The Mechanics of Gravitation – What It Is; How It Operates

Roger Ellman

Abstract

From a start of only the limitation on the speed of light, the necessity of conservation, and the impossibility of an infinity in material reality, the present paper presents a comprehensive development of the mechanics, the operation of gravitation

Experience shows that everything has a cause and that those causes are themselves the results of precedent causes, and *ad infinitum*. Defining and comprehending the causality or mechanism operating to produce any observed behavior is essential to understanding or explaining the behavior.

The behavior of gravitation is well known, described by Newton's Law of Gravitation. But what gravitational mass is, how gravitational behavior comes about, what in material reality produces the effects of gravitation, is little understood. The extant hypotheses include Einstein's General Relativity's bending of space, efforts to develop "quantum gravitation", and attempts to detect "gravitons". None of those addresses the cause, the mechanism of gravitation.

As demonstrated in the present and its prior papers, gravitation is an outward flow from gravitating masses. That means that by manipulating that flow gravitation can be controlled. The procedure for obtaining such control and the design for several various applications are presented in the paper *Gravitational and Anti-gravitational Applications* which is available on the ResearchGate website at *https://www.researchgate.net/profile/Roger_Ellman/info*.

Roger Ellman, The-Origin Foundation, Inc.
    1401 Fountaingrove Pkwy, M-233, Santa Rosa, CA 95403, USA
    RogerEllman@The-Origin.org
    http://www.The-Origin.org

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From a start of only the limitation on the speed of light, the necessity of conservation, and the impossibility of an infinity in material reality, the present paper presents a comprehensive development of the mechanics, the operation of gravitation

The Einstein model of gravitation is that of his General Theory of Relativity. That theory describes the behavior of gravitation and the effects that it produces. But, it does not address the cause, the mechanism, of that behavior and effects. The closest that General Relativity comes to the cause or mechanism of gravitation is the contending that gravitational mass "curves" or distorts "space", the distortion leading to the various effects of gravitation. However, no cause or mechanism for the contended distortion of space is offered nor is an explanation of what that "space" or space-time is and how it is subject to being curved or distorted.

The comprehensive explanation of the cause and mechanism of gravitation as derived from the origin of the universe, the Modern Newtonian Model of Gravitation, is not a replacement for, nor contradiction of, the useful aspects of General Relativity but a supplementing of it with an alternative model which unlike General Relativity leads to resolution of the problem of "Big G" and to partial control of gravitation and applications of it.

The development of the Modern Newtonian Model of Gravitation consists of the following steps. Each step results in new "hard" facts generated directly from prior "hard" facts. The development does not contain nor rely on opinions. Consequently, while it is deemed a "model" it is an exact factual description of what it treats.

1 – How the universe's particles of matter came into existence.

2 – How they came to be propagating an outward flow.

3 – The reservoir supply for the substance of the outward flow.

4 – The speed of the outward flow.

5 – A particle's flow encountering another particle slows its outward flow.

6 – The outward flow has momentum.

7 – Gravitation is the momentum reaction to outward flow slowing.

Only absolute nothing [emptiness containing nothing, the zero of existence] requires no explanation of how it came to be. It is to be expected, as the natural condition. The only way something else, a universe, can come into existence from prior absolute nothing without an infinite rate of change at its beginning is to begin as an oscillation of the form *[1 - Cos(2πft)]*. The only way that can happen without violating the principle of conservation [no something from nothing and vice versa] is for there simultaneously to have come into existence the negative or opposite of that oscillation *-[1 - Cos(2πft)]* so that the two together are still equivalent to absolute nothing .

As with Descartes, because we are here thinking about this, then apparently the two oscillations did not promptly mutually annihilate, which means that they were so unstable that they even more promptly exploded into the mass of matter particles of our universe. That mass of particles can themselves only be like their parents, oscillations of the forms *±[1 - Cos(2πft)]*.

Each oscillation is three-dimensional because three dimensions is the minimum number that can involve space part of which is not its own boundary. Therefore the oscillations are spherical.

Every oscillation that we know in nature exhibits, and the very theory of oscillations in the abstract requires, that the oscillation consist of two aspects of the substance which is oscillating [e.g. pendulum position and velocity, electric potential and current] storing and exchanging back and forth the energy of the oscillation. With one aspect varying in oscillatory fashion then when that aspect decreases there must be some "place" for its energy to go, a place in which it is stored until it reappears in that aspect when it increases again. It cannot completely disappear or be lost because the oscillation would die. That "place" is the oscillation's second aspect and it obviously must vary in a manner related to the first aspect's variation, but with its energy storage in opposite phase.

The matter of the universe is a mass of particles each a spherical oscillation.

STEP 2 – HOW THE MATTER PARTICLES CAME TO PROPAGATING AN OUTWARD FLOW

Each Matter Particle's Central Core

Each of the myriad original matter particle's spherical oscillations had to be of some determined size, some volume. That develops as follows.

Newton's law of gravitation expressed in terms of m_{source} and $m_{acted-on}$ and with both sides of the equation divided by $m_{acted-on}$ is, of course,

(1) $$a_{grav} = G \cdot \left[\frac{m_{source}}{d^2} \right]$$

stating that gravitation is a property of a body's mass.

However, mass and energy are equivalent, so that a mass, *m*, is proportional to a frequency, *f*, that is characteristic of that mass. That is

(2) $$m \cdot c^2 = h \cdot f \quad \text{or} \quad f = [c^2 / h] \cdot m$$

so that the m_{source} of equation *(3)* has a corresponding equivalent frequency, f_{source}.

That being the case, the gravitational acceleration, a_{grav}, can be expressed in terms of that frequency as the change, *Δv*, in the velocity, *v*, of the attracted mass per time period, T_{source}, of the oscillation at the corresponding frequency, f_{source}, as follows.

(3) $$a_{grav} = \Delta v / T_{source} = \Delta v \cdot f_{source}$$

Gravitation and the Planck Length

It can then be reasoned using equation *(3)* = equation *(1)* as follows .

(4) $\qquad a_{grav} = \Delta v \cdot f_{source} = G \cdot \left[\dfrac{m_{source}}{d^2} \right]$

Equation *(5)*, below, is obtained by using that frequency is proportional to mass so that with f_p and m_p as the proton frequency and mass then $f_{source} = [m_{source} / m_p] \cdot f_p$.

(5) $\qquad \Delta v \cdot \left[\dfrac{m_{source}}{m_p} \right] \cdot f_p = G \cdot \left[\dfrac{m_{source}}{d^2} \right]$

Rearranging and canceling m_{source} on both sides of the equation,

(6) $\qquad \Delta v = \dfrac{G \cdot m_p}{d^2 \cdot f_p}$ per cycle of f_{source}.

Then substituting, per equation *(2)*, $m_p = [h \cdot f_p] / c^2$,

(7) $\qquad \Delta v = \left[\dfrac{G}{d^2 \cdot f_p} \right] \cdot \left[\dfrac{h \cdot f_p}{c^2} \right]$

$\qquad\quad = \dfrac{G \cdot h}{d^2 \cdot c^2}$ per cycle of f_{source}.

The Planck Length, l_P, is defined as

(8) $\qquad l_P \equiv \left[\dfrac{h \cdot G}{2\pi \cdot c^3} \right]^{\frac{1}{2}} \qquad$ so that $\qquad G = \left[\dfrac{2\pi \cdot c^3 \cdot l_P^2}{h} \right]$

Substituting G as a function of the Planck Length from equation *(8)* into G as it is in equation *(7)*, the following is obtained.

(9) $\qquad \Delta v = \left[\dfrac{2\pi \cdot c^3 \cdot l_P^2}{h} \right] \cdot \left[\dfrac{h}{d^2 \cdot c^2} \right]$

$\qquad\quad = c \cdot \dfrac{2\pi \cdot l_P^2}{d^2}$ per cycle of f_{source}.

This result states that:

- the velocity change due to gravitation, Δv,
- per cycle of the attracting mass's equivalent frequency, f_{source},
  which quantity, $\Delta v \cdot f_{source}$, is the gravitational acceleration, a_{grav},
- is a specific fraction of the speed of light, c, namely the ratio of:
  - 2π times the Planck Length squared, $2\pi \cdot l_P^2$, to
  - the squared separation distance of the masses, d^2.

That squared ratio is, of course, the usual inverse square behavior.

This also means that at distance $d = \sqrt{2\pi} \cdot l_P$ from the center of the source, attracting mass, the acceleration, Δv, per cycle of that attracting mass's equivalent frequency, f_{source}, is equal to the full speed of light, c, the most that it is possible to be. In other words, at that [quite close] distance from the source mass the maximum possible gravitational acceleration occurs. That is the significance, the physical meaning, of l_P or, rather, of $\sqrt{2\pi} \cdot l_P$.

The physical significance of $\sqrt{2\pi} \cdot l_P$ is that it sets a limit on the minimum separation distance in gravitational interactions and it implies that a "core" of that radius is at the center of fundamental particles having rest mass. That is, equation *(11)* clearly implies that it is not possible for a particle having rest mass to be approached closer than that distance.

Having noted at the beginning of this section 2a: "Each of the myriad original matter particle's spherical oscillations had to be of some determined size, some volume" it has now been derived that that volume is a sphere of radius $\sqrt{2\pi} \cdot l_P$.

The Outward Flow from each Matter Particle

But, the spherical oscillation in a volume of radius $\sqrt{2\pi} \cdot l_P$ is not in a container. There is nothing there except the oscillating substance of the oscillation.

Therefore, what "contains" that core's supply of oscillating substance or why doesn't it all just quickly "slosh" out and be gone? The answer is that it is trying to do just that, to "slosh" out, as hard as it can. It cannot help propagating outward because it has no container. But it can only propagate outward at the limiting rate determined by its surface area, $4 \cdot \pi \cdot (\sqrt{2\pi} \cdot l_P)^2$ and the fastest speed possible for it to flow, the speed of light, c.

STEP 3 – *THE RESERVOIR SUPPLY FOR THE SUBSTANCE OF THE OUTWARD FLOW*

For such a flow to persist and to have persisted the billions of years since the "Big Bang" there must be a supply of that outward flowing substance in every matter particle. And, that "supply" must be an extremely concentrated reservoir of that which flows outward [concentrated relative to the outward flow]. The radius $\sqrt{2\pi} \cdot l_P$ spherical core of each matter particle is the reservoir supplying the billions of years of outward flow propagation from each particle

That the core is impenetrable per equation *(9)* is due to its immense concentration of billions of years worth of flow of the outward flow substance in the minute central core of radius $\sqrt{2\pi} \cdot l_P = 4.05134 \times 10^{-35}$ *meters* of every matter particle.

STEP 4 – *THE SPEED OF THE OUTWARD FLOW*

The outward flow has to be of the same form as the spherical oscillation that generated it, *[1 - Cos(2πft)]*. It travels outward under the same influence or control as does light: that which we call the permeability and dielectric of free space, μ_0 and ε_0 and, consequently, the speed of light. The μ_0 and ε_0, like electric inductance and capacitance, support the two aspects of the oscillation between which the energy exchanges back and forth.

But, when the original oscillation came into existence it did so in absolute nothing. There was no "free space" with μ_0 and ε_0. There was nothing but the original oscillation. And, after the immediate explosion into all of the particles of the universe, each of those particles was propagating its outward flow into *nothing*, *emptiness*.

Where did the μ_0 and ε_0 come from? The only thing they could have come from was the original oscillation. There is no other possible source because everything else was absolute nothing, "the zero of existence". The μ_0 and ε_0 are inherent in the substance of the oscillation, which means, μ_0 and ε_0 are also inherent in the outward propagation. Each particle's outward flow contains its μ_0 and ε_0.

In a universe of the myriad particles resulting from the Big Bang, each of those particles propagating its own outward flow radially in all directions, there are many instances of the flow from one particle [the "source" particle] encountering, running into, the outward-flow-propagating-center core of another particle [the "encountered" particle]. Such "source" particle flows are inverse square reduced in magnitude the farther that their wave front has traveled from its "source".

The flow behavior is analogous to that of an electric transmission line where the rate of travel of an oscillation down the line is determined by the time it takes to build up the electric current for each oscillation cycle through each infinitesimal increment of the line's distributed series inductance [L_p] and to build up the electric potential for each oscillation cycle on each infinitesimal increment [C_p] of the line's distributed shunt capacitance. The transmission line speed of flow is determined by the well-established relationship equation *(10).*

(10) $$\text{Speed} = \frac{1}{\sqrt{L_p \cdot C_p}}$$

For particles' propagating oscillating flow the factor determining its speed of propagation is the time required to build up the flow amount for each oscillation cycle through each infinitesimal increment of the flow's μ_0 and the flow's potential for each oscillation cycle on each infinitesimal increment of the flow's ε_0. But, in radially outward propagating particle's flow, the flow amount is inverse square spread out and the potential likewise both in exactly the same proportion as its μ_0 and ε_0. The ratio of the flow amount to its μ_0 and of its flow potential to its ε_0 remains constant, and so likewise the speed, radially outward, of its propagation, *c*.

Upon encountering another particle that arriving flow's μ_0 and ε_0 (scalar not vector) (much inverse square reduced) combine with the (full magnitude) μ_0 and ε_0 in the new outgoing propagation of the encountered center, the μ_0 sum and the ε_0 sum each being larger values. The result is that that "encountered" particle's new outward flow is slowed relative to its natural otherwise speed. That is, its speed of flow is determined by a combination of the parameters μ_0 and ε_0 larger than its flow's otherwise natural values. The speed of flow is determined by the well-established relationship

(11) $$\text{Speed} = \frac{1}{\sqrt{\mu_0 \cdot \varepsilon_0}}$$

STEP 6 – *THE OUTWARD FLOW HAS MOMENTUM*

The oscillating substance of each of the myriad particles has its mass. There is no other place or thing to be the mass of those particles. Therefore the propagating outward flow has momentum, the inherent effect of the product of mass, inherent in the substance of the flow, and the flow's velocity.

In the absence of other effects the outward flow is naturally radially outward. While the outward flow effectively transmits pulses of momentum outward in its *[1 - Cos(2πft)]* oscillation, the core source of that flow is experiencing radially inward equal but opposite pulses of momentum in accordance with Newton's third law of motion. In effect the core source is under reaction compression. Because that effect is radially uniform it produces no net affect on the particle.

STEP 7 – *GRAVITATION IS THE MOMENTUM REACTION TO OUTWARD FLOW SLOWING*.

The incoming flow from a distant "source" particle having the effect of slowing the speed of the "encountered" particle's outward propagated flow causes that "encountered" particle's outward flow to have less momentum than if it were not slowed, again momentum being the product of mass and velocity.

Therefore the Newton's Third Law reaction to that reduced outward flow momentum, reaction back on the "encountered" particle, is smaller than otherwise. That effect takes place on the side of the "encountered particle" facing toward the "source" particle from which the slowing - causing flow came.

But, on the opposite side of the "encountered" particle no such slowing of its outward propagated flow is present so that the outward flow there has the full natural momentum and the Newton's Third Law reaction on the particle on that side is the full natural amount. Consequently, the "encountered" particle experiencing its usual full momentum reaction back on itself on its side opposite that facing the incoming flow from the "source" but experiencing reduced reaction back on itself on its side facing the incoming flow from the "source", experiences a net momentum reaction toward the "source" particle from which the slowing-causing flow came.

Thus the particle experiences $[1 - Cos(2\pi ft)]$ pulses of momentum increase toward the "source" gravitationally attracting particle which constitute the gravitational acceleration.

SUMMARY AND CONCLUSION

The Universe's matter came into existence in the only possible form that avoids an impossible infinite rate of change and satisfies the requirement of conservation: a pair of oscillations of the form $\pm[1 - Cos(2\pi ft)]$. Witnessed by we here addressing the issue, those did not mutually annihilate so, being unstable, they exploded into the myriad particles of the universe.

Those myriad particles must, inevitably, propagate similar oscillatory outward flow and have been doing so for billions of years.

Their outward flow is at $\text{Speed} = \dfrac{1}{\sqrt{\mu_0 \cdot \varepsilon_0}}$ because the μ_0 and ε_0 are inherent in its flow.

That particle's outward flow encountering another particle slows the encountered's outward flow on the side encountered because the μ_0 and ε_0 of the incoming flow add to the μ_0 and ε_0 of the encountered particle's outward flow so that the encountered's speed of outward flow there is slowed.

That reduces the encountered particle's outward flow momentum there and its reaction back on that side of the encountered particle while on the encountered particle's opposite side the flow and reaction momentum remain the same.

The result is momentum increments accelerating the encountered particle toward the source of the slowing-causing flow, which is gravitational acceleration.

OTHER

The foregoing effects are all due to the oscillatory frequency of the momentum-carrying flow and to its being the only source of μ_0 and ε_0, those all together producing the gravitational effects. But, what about the amplitude of the particles' oscillations and their propagated flows? The details of that are beyond the scope of this paper which is about gravitation.

However, the role of amplitude can be summarized as follows.

1 – The +/- polarities of the $\pm[1 - Cos(2\pi ft)]$ oscillations are the +/- charges of the various particles of the universe.

2 – The $[1 - Cos(2\pi ft)]$ oscillation propagated wave amplitude delivers pulses of momentum onto any other particles' cores that it encounters.

3 – If the **source's** wave polarity is the same as the **encountered** wave polarity then the increments of momentum delivered to the **encountered** particle result in increments of acceleration of it away from, the **source** of the waves, which is Coulomb repulsion between like charges.

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4 – If the two particles involved are of opposite polarity then the increments of momentum delivered by the **source** wave act to cancel or nullify corresponding amounts of increments of momentum in the outgoing pulses of momentum in the propagated flow of the encounter**ed** particle. That correspondingly reduces the **encountered** particle's experienced reaction back onto itself. The **encountered** particle experiencing reduced reaction on its side facing the **source** particle and full reaction on the opposite side experiences net increments of acceleration toward the **source** particle, which is Coulomb opposite charge repulsion.

That constitutes a simple summary of the behavior of Coulomb's Law. For a full development see the paper *Inertial Mass, Its Mechanics – What It Is; How It Operates*[3] and Section 16, *A Model for the Universe (6) – The Neutron, Newton's Laws* in the book *The Origin and Its Meaning*[1].

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