Light as a Matter Wave? A Simple Mathematical Examination of Two Proposed Concepts

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At least three authors have proposed the concept of light as a traveling series of 'matter waves.' Such a concept does not require an 'aether' medium as does the more prevalent concept of light, if behaving as a wave, doing so analogous to other types of 'disturbance waves," such as sound or water. One author's concept is examined mathematically for plausibility and, when found to be so, extended qualitatively to incorporate that of the other authors' to at least what is hoped may be viewed as a reasonable extent.

1. Introduction

The concept of light as a matter wave has been proposed by at least three authors. On his website, http://alternativephysics.org/book/Light.htm, Burchell postulates the following.

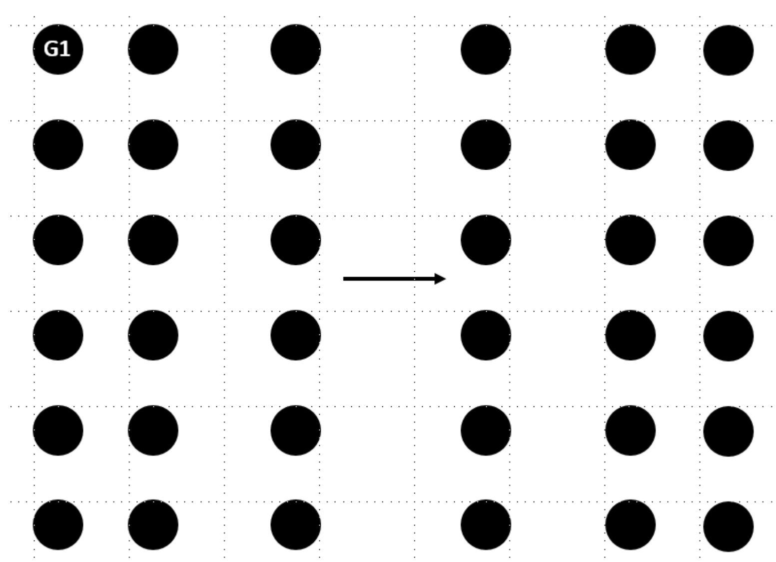
> *If light is a wave it must have a medium to exist in, right? In fact this is not true ... [T]here are two type of waves: disturbance waves and matter waves … A disturbance wave involves small local movements in a (solid, liquid, or gas) medium that propagate themselves into the surrounding portions of the medium. Sound is a disturbance wave. So are ripples on a pond or the plucking of a guitar string. A disturbance wave involves small (up/down, left/right, or forward/back) movements but no net movement of material … Matter waves … are composed of a steady stream of moving material that fluctuates in intensity. For example, … [t]urn on a garden hose and move it left and right. You'll notice the water coming out in a something like a sine-wave pattern. But this water wave is not going through a medium (OK it's going through air but we can also do this in a vacuum). The other important difference … is that a disturbance wave's speed is fixed by the medium it's in. Whereas a matter wave can move at any speed and its speed will increase as the speed of its source increases … How does this relate to light? … [W]e … hypothesized that they [electric fields] consist of a type of substance generated within charged particles and ejected from all sides at the speed of light. When this substance hits another charged particle it applies a constant force … if the source and target remain motionless relative to each other ... But suppose the source particle were not standing still but oscillating … Instead of receiving a constant force, the target will experience a fluctuating force – fluctuating in intensity and direction …, a wave! … Light is a matter wave consisting of a fluctuating electric field. It requires no elastic aether medium to propagate through because it is the 'medium' being transmitted … This also explains why a Michelson-Morley interferometer will get the same result regardless of its net velocity, because there is no medium to slow light down. Instead the velocity of light will be a constant, relative to the equipment generating and reflecting it ... [For example,] … an electron moves up and down in a sinusoidal motion. Its generated field radiates equally in all directions but, due to the motion of the charge, the field pattern becomes distorted. Some of the field ends up moving directly to the right … As a result, a similarly charged particle far to the right will experience a fluctuating field matching the motion of the source … [which] will cause the target particle to oscillate in the same up/down direction as the source … [T]hus the transmission of light has been achieved across empty space.*

Another pair of authors, the de Hilsters, develop their model based on a particle theory of a wave, from which they postulate the existence of two types of particles, the nucleon (replacing the neutron and proton) and G1 (replacing the electron and photon) in their 'particle model' of the atom. [1-2]

One particle cannot describe a wave. But a group of particles could be arranged such that a simple or complex wave is described. If the particles are distributed such that they are close together in the first part of the wave and farther apart in the second part of the wave, this distribution could resemble a sine wave … The physics for the particle theory of a wave … can be shown as a sequence of digital values – 55, 60, 70, 60, 55, 45, 40, 30, 40, 45 – 500 particles in a period of one second. There are 300 particles in the first half and 200 in the second half. Each number represents the number of particles in 0.1 second. The specific shape of the wave is shown in a series of flat steps which indicates distortion, but the basic wave and frequency are still there … It seems logical that this theory can be applied to the full electromagnetic spectrum, from Gamma rays to Radio waves. The highest frequency of gamma rays can be generated if enough particles can be put in a very short wavelength. But physical restrictions will limit the upper frequency. But it would appear that there is no restriction at low frequencies. In fact, a stream of particles could have zero amplitude and zero frequency … exactly what is needed for pushing gravity. Could this one particle be valid for light and gravity? [1]

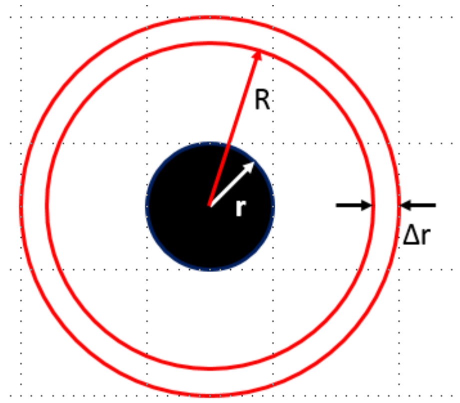
Light is a stream of G1 particles each moving at the speed of c and has a repetitive pattern …[, i.e.,] streams of particles whose patterns have the general form of a sign wave … [T]he speed of the G1 particle is c, but it is not constant. Wave length … is represented by the distance between peaks … If the speed of the stream is c, then the frequency is speed divided by wavelength (c/λ). Since nature cannot do mathematics, frequency is … a man made construct. The intensity of light is dependent on the number of particles per wave. Bright light has many particles and dim light has fewer particles. [2]

Looking at the de Hilsters' construct (below) for the particle model of light, it is evident that a compressional, longitudinal type of matter wave is postulated.



2. Mathematical Model of Light as a Matter Wave

Consider the mathematical plausibility of light as a matter wave, based on the concept shown here.



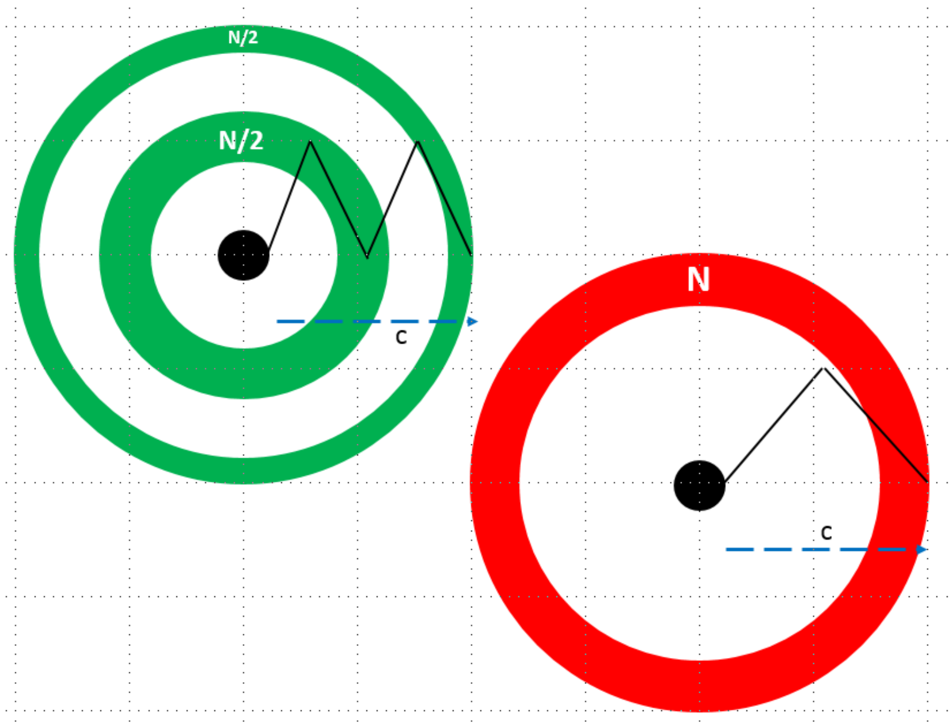
A spherical light source (star?) of radius $r = \sqrt[3]{3V/4\pi}$, where V = volume, releases 'light' from the equivalent of its entire volume at time zero. This light is initially emitted as a spherical shell of inner radius R and thickness Δr (assume R = r initially, i.e., release is from its entire spherical surface). As time passes, this spherical shell of 'light' expands, maintaining constant volume V, such that its inner radius R increases while its thickness Δr decreases. For calculational convenience, start with V = 1 and calculate Δr for each increment of time when R assumes a new value equal to the previous R + Δr. The exact solution requires solving the following cubic equation: $V = 1 = \frac{4\pi}{3}([R + \Delta r]^3 - R^3)$, or $\Delta r^3 + 3R\Delta r^2 + 3R^2\Delta r = \frac{3}{4\pi}$. As the 'light' shell expands, R grows ever larger and Δr ever smaller, such that, for $R \gg \Delta r$, the cube of Δr becomes negligible, and the simpler quadratic formula can be solved as $\Delta r = \left(\sqrt{R^4 + \frac{RV}{\pi}} - R^2\right)/2R$. Eventually, even the term containing the square of Δr becomes negligible, yielding the following 'simple' solution $\Delta r = 1/4\pi R^2$.

It is instructive to determine when the quadratic and then the linear approximations become accurate. With V = 1, the initial inner radius $R = \sqrt[3]{3/4\pi} = 0.62$. The following table shows the exact value and quadratic and linear approximations of Δr as R is increased by Δr until it reaches $2R = 1.24$.

Radius (R)	**Δr Exact**		**Quadratic Approximation**		**Linear Approximation**	
	Frax	**Value = R · Frax**	**Δr**	**Difference**	**Δr**	**Difference**
0.620	0.260	**0.161**	*0.164*	1.49%	*0.207*	28.3%
0.782	0.145	**0.113**	*0.114*	0.555%	*0.130*	15.2%
0.895	0.101	**0.0901**	*0.0903*	0.282%	*0.0994*	10.4%
0.985	0.0772	**0.0760**	*0.0762*	0.175%	*0.0821*	7.92%
1.06	0.0627	**0.0665**	*0.0665*	0.120%	*0.0707*	6.40%
1.13	0.0527	**0.0594**	*0.0595*	0.0826%	*0.0626*	5.36%
1.19	0.0455	**0.0540**	*0.0540*	0.0587%	*0.0565*	4.62%
1.24	0.0400	**0.0497**	*0.0497*	0.0575%	*0.0517*	4.07%

Even before the inner radius has doubled its original value, the quadratic approximation becomes accurate to within 0.1% of the exact. If this table were continued, it would be shown that, after the inner radius has reached 7R (4.34), the linear approximation for Δr (0.00422) becomes accurate within 0.1% as well (0.0945%). At this point, Δr is less than 0.1% of R itself. Thus, the thickness of the spherical 'body of whatever' shell of 'light' rapidly manifests the observed inverse-radius-squared behavior for intensity/luminosity. Given the volume of the spherical shell remains constant, this suggests that at least this observed behavior for light might be explained by light consisting of a 'body of whatever' expanding outward as an ever-thinning spherical shell, not unlike Burchell's concept of light as a matter wave.

To address the concept of frequency-wavelength for different ‘colors’ of light (‘color’ in a generic sense, where ‘gamma’ or ‘radio’ is considered a ‘color’), consider the figure below. The left shows two ‘pulses’ emitted over the same time interval as the one pulse in the right, but with each ‘green’ pulse containing N/2 ‘whatevers’ of light and the one ‘red’ pulse containing the full amount N. Both sets of ‘whatevers’ are of the same intensity, containing a total of N. And each set travels at speed c. However, because there are two pulses for the ‘green’ but only one for the ‘red,’ the ‘green’ can be viewed as having half the wavelength but twice the frequency as the ‘red.’ (The labels ‘green’ and ‘red’ are arbitrarily chosen to represent generically a shorter wavelength-higher frequency ‘color’ vs. one with longer wavelength and lower frequency.) Thus, each light source emits the same intensity (total of N) at the same speed (c), but with different frequencies and wavelengths. Hopefully, this addresses to at least some extent the de Hilsters’ concept of light as a compressional, longitudinal matter wave while remaining consistent with the mathematics of Burchell’s concept.



3. Conclusion

The goal here has been fairly simple – to develop a mathematical interpretation of the concept of light as a matter wave, in the sense postulated by Burchell, at least somewhat consistent, at least qualitatively, with a similar concept postulated by the de Hilsters. With respect to light intensity/luminosity, the ‘spherical shell’ emission model offered here yields results consistent with the observed inverse-radius-squared behavior. This can be at least somewhat aligned with light as a compressional, longitudinal matter wave with varying frequency and wavelength by ‘pulsing’ the emission of the spherical shells.

References

1. Robert and David de Hilster, “Light, Gravity, and Mass,” Proceedings of the First Chappell Natural Philosophy Society Conference, August 2015, Florida Atlantic University, pp. 44-46.
2. Robert de Hilster, “The Candle, the Light Bulb, and The Radio,” Proceedings of the Third Chappell Natural Philosophy Society Conference, July 2017, University of British Columbia, pp. 13-16.