

Abstract:

The fundamentals of physics are investigated via a thought experiment that starts with an "educated guess" about how particles move. This motion is then used in the wave equation developed by Nobel laureate Louis deBroglie¹. This theory has some predictions for very high-energy particles and photons and shows what is ultimately possible in particle physics. It also:

1. Puts inertia/gravity as a fundamental part of the quantum world.
2. Gives physical meaning to the Planck Units and shows the ultimate quantum to be the Planck Mass.
3. Updates Maxwell's equations.
4. Takes gravity from the quantum particle world to the world of distributed masses.

I am calling this as yet untested theory "Digital Wave Theory" or " λ -Hop Theory".

It may even prove to have some merit, keep an open mind and I hope you enjoy the ride.



Tribute paid to de Broglie by C W Oseen, Chairman of the Nobel Committee for Physics of the Royal Swedish Academy of Sciences:

When quite young you threw yourself into the controversy raging round the most profound problem in physics. You had the boldness to assert, without the support of any known fact, that matter had not only a corpuscular nature, but also a wave nature. Experiment came later and established the correctness of your view. You have covered in fresh glory a name already crowned for centuries with honour.

Some readers (who enjoy lots of equations) will probably prefer to jump right into the details of this essay, which start here and continue to section 20. Other more sane individuals may prefer to see what was the motivation for doing this work and then chose to look at the details or not. They can use section 18 as their starting point.

1. Particles must have minimum speeds

The particles considered in this essay are simple and monolithic (they move as one unit) such as electrons and protons. The particles are not confined, and therefore they must propagate because they are waves.² It makes sense to assume that there is a minimum speed at which particles (matter waves) can move. This speed is V_0 .

2. Particles move digitally (the pivotal idea of this essay)

It is postulated that a particle moves by appearing as a mass m with no velocity and reappearing in a different position and time with no velocity. This " λ -hop" is the wave action of the mass (or energy). The λ -hop has a minimum velocity V_0 (distance of the hop " λ " divided by the time it takes to make the hop " Δt ") even though nothing is ever seen to be "in motion". The deBroglie equation ($\lambda = h/(mV_0)$) fits this way of looking at things. Note that h is the reduced Planck constant (aka Dirac constant).

3. Developing an equation for the minimum velocity of a particle V_0 in terms of wavelength (λ)

The inertial viewpoint of a λ -hop

Since we do not know what happens to particles between the appearances at each end of the λ -hop we are free to postulate a plausible mechanism that gives a reasonable result. This may seem somewhat arbitrary, but it is the technique that Newton and Einstein used in their gravitational theories and which deBroglie was the master of (see quote above). So I start by saying "It seems reasonable to me".

The mechanism of the λ -hop is classical Newtonian mechanics. All particles move by making λ -hops, that is they start from zero velocity and accelerate uniformly to a peak velocity V_p , and then

decelerate back to zero velocity just in time to appear at the distance λ the deBroglie wavelength. The average velocity during the complete λ -hop is $V_o = V_p/2$.

The gravitational viewpoint of a λ -hop

The appearance of the particle at the beginning of a hop and at the end of a hop looks like two particles being held together by a force. Since this seems somewhat like gravity, it will be assumed that it is a type of gravity that has the force $F = Gm^2/\lambda^2$. G is the gravitational constant and λ is the wavelength. Yes, I am inventing a "self-gravity" that will be explained as the essay progresses (see section 14).

Equivalence Principle

Einstein's insight that the force of acceleration (inertia) is equivalent to the force of gravity will be used at the basic quantum particle level of matter.³ The equation for the inertial force will be equated to the gravitational force during a λ -hop. From this an equation for V_o will be developed.

A calculation for V_o

Take a particle of mass m and uniformly accelerate it to V_p (peak velocity) over the distance $\lambda/2$.

1. $F=ma$, :This is the force of inertia. $a=\Delta v/\Delta t=V_p/(\Delta t/2)=2V_p/\Delta t$
2. $F=m(2V_p/\Delta t)$, :Since it takes $\Delta t/2$ seconds to get to V_p
3. $F=m(2V_p)(f)$, :Since $\Delta t=1/f$ by definition
4. $F=m(2V_p)(V_o/\lambda)$, :Since $V_o = \lambda f$ (definition of propagation) then $f=V_o/\lambda$
5. $F=m2(2V_o)(V_o/\lambda)$, :Simplifying $V_p=2V_o$
6. $F=4m(V_o)^2/\lambda$, :Simplifying
7. $F=4m(V_o)^2/\lambda$, :The force due to inertia during the λ -hop.
8. $F=G(m^2)/\lambda^2$:Gravity matching the force of inertia for the λ -hop.
9. $4m(V_o)^2/\lambda = G(m^2)/\lambda^2$:Equating this force of inertia to the force of gravity.
10. $(V_o)^2 = Gm/(4\lambda)$:Solving for V_o^2

4. Developing a polynomial equation for the minimum velocity V_o in terms of mass

Equation 10 above is interesting but can be developed further.

In the equation $(V_o)^2 = Gm/(4\lambda)$ we can substitute for λ using the deBroglie equation $\lambda = h/(mV_o)$. For this analysis the deBroglie equation with the Lorentz transform (taking into account relativity) will be used $\lambda = [h/(mV_o)][(1-V_o^2/c^2)^{1/2}]$. Substituting this relativistic value for λ into the equation $(V_o)^2 = Gm/(4\lambda)$ we get a polynomial equation: $V_o^4 - c^2V_o^2 + c^2m^4G^2/(4h^2) = 0$

- a. Note that this equation gives V_o as a function of mass completely in terms of fundamental constants of nature c , G , and h .
- b. The combining of $(V_o)^2 = Gm/(4\lambda)$ and $\lambda = [h/(mV_o)][(1-V_o^2/c^2)^{1/2}]$ can also produce two other equations that are interesting:
 1. $\lambda^2 - (4h^2/Gm^3)\lambda + h^2/m^2c^2 = 0$
 2. $V_o^6 + [(h^2G^2)/(16\lambda^4c^2)]V_o^2 - 1/(16\lambda^4c^2) = 0$

Since this essay starts by postulating a minimum velocity for particles the equation $V_o^4 - c^2V_o^2 + c^2m^4G^2/(4h^2) = 0$ will be investigated for this essay. The other two equations will be analyzed at another time perhaps by an interested reader of this essay.

5. Solving for the four roots of V_o

Let $x = V_o^2$ Then $x^2 - c^2x + c^2m^4G^2/(4h^2) = 0$ a classic quadratic equation. The two roots x_1 and x_2 are found using the standard solution to the quadratic equation:

$a=1$ $b=-c^2$ $k= c^2m^4G^2/4h^2$ (k is used since c is already taken) and the two roots are:

$$x_1 = V_1^2 = \frac{1}{2}[c^2 + (c^4 - c^2m^4G^2/h^2)^{1/2}] \quad x_2 = V_2^2 = \frac{1}{2}[c^2 - (c^4 - c^2m^4G^2/h^2)^{1/2}]$$

$V_1, -V_1, V_2, -V_2$ are plotted as a function of mass in the next section.

6. Plot of the two positive and the two negative roots of V_0

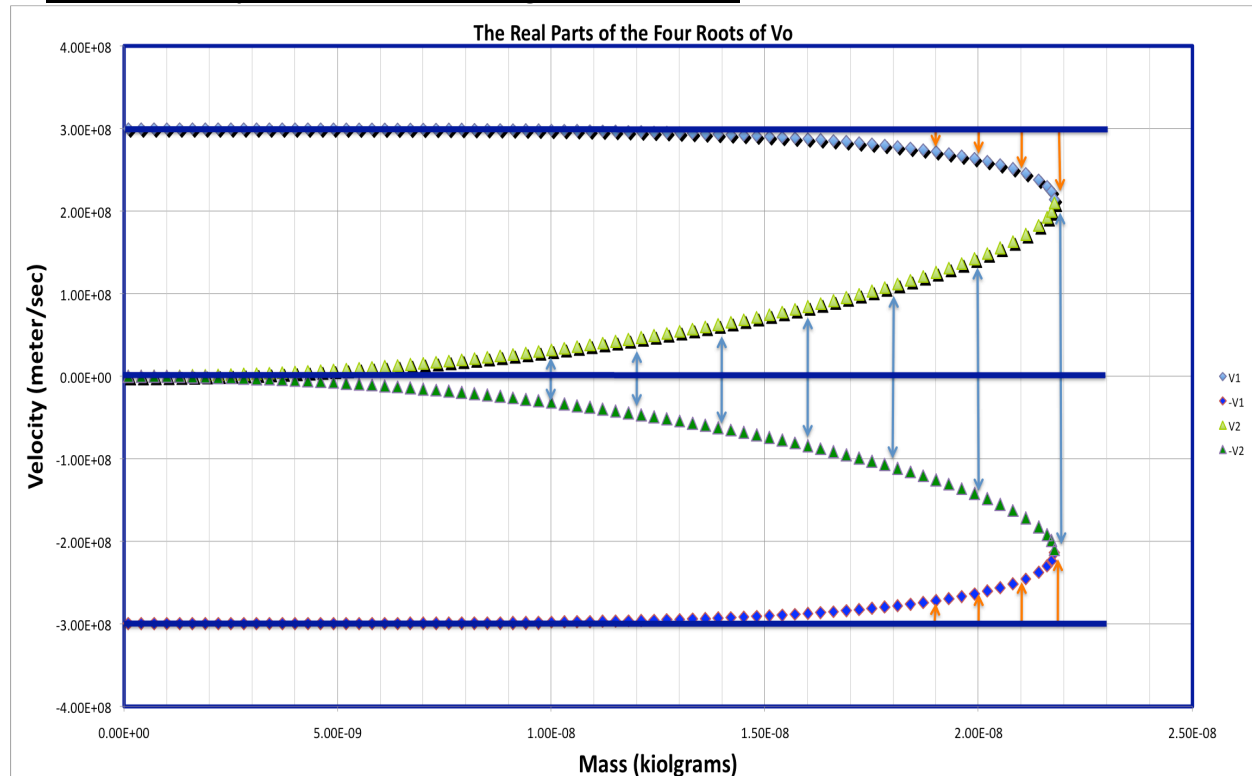


Figure 1

Notes:

- This plot was obtained using a spreadsheet program. Both V_1 and V_2 turn imaginary at the rightmost inflection at the same mass and velocity, at which point the spreadsheet produces errors in the cells. What is shown in the plot are the real parts of the roots (V_1 , $-V_1$, V_2 , $-V_2$) before the values turned imaginary.
- V_1 and V_2 turn imaginary for mass values greater than 21.77 micrograms. This value is recognized as the Planck Mass and it is exact in that the roots go imaginary when the determinant goes to 0:

$$c^4 - c^2 m^4 G^2 / \hbar^2 = 0 \quad \text{and} \quad c^2 = m^4 G^2 / \hbar^2 \quad \text{and} \quad c = m^2 G / \hbar \quad \text{and} \quad m = (c \hbar / G)^{1/2}$$
 The definition of the Planck Mass is: $m = (c \hbar / G)^{1/2}$

7. What does Figure 1 show?

- Figure 1 shows that particle masses can only range from 0 to the Planck mass (21.77 micrograms). The mechanism of the Lorentz transform (that limits the speed space-time will support to c) is also the mechanism that limits the largest particle that space-time will support. Since each particle mass has a wavelength there is also a limit to the wavelength and frequency of these digital waves.

The table below shows the limits of particle mass, wavelength and frequency.

Attribute of Particle/Photon	Minimum Value	Maximum Value
Mass	0.00	Planck Mass (21.77 micrograms) ($2.176\ 44(11) \times 10^{-8}$ kg)
Wavelength	Planck Length ($1.616\ 252(81) \times 10^{-35}$ m)	Infinity
Period (1/f)	Planck time/ $\sqrt{2}$ $5.391\ 24(27) \times 10^{-44}$ s/ $\sqrt{2}$ $= 3.812184272 \times 10^{-44}$ s	Infinity
Particle Speed	Approaches zero when mass goes to zero	$c/\sqrt{2}$
Photon Speed	$c/\sqrt{2}$ for Planck energy	Approaches c when energy goes to zero

- b. V_1 and V_2 are striking in that they unexpectedly show two distinct ways that particles can move when they λ -hop. One way a particle can move is V_1 , which is mostly at the velocity c and only deviates from c at extreme mass values (energy for a photon). Since this resembles a photon, I will assume that it is a photon for the rest of this thought experiment. **Photons are particles that move like V_1 in Figure 1.**

The other way a particle can move is V_2 , which has a velocity profile that increases exponentially with mass. I will assume that this is an ordinary matter particle since its mass increases with velocity as predicted by Einstein. **Particles move like V_2 in Figure 1.**

8. How particles move in general

A glaring omission that needs to be remedied.

We do not object to light (V_1) that is constantly propagating in one direction, but we expect a particle (V_2) to be able to maintain a fixed position unless we move it. Can we have a particle with a minimum velocity V_2 propagate and at the same time stays put? We can if we say that the particle λ -hops back and forth about a fixed position going from V_2 to $-V_2$. This is shown in Figure 1 by the blue lines with arrows on each end.

At this point it is postulated (for the sake of symmetry) that all particles and photons have two velocity components, an oscillating component V_{ac} and a propagating component V_{dc} . The total velocity of the particle or photon is the sum of the two velocities. $V_{total} = V_{ac} + V_{dc}$.

Particles (V_2)

The velocity V_2 changes direction on each λ -hop. This V_2 is now interpreted as the V_{ac} for the particle. This is the minimum velocity for the particle. If we want a particle to have more velocity than this V_{ac} we have to physically move it (perhaps in a particle accelerator) and thus give it a V_{dc} .

9. How photons move in general

Photons (V_1)

The velocity V_1 (Figure 1) is interpreted as having a large V_{dc} value near c and as having a smaller oscillating component connecting it to the " c " line (as shown by the orange lines with arrows). If the c line were connected to the $-c$ line (make the plot surface into a cylinder) then the way photons move relative to c speed looks similar to the way ordinary particles move relative to zero speed. The photons have a V_{ac} part that is equal to $(c-V_1)$ and a V_{dc} part that is equal V_1 . **The total velocity is: $V_{total} = V_{ac} + V_{dc} = c = (c-V_1) + V_1 = c$.** The V_{ac} and the V_{dc} are fixed for each wavelength Photon. A photon's motion is completely determined. This contrasts with ordinary particles where only the V_{ac} (V_2) is determined and the propagation V_{dc} can be zero as shown in Figure 1 or can be any value velocity we can impart to the particle.

10. In what ways does Figure 1 deviate from "standard" physics?

a. A variable speed of light

Figure 1 shows light propagating in free space at speeds slower than c . This result may be objected to on the following grounds:

1. *Light has been measured as having a velocity of c , and no one has seen it deviate from c in free space.*⁴

Unfortunately our instruments need to be a lot better to see how light becomes slower as it becomes more energetic. At the Planck mass the wavelength of both the mass and the photon are the same. We can calculate this wavelength from the deBroglie equation $\lambda = [h/(mV_0)](1-V_0^2/c^2)^{1/2}$. We know the mass = Planck Mass = $(c\hbar/G)^{1/2}$ and that $V_0 = c/\sqrt{2}$. After we make the substitutions we get $\lambda = (G\hbar/c^3)^{1/2}$. This is the definition of the Planck Length (1.616×10^{-35} m).

The most energetic photon observed or created is a gamma ray that has a wavelength of approximately 10^{-12} meters. We need photons 22 orders of magnitude more energetic than gamma rays to see changes in the speed of photons shown in Figure 1. So, in practical terms

we only have enough precision in our instruments to see the speed of light as a constant.

2. Maxwell's equations show that the speed of light is: $c = \frac{1}{\sqrt{\mu_0 \epsilon_0}}$.

Since both the permittivity and permeability are constants for free space the speed of light must be a constant⁵

But something is not quite right; the constants of nature ϵ_0 and μ_0 are measured via experiments that measure the force between current carrying wires (μ_0) and the force between electrically charged plates (ϵ_0). And thus static electric and static magnetic fields are used for determining the value c. If the values of ϵ_0 and μ_0 change with velocity then there could be agreement with "λ-hop theory".

If we make V_1^2 equal to $1/(\epsilon_{0x} \mu_{0x})$ we get an equation that will give electro-magnetism the same velocity profile for light as λ-hop theory.

$$V_1^2 = \frac{1}{2} [c^2 + (c^4 - c^2 m^4 G^2 / \hbar^2)^{1/2}] = 1/(\epsilon_{0x} \mu_{0x}) \quad \text{and} \quad \epsilon_{0x} \mu_{0x} [c^2 + (c^4 - c^2 m^4 G^2 / \hbar^2)^{1/2}] = 2$$

$$\epsilon_{0x} \mu_{0x} = 2/[c^2 + (c^4 - c^2 m^4 G^2 / \hbar^2)^{1/2}]$$

The product of ϵ_{0x} and μ_{0x} is now corrected for electro-magnetic fields that move with different masses (energies). It is a very small correction except at extreme energies. Another way of looking at this is that the index of refraction "n" of space-time is a function of velocity (or mass). $n = (\epsilon_{0x} \times \mu_{0x})^{1/2}$ and that $n^2 = 2/[c^2 + (c^4 - c^2 m^4 G^2 / \hbar^2)^{1/2}]$.

What is "c"?

In this theory c is the ultimate speed space-time will support and it is only approached by particles and photons.

b. Mass energy equivalence⁶

Figure 1 shows that a given particle mass has two velocities associated with it (V_1 and V_2) that satisfy the λ-hopping model. From 0 to 10^{-9} kilogram of photon energy V_1 moves near the speed c and thus enables Einstein's relation $e=mc^2$ where m is the rest mass that moves at V_2 . From 10^{-9} kilogram to 10^{-8} kilogram the speed of light slows down and the relationship $e=mc^2$ gradually changes to $e=m$.

How come this has not been seen before? The answer is that we never have seen particles that approach the Planck mass value. For example the Higgs boson (a big particle) is postulated to have a mass of 138 protons giving it a mass of 2.2×10^{-25} kilograms. The Planck mass is 2.2×10^{-8} kilograms, 17 orders of magnitude bigger than the Higgs boson. The accelerator at CERN (or any other accelerator) is just too puny to produce bosons that approach the Planck mass and show deviation in $e=mc^2$.

Note that when we consider ordinary mass (collections of particles and energy) $e=mc^2$ is exact for all practical purposes unless the particles that make up the masses are near the Planck mass.

c. Rest mass

Is it not a problem that particles do not have a "rest" mass?

We have an innate sense that an object can be at "rest", but ever since the introduction of quantum physics matter has been thought of as wave like. λ-hop theory just takes this notion and gives it some "infrastructure".

A particle having absolute minimum vibration energy is even better than having energy with no motion. The concept of "rest energy" now makes physical sense when it is interpreted as minimum "kinetic" energy.

d. Do photons have mass?

λ-hop theory postulates all particles and photons as having no rest mass because neither of them is ever at rest. A great deal has been made of the fact that photons must be without rest mass. The argument goes that if a photon had a rest mass then it would be forced by special relativity to have infinite mass at the speed c.

Another argument for mass less photons goes like this: If we chase a photon in our super fast rocket ship we will see it have less and less energy as we catch up to it because of the Doppler effect. Eventually the photon energy will go to 0 as we approach c and thus

photons must be mass less. This is not so in λ -hop theory where as we catch up to the photon we eventually see it oscillating back and forth. This is very similar to catching up with a high velocity electron; eventually we match the electron's V_{dc} and just see it oscillating back and forth.

In λ -hop theory, mass less photons are a non-issue.

11. The ultimate quantum:

The ultimate quantum has the following properties:

Mass: The Planck Mass = 21.77 micrograms

Wavelength: The Planck Length = 1.616×10^{-35} meter

Period Δt : ($\sqrt{2}$) times the Planck Time = 7.62×10^{-44} sec

12. The first insight into gravity:

Figure 1 shows the non-linearity in kinetic energy (KE) of a particle with mass value. This means that if we split a mass in two we end up with less "rest energy" than in the original mass. When a λ -hopper's mass is split into two lower mass sub particles there is always energy left over. This energy is what we normally think of as fission energy ($e=mc^2$). When the mass split is of an ordinary object instead of a λ -hopper the energy deficit is gravitational energy.

13. Has relativity been messed up?

This thought experiment indicates that light does not propagate at a fixed speed c . Isn't this a problem in that it defeats relativity?

The special theory of relativity wants the speed of light to be measured as the same value independent of the speed of the observer making the measurement. If relativity were not true then a measurement can be made locally (without looking beyond the measurement frame of reference) to determine the "absolute" velocity of the observer. If you are on a smoothly moving train and there is no way to see outside, then you cannot determine your velocity.

As developed here the speed of any given photon may not be c , but the distribution of speed vs. wavelength for photons is the same for all observers. And thus relativity still holds for λ -hopping photons because there is no way to determine if your reference frame is moving by measuring the speed of light.

14. Gravity for particles

a. Self-Gravity

In section 3 it was stated that the force holding a λ -hopper together is $F = Gm^2/\lambda^2$. This self-gravity is a way of accounting for the "rest energy" of the mass, which is postulated as not being at rest but hopping back and forth across the distance λ . It has not been observed and Newton had no need to account for it. It may someday be experimentally observed, but for now it is just a mathematical way of accounting for the energy innately in matter.

If the force F is applied over the distance λ , the energy $E = Gm^2/\lambda$ is produced. If we can say that this energy is mc^2 then $mc^2 = Gm^2/\lambda$ and $\lambda = Gm/c^2$.

b. Take a single particle and consider splitting it in two.

Note that we are not actually splitting it in two yet we are just thinking about it. Our original particle had the mass m . This mass is now thought of as being m_1 and m_2 . Nothing has changed yet so the wavelength is still λ the distance associated with m . All three masses m , m_1 and m_2 all still λ -hop together. The self gravity force equation $F = Gm^2/\lambda^2$ can be written as $F = G(m_1+m_2)^2/\lambda^2$.

c. The Equations before the actual split

- | | |
|--|-------------------------|
| 1. $F = Gm^2/\lambda^2$ | The starting point |
| 2. $F = G(m_1+m_2)^2/\lambda^2$ | $m = m_1 + m_2$ |
| 3. $F = G(m_1^2+m_2^2+m_1m_2+ m_2m_1)/\lambda^2$ | Expanding $(m_1+m_2)^2$ |

There are now four forces of gravity in the λ -hop:

1. $F = G(m_1^2)/\lambda^2$ The self-gravity of m_1 .
2. $F = G(m_2^2)/\lambda^2$ The self-gravity of m_2 .
3. $F = G(m_1 m_2)/\lambda^2$ The force of m_1 on m_2 .
4. $F = G(m_2 m_1)/\lambda^2$ The force of m_2 on m_1 .

Note that forces 3 and 4 are what we consider ordinary gravity except that it is at a fixed distance λ within a particle.

d. **Take a sharp knife and split m into m_1 and m_2 .**

When the two new particles are separated by the distance d , the original λ will change into λ_1 and λ_2 the two new wavelengths associated with the new masses m_1 and m_2 .

The Equation after the actual split into two particles is:

$$F = G[(m_1/\lambda_1)^2 + (m_2/\lambda_2)^2 + (m_1 m_2)/d^2 + (m_2 m_1)/d^2] \quad \text{Equation 1}$$

We can see the self-gravity of the two new masses m_1 and m_2 , but what are the two other terms? These terms are needed for conservation of energy. The two new masses m_1 and m_2 have longer wavelengths and therefore smaller V_2 and when converted to energy do not sum to the energy in the original mass m . Remember that mass and wavelength are not linearly related. This non-linearity is also seen in the "kinetic" energy of the particles. This splitting process in general results in a release of energy. In atomic physics this splitting process is the fission process. It is very closely related to gravity.

e. **How did the distance d get into Equation 1?**

It is a logical argument that goes like this:

1. When a λ -hopper splits there is an energy deficit because the two particles that result have less energy than the original mass.
2. This energy deficit can be accounted for in either another mass (masses) or photons (energy) or a mix of masses and photons. This comes from Figure 1.
3. In section b above (for phenomena within a λ -hop) we have two terms of the form $F = G(m_1 m_2)/\lambda^2$. I am going to try to keep this form as much as possible and turn it into what we recognize as gravity: $F = G(m_1 m_2)/d^2$
4. This is simple, just make $d = \lambda$. Is this a legitimate thing to do? Well yes, because the energy balance is:
 - a. Original energy of m - Energy of two masses = Energy of gravity
 - b. $G(m^2)/\lambda_{org} - 2G(m_1 m_2)/\lambda_{new} = G(m_1 m_2)/d$ solving for d we get a complicated equation. So, let us make this simpler by splitting the original mass in half $m_1 = m_2 = m/2$.
 - c. Now we have: $G(m^2)/\lambda_{org} - G(m^2)/2\lambda_{new} = G(m^2)/4d$
 - d. Solving for d we get: $d = (\lambda_{org} \lambda_{new})/(4\lambda_{new} - \lambda_{old})$
5. The distance d is what allows for the force of gravity to manifest. When we separate two identical masses the distance $d = (\lambda_{org} \lambda_{new})/(4\lambda_{new} - \lambda_{old})$ against the force $F = G(m_1 m_2)/d^2$ we can regain the energy lost in the wavelength change.

To this point we have been looking at the gravity of λ -hoppers. Ordinary matter is made up of many different λ -hoppers. How does gravity manifest there?

15. The gradient scale from pure λ -hopping to ordinary objects and ordinary gravity

1. Pure λ -hopping: The motion of indivisible particles also known as elementary particles. The ultimate mass of an elementary particle is 21.77 micrograms and has never been seen in nature. This is approximately the mass of a flea and is huge for an elementary particle.
2. Atoms: Are not indivisible and are not as "rigid" as elementary particles. But they still qualify as good λ -hopping particles because the electro-magnetic forces keeping the atom together are much much greater than the inertia-gravity forces that cause the λ -hop.
3. Molecules: Are not indivisible and are not as "rigid" as elementary particles or atoms. But they still qualify as good λ -hopping particles if their wavelength is longer than

their physical length. Recently it was demonstrated that "Buckyballs" C_{60} could interfere with each other.⁷

4. Golf Balls: Are strictly distributed matter. Golf balls are held together mostly via electromagnetic stickiness (Vander-Waals forces).
5. Solar systems: Distributed matter held together via gravity.

16. Gravity for ordinary mass

a. Using the deBroglie equation for ordinary mass

A question that is often asked of physics students is: What is the wavelength of a golf ball that has 80 m/s velocity and 0.045 kg mass. The student is expected to use the deBroglie wave equation $\lambda = h/mv$ to calculate the wavelength. The result is a very short wavelength close to the Planck length. This exercise is included to stress that ordinary objects do have wave properties and that these properties do not result in observable wave actions because they are so small. And this is the reason golf balls do not interfere with each other but theoretically they are wave phenomena.

This is silly. Golf balls do not interfere with each other and they are not waves. A golf ball is made up of particles that can interfere with each other but they are physically isolated from other objects because they are within the golf ball. The deBroglie equation is valid for elemental masses up to the Planck mass of 21.77 micrograms. To go beyond this mass requires distributed matter and the transition into classical physics.¹⁰

b. The wavelength of ordinary mass needs a definition

In section 14a we developed an equation $\lambda = Gm/(c^2)$ using Einstein's relation $e=mc^2$ for the energy in the mass m . Einstein used c as the speed of light, but as developed here the speed of light is V_1 as shown in Figure 1. The Updated equation is $\lambda = Gm/(V_1^2)$.

This equation makes sense as a definition of the wavelength of ordinary matter if we use the V_1 term as the average velocity of the energy in the mass.

c. What does ordinary mass having a "wavelength" mean?

I have pointed out that for ordinary matter the deBroglie wavelength does not make sense and yet I am proposing another wavelength for ordinary matter? Why am I doing this?

The answer is that a golf ball may not act as a wave but its self-gravity definition $F = Gm^2/\lambda^2$ needs a matter wavelength. This wavelength is defined as $\lambda = Gm/(V_1^2)$ and satisfies the rest energy requirement, and for all practical applications $V_1^2 = c^2$. I hope no one uses this equation to show that a golf ball can interfere with other golf balls.

d. The force of ordinary gravity

When we split a particle (section 14) we got an equation (equation 1) that resembled gravity, as we know it. $F = G[(m_1/\lambda_1)^2 + (m_2/\lambda_2)^2 + (m_1m_2)/d^2 + (m_2m_1)/d^2]$

To make this equation fit in with ordinary gravity all that is needed is to interpret λ_1 and λ_2 as the matter wavelengths of the masses m_1 and m_2 . The definition in part c above satisfies this requirement.

And in a fashion similar to splitting particles, splitting masses results in two new masses that have lower wavelengths such that when they are recombined mass is missing. This missing mass is in the gravitational field and the forces between the two masses.

Or we can say that the proximity of masses bends space-time since wavelength is space that is associated with a period (time). And thus λ -hop theory and general relativity are in accord. It is interesting to note that Einstein's insight (of a virtual equivalence of gravity and acceleration) was used on the quantum level to create the λ -hop. Then ordinary gravity develops from this quantum start, **but now gravity is no longer equivalent to acceleration, it is acceleration**. The force of gravity is developed by real particles λ -hopping on a gradient of space-time. Even if the two masses are fixed at the distance d there is still a "real" acceleration producing a force due to the λ -hoppers that comprise all masses. Said another way, when a λ -hopper hops back and forth in a gravitational field it sees a different space-time on each hop. This is a real force of acceleration.

17. Electro-Magnetic forces and matter?

Electric and magnetic forces at the quantum level are potent and they completely mask gravity. The force between the electron and the proton may be tremendous but they both λ -hop via inertia and gravity and the electromagnetic force piggybacks along for the ride.

If an electron and a proton are released near each other they will attract with strong electro-magnetic force. Both particles will λ -hop toward each other but not make contact; they always hop over each other. Because the electron is the lighter faster particle it looks like the electron is making continuous passes at the proton forming a cloud around the proton. This is a possible way that hydrogen atoms can form.

When multiple protons are in a nucleus of an atom, they can form symmetrical arrangements of their λ -hops so that the repulsive forces push one way and then the other, forming what looks like a single charged particle. This is a possible way that multiple protons can exist in atomic nuclei.

18. Insight into Philosophical Questions:

a. **If mass is wavelike energy, how can there be any such thing as a rest mass?**

All energy propagates except when it is trapped in resonating structures in which case standing waves can be formed. When wave energy is unrestricted it must propagate and it is reasonable to make a case for particles having a minimum velocity that corresponds to a minimum energy state for that particle. A particle that λ -hops back and forth meets this criteria and fits in with the rest of physics. Hopping back and forth is different than a standing wave in which there is no motion. With this theory the wave nature of objects can be kept and objects can be kept local to a position.

b. **Where is gravity on the quantum scale?**

It seems the world of physics is dominated on the small scale by quantum mechanics and on the large scale by gravity. The viewpoint developed here shows that gravity is fundamental on the atomic scale.

c. **How can anything move?**

Zeno's (of Zeno's paradoxes)⁸ presented a logic that is compelling about why motion is impossible. Paraphrasing Zeno's argument in more modern terms: Motion is impossible because an object at point A must first pass through a whole bunch of points (continuum) before it reaches point B. Zeno argued that any first point that A can reach cannot be a valid first point because there is an infinity of points that are closer. From this infinity of points none can qualify as the closest point, for any one that is chosen there is still an infinity of points that are closer to A. The argument continues in this fashion. This is the nature of non-dimensional points on the continuum of space. Thus A can never make any progress toward B and motion is impossible. We know that an object can move, so what is going on?

λ -hopping theory has objects "hopping" over space and time in digital increments of their wavelength. Objects are **not** required to encounter each point of the continuum when they move. Zeno's logic may be compelling but his assumption that anything that moves must go through a continuum of points is incorrect when matter is thought of as a "digital wave". When Achilles gets close to that sprinting tortoise he does not invoke calculus, he simply λ -hops over the tortoise to win the race.

d. **How can the earth rotate under Foucault's pendulum?**

If we are in a closed building with a Foucault pendulum⁹ (not at the equator) we can know we are rotating with respect to the stars without looking outside. This does not violate relativity, which technically applies to only translational frames of reference and not rotating ones. However, Even though the Foucault pendulum does not violate relativity it still strikes us as strange. Why is the background of the stars special?

The digital wave nature of objects can offer an explanation. The entire universe can be considered a λ -hopping object. The distributed mass of the universe as a whole creates an overall space-time. When energy of motion is given to Foucault's Pendulum it is given with respect to a reference frame and that reference frame is the space-time of the universe

created by the mass of the universe. The mass of the universe can be thought of as causing a distributed space via deBroglie's equation.

This viewpoint has matter and space-time as essentially the same thing. They spring into existence simultaneously. We can look upon a piece of matter M as bending the background of space-time, and that background of space-time exists because of all the mass-energy of the universe including M itself.

The deBroglie equation looks as if it uses the variables of space (λ) and time (Δt). However it can also be considered as the source of the variables of space and time.

e. Giving meaning to the Planck units

The Planck units are fundamental to λ -hop theory. These units appear as a consequence of how things move and deBroglie's wave equation. It is shown that the Planck mass is the largest particle mass that space-time will support. This is in agreement with Roger Penrose's belief that the Planck mass marks the crossover to classical physics from quantum physics expressed in his book "The Emperor's New Mind".¹⁰

19. Cosmology 101

- a. In the equation $d = (\lambda_{org} \lambda_{new}) / (4\lambda_{new} - \lambda_{old})$ developed in section 14 the distance d can be thought of as a function of the wavelengths of the masses it separates. This points to the answer to an age-old cosmological question: Is space present when no masses are present? The answer is no, because space "d" only exists between masses. Mass and space-time arise together.
- b. Mach's principle can be stated as: Inertia stems from an interaction between a body and the mass of the Universe as a whole. However, how a body 'knows' its state of motion relative to the Universe at large is not made very clear.¹¹

"Digital physics" makes the connection clear. An individual body at a position in space has a mass value (wavelength) and distance that is dependent upon all the objects in the universe. Mach's principle is correct. See Foucault's pendulum in philosophy section 18.

20. Some ultimate possibilities for physics have been given. I hope you enjoyed the ride.

End

- References:
1. The Nobel Prize awarded to deBroglie (deBrouglie in English sounds like "duBroy")
http://nobelprize.org/nobel_prizes/physics/laureates/1929/press.html
 2. The nature of waves
<http://en.wikipedia.org/wiki/wave>
 3. Equivalence Principle
http://en.wikipedia.org/wiki/Equivalence_principle
 4. The Speed of Light
<http://galileoandeinstein.physics.virginia.edu/lectures/spedlite.html>
 5. Electro-magnetic phenomena
http://www.phys.unsw.edu.au/einsteinlight/jw/module2_FEB.htm
 6. $E = mc^2$
<http://www.osti.gov/accomplishments/nuggets/einstein/speedoflight.html>
 7. Quantum nature of C_{60}
<http://sci.tech-archive.net/Archive/sci.physics/2009-04/msg00842.html>
 8. Zeno's Paradox
<http://members.authorsguild.net/mazur/work1.htm>
 9. Foucault's Pendulum
http://en.wikipedia.org/wiki/Foucault_pendulum
 10. The meaning of the Planck mass
<http://home.comcast.net/~earlwajenberg/onlinestorage/EmperorsNewMind.html>
 11. Mach's Principle
<http://www.einsteins-theory-of-relativity-4engineers.com/origin-of-inertia.html>