3d \), we have only one beam passing through each of the area units, resulting in an intensity reading \( I = (1/3)^2 = 1/9 \). Hence, when measuring the optical flux from such a radiator, or of radiation incident over a Geiger counter window from a radioactive stone, the inverse-square law would still be obeyed. This would easily give the false impression that the radiation is emanating from just a single point source when in fact the story is altogether different.

Related Experimental Evidence
I am thankful for one of our Blaze Labs Yahoo Group members, Eric Reiter, who has brought to our attention his past great work, which may be read at The Unquantum Effect web site (http://www.unquantum.net/). In his experiment with low-frequency \( \gamma \)-rays, he clearly obtained data showing simultaneous reception beyond chance coincidence rates for a single “photon,” an effect which poses a serious challenge to quantization theories. His experiments support the position that a photon is nothing more than a pure wave phenomenon.

Quantization
Once freed from the light-quanta paradigm, quantization (See Figure 11.) can be simply defined as the frequency response of the atomic (dipole) antenna. Max Planck, the originator of light quanta himself, referred to the quantized phenomena observed as effects regulated by characteristics of the oscillators. He resisted Einstein’s hypotheses attributing a point-particle nature to light quanta. In his recorded remarks delivered from the audience at one of Einstein’s talks, he argued against Einstein’s hypothesis about atomistic light quanta propagation through space.

If Einstein were correct, how could one account for interference when the length over which one detected interference was many thousands of wavelengths? How could a quantum of light interfere with itself over such great distances if it were a point object? Instead of quantized electromagnetic fields, one should attempt to transfer the whole problem of the quantum theory to the area of interaction between matter and radiation energy.

If the light quantum is considered to be just the effect of the interaction of electromagnetic radiation with matter, as Planck insisted, quantization cannot be applied to a “flying photon,” since Maxwellian electrodynamics, which describes the laws governing radiation, is a continuum theory. Planck appears to have been right all along when stating that discontinuity is only at play during the process of energy transfer between the continuous radiation field and the oscillator. In March 1905, Einstein warped this truth in his paper, “On a Heuristic Point of View Concerning the Production and Transformation of Light,” since he stated that quantization was explicitly not limited to resonators or the interaction between matter and the field, but was also a requirement of the EM field itself. From there on, the term “light quanta” took on the meaning of a particle-light phenomenon. As a confidential letter from him to Lorentz confirms, Einstein knew that for such a statement to be true, Maxwell’s and Lorentz’ electrodynamics must be wrong, but he never explicitly mentioned this fact in public. At that time, he was also aware that his model ran into other rather unresolved problems:

![Figure 11. A classic electronic energy level diagram representing the first (Lyman) series of quantized line emissions from hydrogen spectra.](imageURL)
• The particles of light quanta should have mass \( E/c^2 \), yet by his own theories, no matter can attain the speed of light.
• Light quanta can’t account for the interference of light.
• Particulate light quanta cannot be split, and therefore cannot account for partial reflection.
• A helically traveling photon, advancing at the speed of light, would have to exceed the speed of light along its helical path.

These must be the reasons behind the careful choice of the word “heuristic,” which means tentative or unverifiable, in Einstein’s paper title. Planck remained skeptical of the physical existence of the flying light quanta, together with many other scientists, and in his opinion, Einstein had missed the point. These logical fallacies were ultimately patched up by declaring the photon to have zero mass, and declaring the wave-particle duality as truth. With the proposed model of quasi-planar waves, all these problems vanish altogether. Not only do they vanish, but speed of light propagation, interference, particle reflection, and polarization are all predicted outcomes from the beamed wave model.

The problem can be compared to an analogue-to-digital converter sending serial data over a pair of wires to a digital-to-analogue converter. The data passing over the wire is indeed quantized, as either 0V or 5V, since this is what the AD converter is sending over the wires. Also, the DA receiver has no way to either receive any other voltage levels nor to interpret any other voltage combinations. However, this does not mean that the voltage across the wires is restricted to quantized levels, and in fact it is known that the wire can indeed handle an analogue signal. With a digital source and detector, there is no way one can confirm whether or not the method of propagation itself is quantized. The measured results would be reliable only so long as 0V and 5V were the only allowable inputs. Changing the oscillators from atoms to radio antennas, we have the ability to send non-quantized energy using the same propagation method. It is found that the EM propagation handles non-quantized energy very well, and that Einstein’s extension of quantization to energy of the EM field itself was a redundant and incorrect step.

The discontinuities which are experimentally known to occur are simply multiple resonant frequency peaks (See Fig. 8.) set within the antenna structure of each atom. Each atom can be a very efficient transmitter or receiver on a number of different stations, all preset in its memory due to its internal nuclear structure. It is not surprising that unless the transmitter is transmitting on an energy level (frequency) for which the receiver can be tuned, the receiver will never get into resonance even if one increases the intensity/carryer amplitude of the transmitting source. These nuclear structures must be working in a manner very similar to fractal antennas, in that the frequency response of each is not peaked on a single frequency, but on a geometric progression of channels governed by its internal nuclear structure. These preset channels are what are referred to today as quantum levels. Figure 12 shows how these levels come as a natural consequence when they are considered to be the result of resonances of different pieces of a fractal atomic structure. Wavelengths generated between intermediate structure levels would also explain the existence of the Lyman, Paschen, and Brackett spectral series. All quantum mechanics can be explained using our present knowledge of electromagnetic fields, thus eliminating incorrect concepts of probability and duality.

![Fractal antenna structure and logarithmic resonant frequency responses](image-url)