Wave-particle duality explained within a pre-fermion framework

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The success in explaining almost all the features of the universe using a hypothetical pre-fermion framework is extended to include how light can be observed as both a particle and a wave. The explanation is that light is emitted in two parts that are intimately linked at emission and observation. The photon travels within an initially spherical expanding shell whose changes in width reflect the density of the background through which it moves. All points on the shell travel at the local light speed resulting in a distorted shell surface, with some points trapped where local light speed is zero. The photon moves randomly and non-locally within the shell because the background is always excluded from some of the shell volume. The initial width of the shell is set by the photon emission frequency but increases as the shell expands and loses energy.

Observation is either due to the photon stacking, so that its velocity becomes zero, the shell width becomes zero as it evaporates and the photon loses frequency to the shell components reflecting the energy loss to that point or alternatively the shell is disrupted and the photon moves to a random pre-existing point on the shell where its velocity will be zero. The former observation is particulate with no probability involved whereas the latter is wave-like. The shell is composed of the gap created between merged meon pairs in the background that do not themselves travel but that transmit the wave, as occurs in water waves. It may be possible to prove this light hypothesis in a slit experiment that disrupts the shell and causes the photon not to arrive at the observing screen.

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I. INTRODUCTION

The treatment of light separately as either particulate or wave-like has been at the core of the difficulties in explaining exactly what constitutes quantum mechanics and, more specifically, a photon. In previously published papers of a pre-fermion hypothesis [1, 2, 3, 4] the explanation of a particle and a wave was only made in terms of two different ways of understanding how a photon moves, without linking the them directly.

It is now possible to explain the relationship between the two travel modes in one overarching new interpretation that shows how a wave and a particle exist together. The explanation also provides a possible experiment that can prove whether, or not, the interpretation is correct.

The paper is written as if everything hypothesized is correct and does not cover issues that the previously mentioned papers treat appropriately, such as photon structure, tired light, background composition, meons, zero mass black holes, merged meon pairs, mass chasing forces, quantum energy levels, entanglement and superposition.

II. SIGNIFICANCE and OBJECTIVES

The significance of the new interpretation of how light is both a wave and a particle is fundamental to quantum mechanics as a whole.

The objective is to produce an explanation that is simple and yet covers all the previously unexplainable phenomena associated with light.

III. EXPLANATION

The starting point is to recognise that when light is emitted, there are two parts that are produced.

The first part is the photon, which is a merged loop and anti-loop in a rotating double-loop structure composed, in our normal matter environment, of three pairs of meon and anti-meon in each loop which are chasing transversely their opposite meon-type, in the other loop, perpendicularly to their mutual axis of rotation.

The chasing between the two meon types accelerates the photon up to a maximum speed at which point the force that is driving the chasing is matched by the frictional viscosity on the meons of the local background and gravitational or charge fields produced by bodies composed of loops. That maximum speed is what we call light speed **c**, but it is not a constant. When light speed is measured in ‘empty space’, there is still the local background, of merged meon pairs and zero-mass black holes, through which the photon is trying to travel, like a very dilute aether.

Where the density of merged pairs in the background is greater than ‘empty space’, for example around stars or large black holes, the background viscosity will be greater and light speed will be slower. Around a massive enough black hole light speed could reach zero. There may be experiments in space able to confirm the change in local light speed in different gravitational fields.

The second part produced during light emission is a spherical wave whose thickness at emission is equal to the wavelength of the photon emitted. Although this is described as a wave, because that simplifies the mental image of a high and low pressure in the background that expand outwards, the better description is of a double-shell whose initial gap thickness is the wavelength of the emitted photon. The shell is composed of the gap created between merged meon pairs in the background that do not themselves travel but they transmit the wave, as occurs in water waves.

Thus the emission of light is a photon that surfs non-locally within an expanding double-shell, composed of background merged meon pairs, expanding outwards at local light speed.

The surfing aspect is a deeper description of the photon's motion because the shell excludes background merged pairs as it travels, enabling the photon to skip around the double-shell, within the gap, without experiencing any viscosity, so non-locally.

At some points and times the shell may not completely exclude the background, as it passes through other shells, but the photon will not skip into those volumes.

The shape of the shell may start out as a sphere, but will be affected by the density of the background and other mass and charge fields through which it travels. The result will be a misshapen sphere where some parts will lag behind others, even though all parts travel at their own specific local value of **c**, but no part of the shell will travel outwards faster than 'empty space' **c**.

IV. EVENTS

As the shell expands, and the photon skips around just inside the front shell, within the gap to the lagging rear shell, where it is able to and unless there is an 'event' at the instant when that photon is at the event point, the shell and photon will keep going.

One event that causes the destruction of the shell is the stacking of the photon, effectively the photon hits something and attaches itself to that loop or stack of loops. This means that the photon's velocity becomes zero and the shell wavelength should become zero.

In normal environments like 'empty space' the equation for light is

$$\mathbf{c} = f\Lambda$$

Where **c** is light speed, f the frequency of rotation of the photon double-loop and Λ the wavelength associated with the photon.

However, the wavelength is the property of the shell and the frequency is the property of the photon whilst travelling. At emission the two are related. As the shell expands, the wavelength, or radial width of the shell, changes because it itself is passing through the background, even if the interior of the shell generally excludes the background.

The result is that the width of the shell increases as it passes through the background – it is effectively losing mass energy as it travels, even though its total energy is always zero. The front shell travels at local **c**, whilst the back of the shell is gradually delayed so that the gap between front and back, the width of the shell and the volume within which the photon exists, increases.

The photon will retain its original frequency within the shell, travelling non-locally, because there is no viscosity to overcome. It will always be at the front edge of the shell since it is always travelling radially at local **c** no matter at which point on the shell it is from instant to instant.

The local value of **c** at each point on the exterior of the shell will depend on the local viscosity, that is the background density and mass and charge fields present, at that point. At some points on the shell the local light velocity could be zero, for example near a massive black hole. Now the light equation becomes

$$\mathbf{c} = f\Lambda = 0$$

and the wavelength of the shell should go to zero, effectively the width of the shell should be zero because the photon still retains its original frequency. This locks the shell at that point in space so that it cannot move but has no consequence unless the photon skips to that point.

If, at that instant, the photon lands at that point on the shell where the width should be zero, the photon velocity becomes zero – it effectively stacks on the source of the high density that has locked the shell in place. The photon instantaneously transfers some of its rotational frequency to the shell components, the merged meon pairs.

The energy transfer to the shell is effectively repaying the cost of the shell moving to that point. The merged pair chains, usually attached to meons in loops when within the background, are absent from the meons in the photon double-loop whilst in the shell gap.

These chains become reinstated as the shell merged pairs form new chains attached to the photon, which reduce the photon rotational rate to the rate it would be had it travelled there directly itself, through the background.

The shell can be considered to immediately evaporate and its components attach to the photon because within its walls the message of the event travels non-locally.

The other event is that the shell is disturbed, which forces the width to zero and causes the photon to travel to a random point on the shell where the shell velocity is zero. The shell evaporates and the merged pairs attach to the photon at that random point.

These are the only two events possible in this shell and photon hypothesis. The first type of event, where the photon causes the event, leads to the shell evaporation and attachment at the point where the photon has been stopped – with no probabilities it is a particulate event. The second type of event, where the shell causes the event, leads to the photon skipping to a random point on the shell where the shell evaporation and attachment occur – which is based on probabilities and is therefore a wave event.

V. EXPERIMENTAL OBSERVATION

A double-slit experiment may enable the validity of this description of light as a photon within a shell. There are two normal possible routes to observing an event in such an apparatus. There is a third unexpected route that could be tested.

The first normal route is if one slit is closed before the photon gets to the apparatus, then the photon, if it afterwards coincides with the screen, will cause the evaporation of the shell and the stacking of the photon in one place on the screen. The photon causes the event, if it is at the screen.

The second normal route is when one slit is closed after the shell has passed, but before the photon hits the screen, then the photon may or may not skip around the shell so as to be coincident with the screen for observation when the shell hits. The result will be a wave-like effect over time with the properties of the photon stacking on the screen being those of the shell at that point.

The shell in this instance may keep expanding beyond the screen without the photon being coincident on it, and the eventual event is elsewhere on the shell. There is only an observation when a photon is at that point in the shell and the screen. The shell causes the event, if at the screen.

The first route produces a particulate result because there is no probability involved. The shell is evaporated because the photon has stopped travelling.

The second route produces a wave-like result because the photon does not stop unless the shell is coincident with the screen and the photon skips to there at that instant.

There is, however, a third unexpected route to an event that could be produced but has been misidentified as just the photon being blocked at the slit.

If, after the front shell has passed through the double-slit apparatus but before it has had time to hit the observing screen, one slit is closed within the passing shell width, then the shell should evaporate and the photon will not necessarily hit the screen at all.

The photon will instead become stacked somewhere on the shell where the shell is locked in place. To be clear, a shell must be unambiguously on its way through the apparatus so that the photon's non-appearance on the observing screen is confirmable. The shell causes the event, and the photon stacks elsewhere on the shell.

The difficulty here is that the photon could simply stack on existing electrons or atoms that are at that instant in its line of motion if within the apparatus, even in the highest vacuum experiments.

These three routes to two types of event are what define a 'measurement' for light. If the shell causes the event, the result is wave-like. If the photon causes the event, the result is particle-like. It is either that the photon speed **c** has become zero or the shell has been evaporated, effectively its width has become zero. The same effect will be found no matter whether a photon is emitted in a laboratory or from Alpha Centauri.

The same shell and particle hypothesis may be envisaged for loop combinations other than photons. Provided the combinations were small enough to be able to move non-locally around their emission shell, quantum mechanical type behaviour should be possible, although the speed of the expansion of the relevant shell may not be local light speed.

VI. SPECIFIC LIGHT POINTS

It is the wave/shell gap between the merged meon pairs that moves overall, not the individual merged meon pairs – like a water wave. Shell skipping produces the probability of photon being at any point.

A photon is either stacked with a zero relative velocity or skipping non-locally within a shell that is travelling at local **c**. All stars and other bodies, unless they have sufficient density to create c=0, will only distort the shell.

For wavelength measurements, the use of DASI units will require the adjustment of the photon frequency as $\boldsymbol{f}\sqrt{G}$ and the shell wavelength as $\Lambda/\sqrt{G}$. The loop sizes require additional adjustment of photon frequency as $\boldsymbol{f}/2$, internal velocity of $\boldsymbol{v}/\sqrt{2}$ and internal radius of $\boldsymbol{r}\sqrt{2}$.

There is a maximum distance that a photon can travel. This distance is set by the 'empty space' fractional energy loss figure and the initial emission frequency. The distance could be shorter if the background density and local gravitational or charge fields are higher.

The equation for the total red shift of a photon, including only viscosity and velocity red shifts and using the definitions from the previous paper [1], will be

$$(\boldsymbol{Z_t}+1) = (\boldsymbol{Z_v}+1)(\boldsymbol{Z_c}+1)$$

$$= (\boldsymbol{Z_v}+1)(\boldsymbol{f}\,\boldsymbol{D}+1)$$

and

$$\boldsymbol{v/c} = ((\boldsymbol{Z_v}+1)^2-1)/((\boldsymbol{Z_v}+1)^2+1)$$

Graph 1 shows the resulting stellar velocities at different total red shifts between $\boldsymbol{Z_t}$ =0 and $\boldsymbol{Z_t}$ = 12 versus distances between $\boldsymbol{D}$=0 and $\boldsymbol{D}$= 1.2 x10^{10} Ly.

The figure used for the maximum value of $\boldsymbol{D}$ should be the same as the 13.8 billion years that the age of the universe (or our part of it) is currently estimated to be. However, limits in computing have caused the slight shortfall, although this does not affect the general result. Since the pre-fermion hypothesis does not require any expansion of space, the age and size of the universe (or our part of it) are directly proportional.

The higher value for $\boldsymbol{f}$ from the later paper [4] as $\boldsymbol{f}$ = 8.4 x10^{-11} Ly^{-1} is used, which corresponds to the 'acceleration of expansion' which underlies the need for dark energy. In this hypothesis, this higher rate is the actual 'empty space' value for the viscosity red shift which is the upper linearly increasing line on the graph, since it is proportional only to the distance traveled by any photon, rather than the photon frequency.

The net effect is that the higher viscosity red shift is set against the contraction of our Big Bang components, leaving the lower Hubble rate of 7.15896 x10^{-11} (70 km s^{-1} Mpc^{-1}) out to the limit of our Big Bang envelope, after which the viscosity red shift is the only general component, ignoring specific velocities of objects beyond that distance.

The graph shows that at all object velocities of zero, the only contributor to the red shift is viscosity when those objects have around $\boldsymbol{Z_t} < 1$. No objects exceed light speed either towards or away from the observer.

At, for example distance $\boldsymbol{D}$ =4.26x10^9 Ly, where the $\boldsymbol{Z_t}$ = 1 and $\boldsymbol{Z_c}$ lines cross, the two components are equal at $\boldsymbol{Z_v}$ = 0.369 outwards and the same value for **v/c**. For an object observed at $\boldsymbol{Z_t}$ = 0.1 and $\boldsymbol{D}$= 1.46 x10^9 Ly, the $\boldsymbol{Z_c}$ = 0.123 means that the object velocity will be v/c = -0.0204, towards the observer – a blue shift.

The limit for objects contracting within the maximum distance for $\boldsymbol{D}$ is around $\boldsymbol{Z_t}$ = 1 when the total $\boldsymbol{Z}$ shift can no longer cause the object velocity to go negative. This suggests that any object with approximate total red shift around $\boldsymbol{Z_t} > 1$ is likely to be outside our Big Bang envelope.

The alternative way of expressing these relationships uses the emission and observation frequencies of a photon, as

$$\boldsymbol{W_e} - \boldsymbol{W_o} = \boldsymbol{Z_t}\,\boldsymbol{W_o}$$

which can be split into two components due to velocity and viscosity as before. The equation is

$$(\boldsymbol{W_e}/\,\boldsymbol{W_o}) = (\boldsymbol{Z_v}+1)(\boldsymbol{f}\,\boldsymbol{D}+1)$$

But $\boldsymbol{Z_v}$ has the same structure as $\boldsymbol{Z_t}$ in terms of $\boldsymbol{W}$, except that the observed frequency should be higher at $\boldsymbol{W_v}$ because the viscosity effect has produced the extra frequency lowering, with both emission frequencies the same. The result is that

$$(\boldsymbol{W_e}/\,\boldsymbol{W_o}) = (\boldsymbol{W_e}/\,\boldsymbol{W_v})(\boldsymbol{f}\,\boldsymbol{D}+1)$$

or

$$(\boldsymbol{W_v}/\,\boldsymbol{W_o}) = (\boldsymbol{f}\,\boldsymbol{D}+1)$$

meaning, as expected, that the frequency loss due to viscosity will be a different fraction for different emission frequency photons when the source is in relative motion – it is a constant function of the distance travelled.

The same different frequency ratio effect exits wen the source is not in motion and the equation becomes

$$(\boldsymbol{W_e}/\,\boldsymbol{W_o}) = (\boldsymbol{f}\,\boldsymbol{D}+1)$$

Because $\boldsymbol{W_o}$ cannot usefully be used if it is equated to zero, a cut-off frequency has to be chosen. Initially letting $\boldsymbol{W_o}$ = 1 Hz and $\boldsymbol{W_e}$ as the H alpha emission frequency of 656.28 nm or 4.568 x 10^{14} Hz (as a ratio there is no need to convert into DASI units) leads to a maximum travelable distance of

$\boldsymbol{D}$ = 4.568 x 10^{14}/8.4x10^{-11} = 5.438x10^{24} Ly

If, instead, the CMB temperature of 2.725K and frequency 160.23 GHz were used for $\boldsymbol{W_o}$, then the maximum distance would be

$\boldsymbol{D} = 4.568 \text{ x } 10^{14}/(1.6\text{x}10^{9} *8.4\text{x}10^{-11} = 3.4\text{x}10^{15}$ Ly

which is considerably closer to some reasonable estimates which put the size of (our part of) the universe, at around $2\text{x}10^{13}$ Ly.

However, the equation indicates that the greater the frequency, the longer the lifetime of the photon, so the distance could be significantly larger than both estimates.

VI. FUTHER PRE-FERMION POINTS

The supposed fine-tuning of the values of many of the properties of our part of the universe may be why our Big Bang is as long lasting and large a volume as it is. Other non-appropriate values would have shortened the lifespan of other big bangs and turned them more quickly into failed big bangs. But all bangs eventually fail.

The existence of other big bangs with different property values (inflation-caused loop sizes and loop pair-numbers) is equivalent to having many universes, except they are all within our only universe using our only meon properties. This enables their identification through spectrum and red shift observations, which would not be the case for multiverses formed outside our own universe.

There is no information loss when loops enter massive black holes. As the meons have far greater density than any black hole composed of chains, they cannot ever be broken.

When a loop enters a massive black hole, it is first stretched as the differential gravitational effect across the loop affects the meons in the loop differently. In that stretching, the ‘mass’ of the loop, really its rotational rate, is transferred to the black hole, as is the equal size and opposite type spin energy.

The black hole absorbs the spin energy as part of its own rotational rate and the mass energy as its size. The pressure balance within the black hole is a function of the number of chains within it versus the volume or surface area that it has.

The fundamental mass and charge remain with the individual meons, as do the twist and equal size one-sixth charge energies. These properties, as meons, enter the black hole as the loop breaks into a chain.

The chain will reform with other chains inside the black hole, break apart, swap pair-partners and generally chase about. This is what a black hole is – a chain star.

Occasionally a chain and anti-chain may reform loop and anti-loop with sufficient rotational frequency to escape from the black hole perpendicular to its surface as a photon, which could be of any pair number. This is how the black hole evaporates.

The most likely place for photons to form is orientated along the black hole’s axis of rotation, so that the photon takes away rotational energy from the black hole as well as an equal amount of mass energy and charge. This probably explains high energy emissions along opposite poles of celestial objects that are dense enough to break loops into chains.

So what goes into a massive black hole is also what emerges, although the identities of the loops may be different. The loop components are always the same and their overall charge, spin and mass energies as loops are always conserved.

Although the above has been explained in terms of the strong fields generated by massive black holes breaking loops into chains, each meon itself has a far stronger mass and charge field than any massive black hole. This means that ripping loops apart can happen anywhere where there are meons and loops – everywhere.

So the change of identity of two loops can occur almost anywhere, where one or more meons, or meon pairs, in each loop are swapped. Two swapped meons do not have to be from the same meon pair that was unmerged together originally from within a zero mass black hole.

A simple example would be an electron and positron loop each swapping a meon pair to become a down quark and an anti-down quark. The charge, spin and rotational rates would be unchanged if the two loops started out merged as a photon and ended as a photon, although this is unlikely as the asymmetry of the quarks may preclude their forming photons.

It is likely that the same effect is at work in the weak force process, where a need for other loops to provide appropriate gravitational and charge fields appears necessary, even though the simple replacement of an electron loop in a neutron stack by a neutrino loop, with unchanged quark content would seem the easier route.

If the process requires that the down, up, down quark stack in the neutron core changes to the up, down, up quark stack in the proton core, then using boson loops to provide strong fields in order to break one of the stack down quarks with a neutrino loop, swap meons around and then form a stack up quark and ejected electron would be a possibility. Loop identities have changed but properties, other than stack radius adjustment, remain unchanged.

The existence of the meons in the loops in a stack explains why the electromagnetic forces between nucleons do not cause the nucleus to be instantaneously unstable. It is the mass forces between meons in stacks and across stacks that balance the electromagnetic forces. This is also why electrons and neutrinos can exist within stacks, because they also are composed of meons. A nucleon uses both charge-related and mass-related forces to exist within a nucleus.

The existence of other energies and forces not included in standard systems extends to gravitational orbits and quantum orbitals. Once the gravitational constant has been eliminated from all equations, it is immediately apparent that gravitational mass and inertial mass are identical.

What has been missing from orbital equations is the effect of the kinetic energy of the spin of loops, which is equal in size, although opposite in type, to the mass energy of a loop.

The spin energy itself does not appear in the gravitational part of the equation for large objects because spin energies only affect spin energies and generally the spin directions of loops within a large body are random and so mostly cancel out. It is only where the two bodies in a system are small, such as nucleons and electrons, that the effect of the spin energies become apparent and need to be accounted for, as they are.

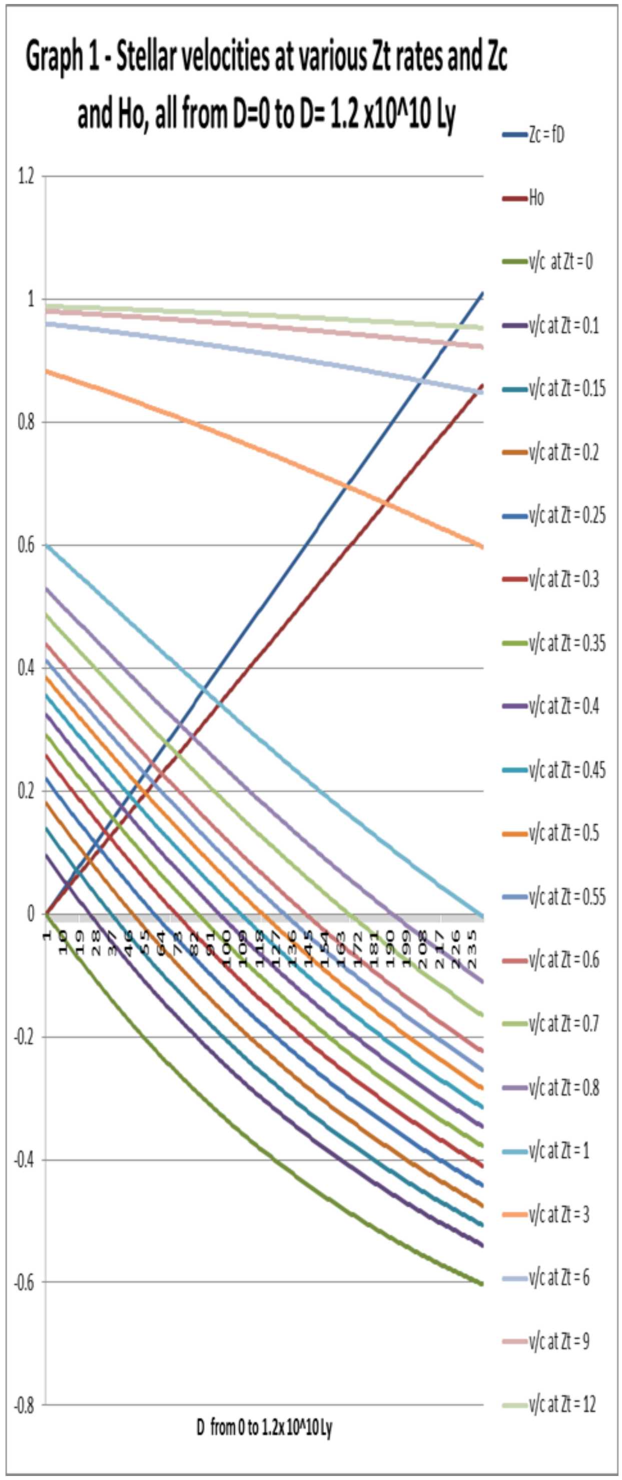
However, even in these orbital energy equations, the kinetic energy of spin, which is in the same outward direction as the mass kinetic energy is ignored. This is what confused previously when there was no explanation for why the electron did not just decay into the nucleus - since it did not have enough motional energy to balance the electrostatic attraction of the nucleus and yet the force equation with the same variables indicated that the orbit should be stable..

That lack of the spin kinetic energy led directly to the notion that the electron could only have certain quantum states where the energy and momentum were a whole number fraction. That is still the case when the spin kinetic energy is accounted for correctly, but the fraction is instead twice the size.

This is then also the case for large bodies, except that the net spin energy orientation needs to be known for both bodies before any fractional relationship, or otherwise, can be established. This is probably not possible beyond a system of small sized simple bodies. So there will be a continuum of values between the very large and the very small, along which a null relationship becomes whole number fractions.

VII. CONCLUSION

The pre-fermion hypothesis covered by this, and other papers, enables almost all of the main features of our universe to be explained and deserves to be more widely considered.



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