Diffusion Gravity: Dynamics and Scalability

dhfulton@ieee.org

1. Abstract

A previous paper introduced the heuristic model of Diffusion Gravity (DG) based on the principle of mass diffusion [1]. That work provided an initial development of an explanation of inertia, acceleration, and gravity from the interaction of mass objects with the active quantum vacuum environment via virtual particle mechanisms. This follow-on article extends the model to incorporate the related dynamics of the virtual particle outflows from mass objects and presents model specifics for inertia, kinetic energy, and orbital motion. ***Mass Diffusion*** is the primary active force that drives interactions of the virtual particle agents of the quantum vacuum to produce linear and orbital motion; the active quantum vacuum may be more accurately described as a an *agent* in gravitation; these aspects of diffusion gravity and other mass-energy considerations are described and discussed in this paper, including derivation and consistency with mass-energy $E_0=mc^2$. Motion models and their descriptions, which comprise *Diffusion Gravity Dynamics* (DGD), are added to the Diffusion Gravity theory. The Diffusion Gravity model and theory implies application to other physical phenomena such as relativity, light refraction and the role of virtual particles therein, and the model's scalability to astrophysical phenomena such as flattening of the galactic rotation curves.

2. Introduction

In the first research paper, historical background and the foundation of this model were formulated using the diffusion laws of classical physics along with the development of quantum electrodynamics of VP (Virtual Particle) behaviors. The existence and usage of *active* VP's for explanations of quantum phenomena include transmission of light and transfer of mass information using VP mechanisms; examples such as the Casimir effect [2][8] and more recently, light transmission via virtual fermions through the vacuum [3] were cited to substantiate a model of gravity that is consistent with diffusion and quantum electrodynamics. The force of mass diffusion was elaborated as the specific prime motivator that causes matter to coalesce with and attract other matter, in the effect we know as gravity. The same diffusion gravity model was shown to apply equally to all accelerating masses to explain the Equivalence Principle. Equations were developed to integrate diffusion with gravity in a composite model that parallels Newtonian mechanics with underlying explanations for inertia and acceleration. The model is summarized in an equation expressing the acceleration gradient as the efflux due to diffusion of virtual mass from real mass

$$\boldsymbol{J_r} = \nabla \bullet \mathrm{a}_{net} = \kappa_r \int^{V} \boldsymbol{\rho_r}\, \boldsymbol{dV} \qquad \textbf{\textit{(1)}}$$

This equation relates the flux from a mass through the surface (outflow) of a sphere of volume of radius r, to mass diffusion-gravity κ_r coefficient that incorporates the diffusion coefficients and gravitational constant as $4\pi G/D\nabla\varphi$, where G is assumed the constant G, and $D\nabla\varphi$ is the *diffusion* parameter (see previous article[1]). This flux drives outflows of VP's (virtual particles) from real masses. The important concept in the DG model is that virtual particles are generated from ordinary matter by the process of mass diffusion, and thereby can play active *agent* roles in common physical phenomena such as photon transmission, gravity, and motion. The non-determinism of random probabilistic quantum phenomena is thereby unified with the determinism of classical diffusion to provide a quasi-deterministic model of gravity. Moreover, the model affords the opportunity to offer new explanations for classical physics through a mass diffusion perspective. The first presentation of this model demonstrated how the basic mechanism underlying inertia and acceleration led to the key explanation for gravity. The force of gravity is the interaction of mass diffusing into the ambient quantum vacuum; The overall Diffusion Gravity model-driving concept is illustrated as in Figure 1.

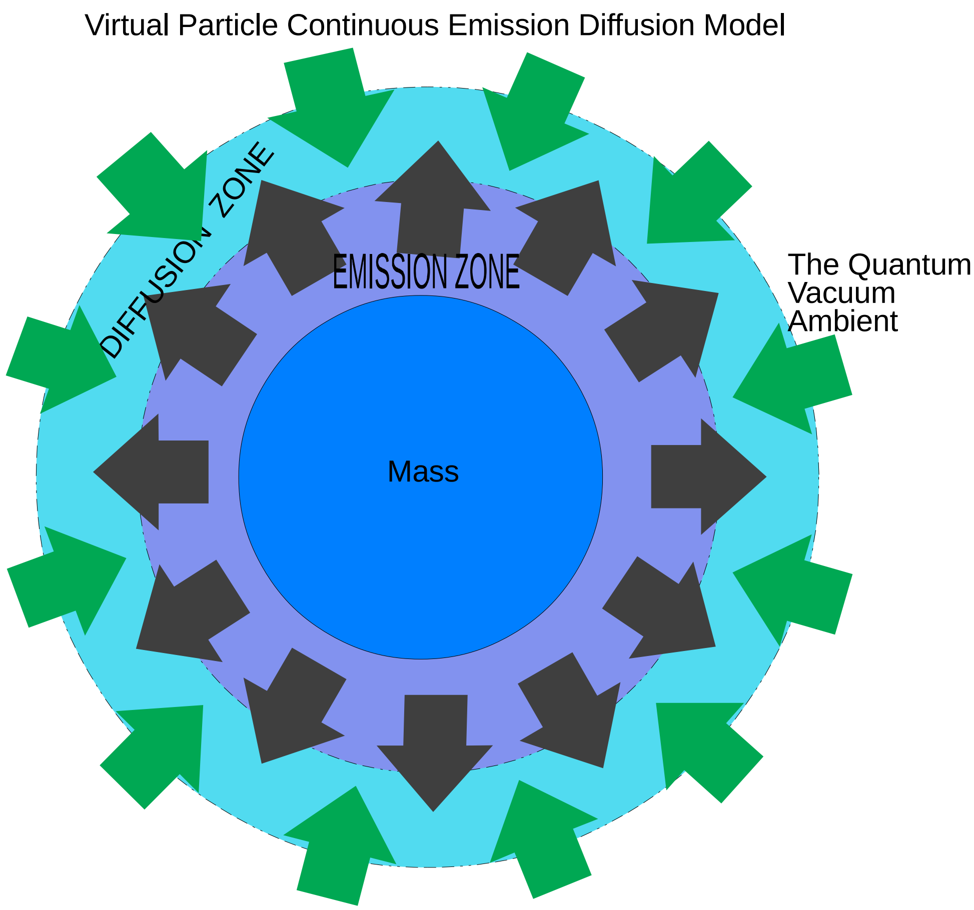


Figure 1 Diffusion of Emitted Virtual Particles with Ambient

Continued development of the DG Dynamic model is dependent upon assumptions that were included in the original paper, with some additions:

(1) Virtual particles are well known and accepted mediators of processes and are necessarily required for the physics of quantum electrodynamics as well as quantum field theory.

(2) Diffusion is a fundamental physical process that operates on *virtual* as well as *real* particles, and follows the known laws of diffusion from classical physics.

(3) All matter is surrounded by its own gravitational potential field of virtual particles in proportion to its mass. This is equivalent to the gravitational potential *V* of the Newtonian model.

(4) Virtual particles themselves supposedly do not gravitate like ordinary matter, (see Rafelski in [6,7]), but in the diffusion gravity model, they gravitate in a *time-averaged collective* sense, as limited by the Uncertainty Principle and known quantum mechanical probabilistic behaviors. The model assumes the instantaneous sum of all active VP's within the gravitational potential field of an object will equal one half the mass of the object, i.e., the average ½ ($\hbar = \Delta p \Delta x$).

(5) Energy and momentum conservation must apply to the interactions of virtual particles as they do to real particles. Virtual particles outflow from masses at velocities of $0 \rightarrow c$.

(6) Volumes and areas of virtual particle flux and virtual particle diffusion provide physical mechanisms for acceleration and the force of gravity.

The sections that follow develop the DG model with dynamic behaviors as a review and continuation of the initial paper on Diffusion Gravity. Refer to the model schematic of gravity in Figure 1b.

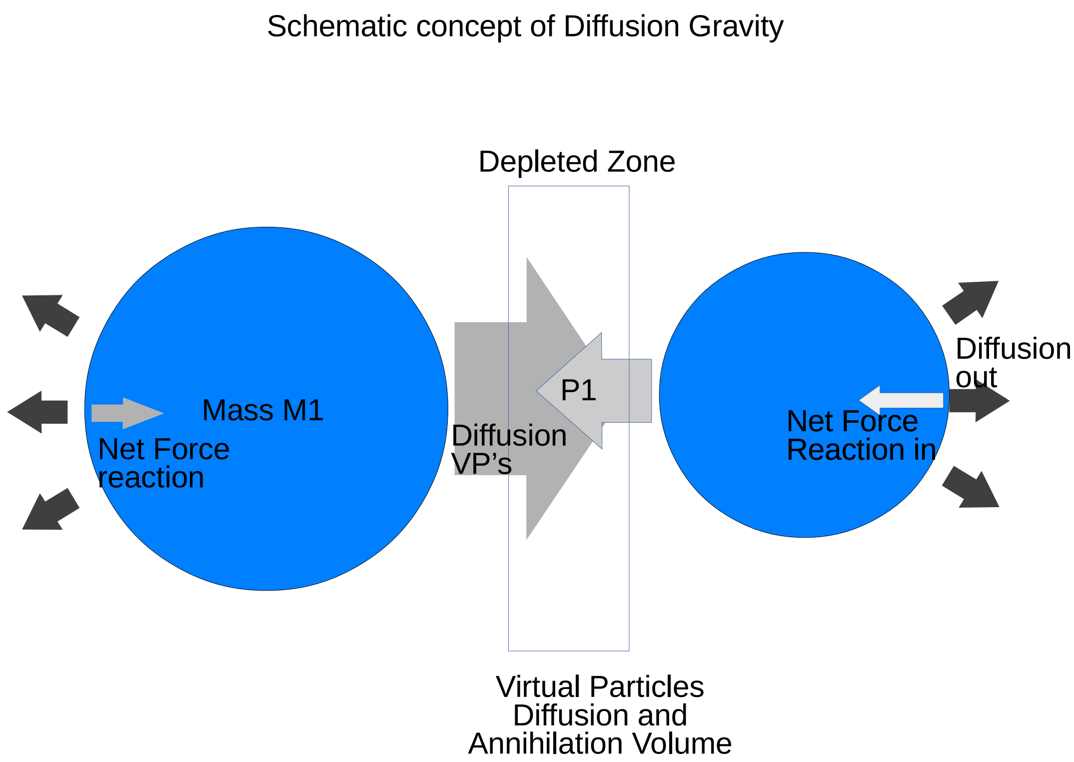


Figure 1b The Diffusion Gravity Attraction Mechanism

3. Diffusion Driven Dynamical Model Development. The Diffusion Gravity model was developed from first principles of diffusion of mass in accordance with Fick's Law[4][5]. This approach differs from the diffusion of energy as governed by thermodynamics in that it applies the important entropy principle to matter. The gradient of diffusion between matter and vacuum is the prime mover for the quantum vacuum virtual particle agents that act to convey information. The continuous stream of virtual particles out of a mass is the "projection" of that mass' information into the vacuum around it. The information projected includes the direction and mass of the source object. The information propagates outward through the vacuum to other masses, which also emit their own continuous stream of information as to location and mass. This "information" manifests as the potential field around matter given by

$$V = \frac{Gm}{r} \qquad (2)$$

Ephemeral virtual particles are instantiations of generic fermions that obey the limited lifetime constraint of the Uncertainty Principle, relaying their respective information onward to the next virtual particle that succeeds them. Thus the field is continuous, but the individual virtual particles are not. Information is thereby transmitted, but energy is not expended, unless and until another mass potential field is encountered. The most fundamental quantity for the Diffusion Gravity Model is the outflow of the virtual particles from a mass object. Correspondingly, the most fundamental vacuum quantity is the reactive ambient VP flow, which is generated at a matching rate to the mass object's outflow.

A spherical static m*ass diffusion* of virtual particles balances with the ambient vacuum virtual particle flux shown in the original article, summing to zero (the Laplacian), thus the same equation applies to both static masses and masses moving at constant velocity. This equation, given by $\nabla^2\varphi = 0$, is derived from from the sum of fluxes

$$\int_{V_f} J_{FM}\, dV + \int_{V_t} J_{FM}\, dV = 0 \qquad (3)$$

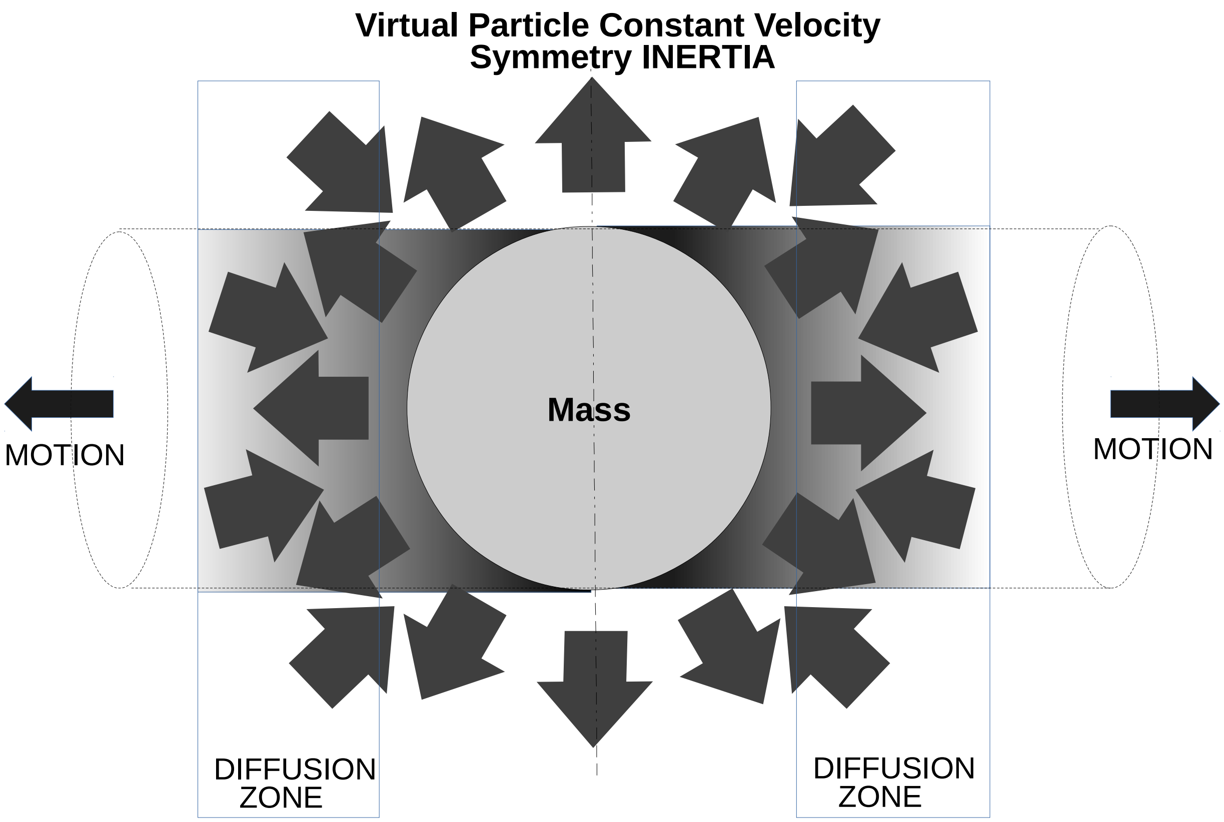


Figure 2 Diffusion Gravity Constant Velocity Inertial model

where J_{FM} is the total flux to mass ratio of the forward and trailing volumes containing virtual particles diffused from the source mass. The inertia of constant velocity is presented in the conceptual diagram, shown in Figure 2. DG's constant velocity model completely explains why gravity cannot be shielded, and may also explain variability of clocks since the fluxes are symmetrical and the sum of fluxes is zero. This will be covered in further detail in subsequent presentations of the DG Model.

In the previous paper, constant velocity inertia, i.e., momentum, was extended to account for acceleration, which is shown as an *imbalance* between the forward and trailing volumes of diffusion

$$a_{net} \;\alpha\; \int_{V_f} J_{FM}\, dV \;+\; \int_{V_t} J_{FM}\, dV \;\neq\; 0 \qquad (4)$$

where a_{net} is the acceleration due to the net flux, which also was previously expressed in [1] as

$$\boldsymbol{J}_{net} = \nabla \bullet a_{net} = \kappa_r \int^V \rho\, dV \qquad \textbf{(5)}$$

where κ_r was a coefficient combining the gravitational constant with diffusion flux as $4\pi G/D\,\nabla\varphi$. The acceleration is illustrated in Figure 3 which shows the imbalance between the forward and trailing diffusion volumes of virtual particles. This model of acceleration therefore implies energy expenditure as well as energy conservation. An important objective of this research is therefore to present the energy characteristics of the Diffusion Gravity model.

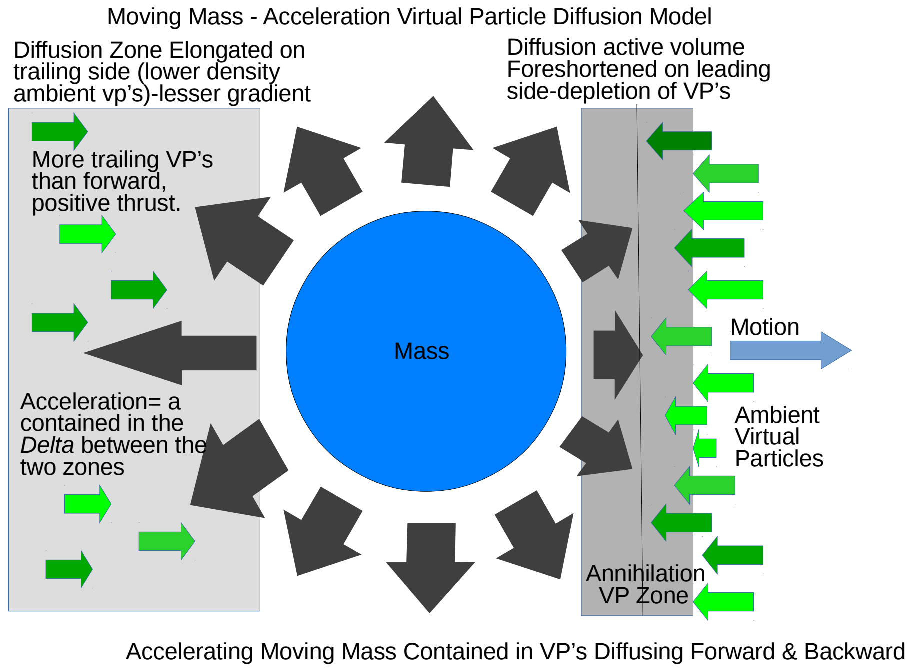


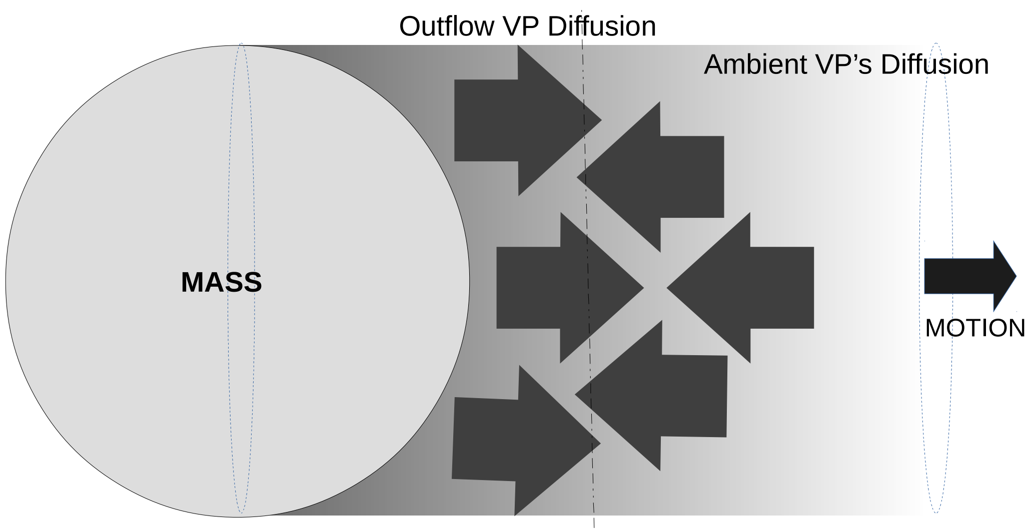
Figure 3 Acceleration Model in Diffusion Gravity

Using the basic concepts established for the model, energy considerations for kinetic energy and orbital motion are presented in the following sections.

4. Kinetic Energy Derivation from Diffusion Gravity

The initial presentation of Diffusion Gravity [1] provided some of the principles of motion that result from the model. This section adds kinetic energy and related concepts of motion energy; the fundamental quantities of momentum and mass are combined with the virtual particle and vacuum mechanisms, in contrast to the standard *behavioral-only* descriptions of classical mechanics. The conventional Newtonian derivation of kinetic energy starts from the concept of force times distance, or F • **d =** Work, which is then converted through several steps to K.E. = $\frac{1}{2}mv^2$ [e.g., wikipedia derivation for *kinetic energy*]. However, this definition requires the *a priori* work requirement for the mass to be in motion, i.e., that some previous action had to have been performed to "create" the kinetic energy of motion. No such assumption need be levied in the Diffusion Gravity "current state" model. This is analogous to the relative energy concept of potential energy, which likewise required work *a priori* as a prerequisite action to "create" the potential energy relative to some reference point. But with momentum as *the* fundamental quantity in nature, mechanics can overcome this paradox by using "current state" as the default state of the mass object. In the Diffusion Gravity model, current state is directly expressed as momenta, as shown in Figure 4, using a geometric distribution of virtual particles of velocities from zero to $\boldsymbol{u}$ within the respective forward and ambient cylindrical volumes, which sum over volumes to a net momentum

$$\tfrac{1}{2}\,\boldsymbol{m}\int_0^{u}\boldsymbol{u}\,du\int_0^{r} dV_{Forward} \;-\; \tfrac{1}{2}\,\boldsymbol{m}\int_0^{-u}\boldsymbol{u}_{FM}\,du\int_0^{\boldsymbol{r}} dV_{Ambient} \;=\; \sum_0^{n}\int^{V}\boldsymbol{p} \qquad (6)$$



$$\tfrac{1}{2}\,\underline{\boldsymbol{m}}\left(\frac{u^2}{2}\int_{vol}^{r} dV \;+\; \frac{u^2}{2}\int_{Vol}^{r} dV\right) = K.E.$$

Figure 4 Diffusion Gravity Kinetic Energy

where $\boldsymbol{m}$ is mass of the moving object, $\boldsymbol{u}$ is the velocity of the virtual particles from the moving mass or from the ambient matching vacuum, $\boldsymbol{r}$ is the radius of the cylindrical volume *n* of diffusion for a spherical mass, and $\boldsymbol{V}$ is the volume of operative space in which the kinetic energy is contained.
From the initial DG model, one-half the mass is the effective, or average "mass" for any given instant due to the Uncertainty Principle for the virtual particles out-flowing from the object; given by the average $1/2(\hbar = \boldsymbol{\Delta p \Delta x})$, which then in this model equates to $m = m_{avgVP} = ½\, m$. All the virtual particles in the active diffusion volume around the mass are summed over their velocities and over the forward volume projecting from the moving mass object as shown. The ambient vacuum environment will always produce equal and opposite virtual particles, so the forward ambient virtual particle volume is an exact mirror image of the forward volume of the moving mass outflow of virtual particles. That is, for any velocity distribution of emitted and ambient VP's $\boldsymbol{u = 0 \rightarrow +/- \; c}$ where $\boldsymbol{c}$ is the speed of light. The forward velocities of VP's are included in the first term; the ambient VP's will always *MATCH* the mass' outflow VP's, which is added by the ambient or second term on the left side of equation 6. Therefore upon integration of momentum with respect to velocities and summing the forward and trailing volumes, the energy becomes

$$½\, \underline{\boldsymbol{m}} \left(\frac{u^2}{\boldsymbol{2}} \int_{vol}^{r} dV_{Forward} + \frac{u^2}{\boldsymbol{2}} \int_{Vol}^{r} dV_{Trailing} \right) = \int_{Vol} \boldsymbol{p}\, dt \quad = m \int_{Vol} \boldsymbol{u}\, dt \qquad (7)$$

And upon summing over the volumes on the left side of the equation and integration of the volumes, geometric summation equals net kinetic energy

$$\boldsymbol{½\, m\, u^2_{FM} = K.E.} \qquad (8)$$

The virtual particle vacuum as the *re-active* agent combines with the virtual particles outflowing from a mass object by diffusing into that flow for the kinetic energy of a moving mass. Energy is conserved by the matching of outflows of VP's at any velocity u, to the ambient VP's that combine with them to give the total kinetic energy. This derivation has thereby demonstrated and substantiated the Diffusion Gravity model for moving masses, and their energy consistent with Newtonian mechanics, since the assumptions and equations used in this derivation conform with the Diffusion Gravity model. In a similar way, acceleration within the model was directly derived from the interaction of virtual particles of the ambient vacuum with the outflow of VP's from a mass object, as a current or default state of the object. The Diffusion Gravity model thus explains how energy is "stored" in the vacuum around the mass due to interaction with ambient virtual particles; this is another key concept in the model, and will be applied to show orbital motion. The model and the theory continue to adhere to the heuristic approach by using examples and component models for the logical build-out of mechanism concepts and energy consideration.

5. Diffusion Gravity Model for Orbital Motion.

Orbital motion is a fundamental instance of gravity in nature. The Diffusion Gravity model can be applied straightforwardly by adding an offset in velocity or acceleration to the simple linear gravitation attraction described in the first research paper[1]. The net acceleration from the offset generates angular momentum which results in orbital motion with both tangential and radial acceleration

$$a_{net} = \underbrace{\left(\int_{V_f} J_{TM}\, dV_{Fwd} + \int_{V_t} J_{TM}\, dV_{Trail} \right)}_{Tangential} + \underbrace{\left(\int_{V_f} J_{RM}\, dV + \int_{V_t} J_{RM}\, dV \right)}_{Radial} \qquad (9)$$

where for the "current state" there is constant velocity v for the tangential motion, and with the radial acceleration component being

$$J = \nabla \bullet \; a_{net} = \; \kappa_r \int \rho_r \, dV \qquad (10)$$

$$\nabla \bullet \; a_{net} = \; \kappa_r \int_V \rho_r \; dV \qquad (11)$$

Applying the motion models developed thus far, the VP vacuum acceleration and momentum applies to the "current state" centripetal acceleration a_r and an orbital velocity v. The model developed for acceleration and gravity as applied to orbiting objects must be consistent with the Newtonian model

$$a_r = \frac{v^2}{r} = \kappa_r \int_{Vol} \rho_r \; dV \qquad (12)$$

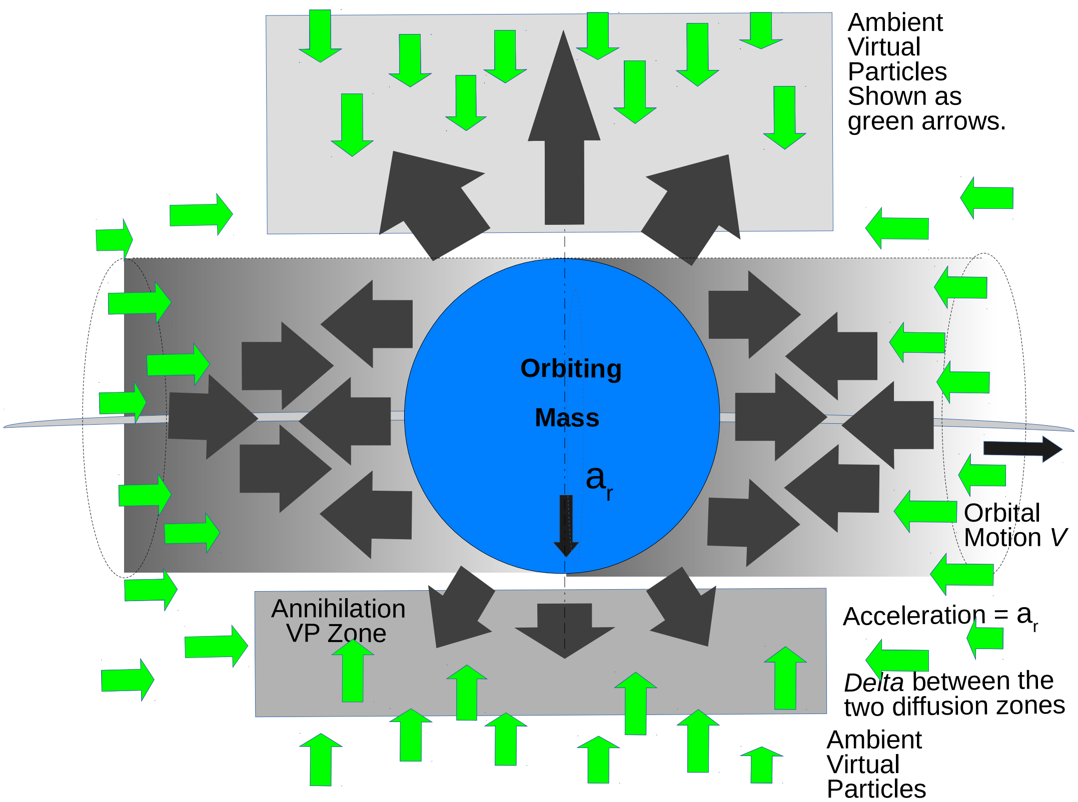


Figure 5 Diffusion Model For Constant Velocity Orbital Motion

where r is the orbit radius for a circular orbit, and the coefficient κ_r is $4\pi \mathbf{G/D} \nabla\varphi$; this is the expression for centripetal acceleration due to the diffusion gradient of virtual particles between the central and orbiting mass over the entire volume of radius r. Figure 5 illustrates the Diffusion Gravity model for "local", i.e., in our solar neighborhood. This simple orbital motion model implies possible variations or adaptations of orbiting masses in the quantum vacuum where r is large, and the effects of larger distance from the central mass on the empirical value of a_{net}. For example, consider the flattening of rotation curves for galaxies, which has been extensively studied and for which hypothetical causality has been proposed by theories of dark matter. As $a_{net.}$ approaches the Modified Newtonian Dynamics (MOND) point value of $\mathbf{a_0} = 1.2 \times 10^{-10}$ m/sec^{2}., observations of myriad galaxies show that velocities "level off" instead of "rolling off" as required by the Newtonian model. The Diffusion Gravity model proposes an alternative explanation in which the quantum vacuum and virtual particle flux vary due to large distances. This has been suggested in works by Rafelski with "true" vice "false" vacua [6][7]. If the flux of the virtual particle ambient background *decreases* to some lower ambient value, that could force the orbiting star's tangential velocity $\boldsymbol{v}$ to maintain a constant value, and at the same time the value of a_r continues its behavior in accordance with $\mathbf{v}^2/r$. As the flux of the ambient virtual particles decline, the orbiting mass will also commensurately decrease its outflow of VP's, due to reduced mass diffusion gradient between itself and the ambient vacuum, thereby "preserving" the orbital parameters of velocity and radial acceleration. This would vary κ_r to maintain $\boldsymbol{v}$. In the DG model, the most likely variation would be the diffusion gradient contained within κ_r due to the ambient vacuum activity change at large distance from the galactic core, for the velocity v to remain constant (ρ_r would also vary over large distances). The net result would therefore be a "flattening" of the velocity curve as observed. The constant velocity inertial characteristic of the DG as discussed previously and shown in Equation 3 and illustrated in Figure 2, is due to the balance between forward and trailing volumes of the orbiting mass, as expressed in the Laplacian for net flux. Momentum conservation then requires

$$\nabla^2 \varphi = 0 \qquad \text{(Equation 7 in [1])}$$

At larger scales such as the galaxy, the model suggests that tangential velocity will be preserved, and will constitute the preponderance of the inertia, so it will dominate the orbital motion model. The DG motion model suggests, therefore, the quantum vacuum ambient levels must change with increasing distance from massive objects (galactic cores) and with their correspondingly declining gravitational fields. Essentially, then, the virtual particle vacuum likely plays a significant role in that it maintains the momentum of the mass by the diffusion gravity mechanism presented. The hypothetical change of the Diffusion Gravity effect is shown schematically in Figure 6. Assuming that conservation of momentum holds, the original derived quantity of flux J from [1]

$$J = 4\pi G \int \rho_r = D \frac{d\varphi}{dr} \qquad (13)$$

where $\boldsymbol{J}$ represents the acceleration as is the sum of fluxes over the volume, and $\boldsymbol{D d\varphi/dr}$ is the diffusion for a given orbital radius r. This equation would then provide a constant flux J only if the diffusion $\boldsymbol{D\, d\varphi/dr}$ gives a constant density $\boldsymbol{\rho_r}$. This requires the ratio of diffusion $\boldsymbol{D\, d\varphi/dr}$ to $4\pi G$ to be 1, to maintain the acceleration for a given volume at radius r. The DG model, therefore, shows that diffusion $\boldsymbol{D\, d\varphi/dr}$ *would not manifest the classical Newtonian* v^2/r *roll-off* for a constant diffusion of VP's from the mass relative to the ambient VP levels. This indication of the model applies at large *r*, where the remote vacua characteristics are likely not the same as our local solar system. The outflow of VP's would then balance against the ambient VP flux to maintain an "equilibrium" or relative density. This simple model mechanism would thereby preserve orbital constant velocity of orbiting objects, thereby suggesting there is no need for dark matter. Further research and investigation might reveal vacua variations over large galactic scales to confirm the model.

Another aspect of DG's constant velocity at larger scale is that of diffusion variability of the orbiting mass as the ambient VP levels change, implying that the interaction and relationship between a mass and its ambient vacuum changes the outflow rate and quantity of VP's. The re-active vacuum may therefore more accurately called a *"reagent"* than a simple agent.

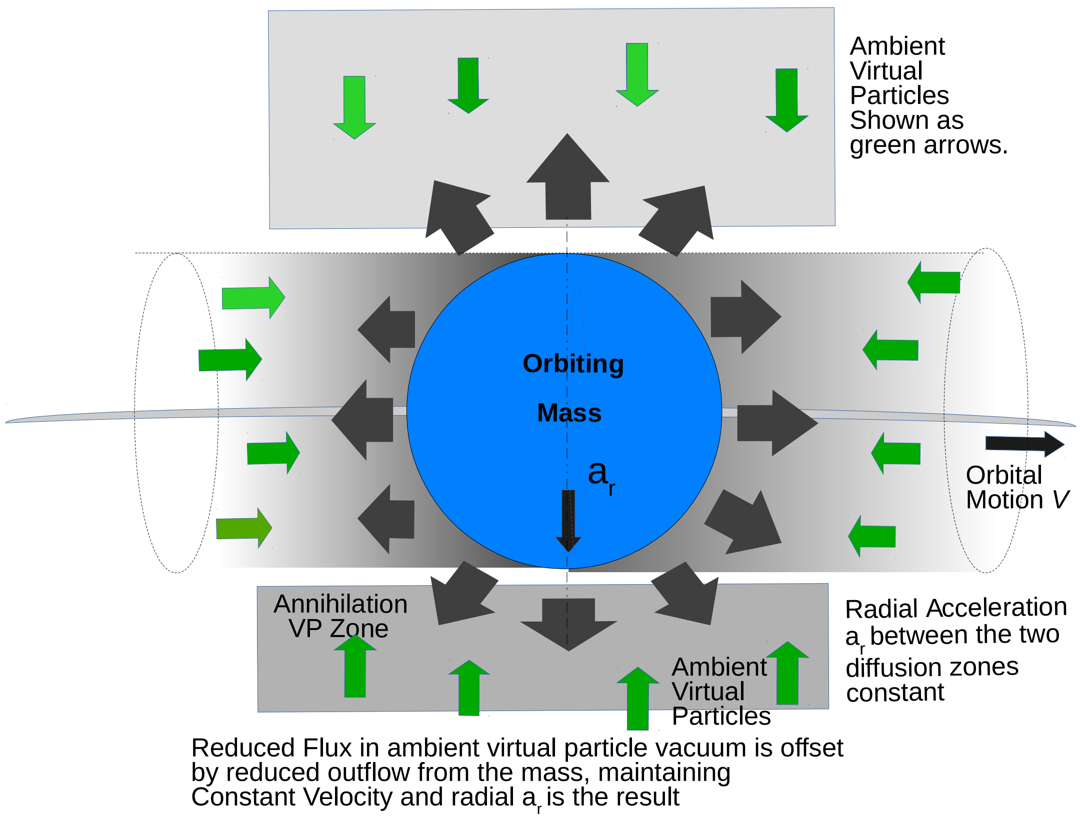


Figure 6 Relative Diffusion Model For Constant Velocity Orbital Motion

6. Implications of Diffusion Gravity Model .

The Diffusion Gravity model extended for motion and energy can be further applied to larger scales to explain phenomena that hitherto have been incompletely explained, or perhaps attributed to controversial unprovable theories. An example of this is scaling to the solar system, to show the compatibility with Newtonian mechanics as well as general relativity. DG fluxes most certainly can augment or replace curvature in the theoretical constructs of modern physics to simplify the physical underpinnings of the theory. Furthermore, diffusion of virtual particles as the prime mover for gravity can be applied at larger galactic and cosmological scales. If the ambient VP flux declines from concentrated matter sources (the sun, galactic cores), then our concept and standard model of the universe may change accordingly. Virtual Particle flux variations may also change the foundational theory of distance-versus-redshift in the standard model of cosmological expansion, and perhaps even the value of *c* as a universal constant. The outflows of VP's depicted in this Diffusion Gravity model travel at velocity up to *c*, giving them a virtual momentum of up to ½ *mc*, due to the uncertainty principle as covered in section 2 within the stated assumptions. Proceeding with the logic of the DG model, then, the momentum of the emitted VP's plus its *matching ambient VP s* would lead to a maximum "VP energy" of $\boldsymbol{mc^2}$, as previously shown in equation 6 and 7

$$\tfrac{1}{2}\,\boldsymbol{m}\int_0^{c}\boldsymbol{u}\,\mathrm{du}\int_0^{r} dV_{Forward} \;-\; \tfrac{1}{2}\,\boldsymbol{m}\int_0^{-c}\boldsymbol{u}_{FM}\,\mathrm{du}\int_0^{r} dV_{Ambient} = \sum_0^{n}\rho. \qquad (14)$$

where as shown before, the summed momenta over the forward and trailing volumes give an overall energy,

$$\int_V \rho = \tfrac{1}{2} mc^2 \qquad (15)$$

This takes the "mystery" out of the shop-worn $E=mc^2$, by showing it to be a logical and mathematical artifact of this diffusion gravity geometrical motion model for total energy. Adding in both the trailing volume and its matching ambient annihilation VP's for total energy, since the trailing volume also outflows with VP's, gives the total volumetric mass energy of $2(\tfrac{1}{2} mc^2) = mc^2$. Now the total energy of the mass adds to the Kinetic Energy for regular motion << $\boldsymbol{c}$. So the Total Energy for the moving mass becomes

$$K.E. + E_{VP\ Flux} = \tfrac{1}{2} mv^2 + 2(\tfrac{1}{2} mc^2) = \tfrac{1}{2} mv^2 + mc^2 \qquad (16)$$

These additions and extensions to the Diffusion Gravity model apply to DG dynamics and highlight the flexibility, compatibility, and applicability to standard Newtonian dynamics. Beyond this simple derivation, there is an implication for VP flux induced effects such as a variable speed of light virtual particle refractive index, and for a variable gravitation flux throughout the universe, with consequences to all of physics. The implication for relativity theory is that better explanations may be forthcoming by application of real physical mechanisms.

7. Experimentation and Further Observation and Research

The objective is to demonstrate conclusively the models proposed in this theory. Matter and mass diffusion of virtual particles, not energy diffusion, is the fundamental quantity and behavior in the explanation of gravity. According to the DG model, any discovery of control of gravity will involve matter and virtual particle flows as described in the Diffusion Gravity model. In fact, it is likely that the primary reason that gravity has not been explained is that the research focus is on *energy* and not on the *matter*, *virtual matter*, and their manifestation as fields. The direction of experiments must confirm "matter" mechanisms rather than energy; this includes Casimir effect detection devices, gravimeters, and other sensitive instrumentation. A separate research article will investigate the design of experiments to discern among mass-versus-energy approaches; experiments are currently in development. The Diffusion Gravity model continues to focus on mass, matter and virtual matter (particles) and their behaviors *without* conversion between matter and energy. With this focus in mind, the experiments will adhere to mass concepts and virtual particle fluxes to prove the theory and achieve greater understanding of gravity. The model depends on Fick's law, but does not as yet include any temperature effects on diffusion, which are known to exist. Future additions or modifications to the model will factor in those temperature effects, which might then provide further heuristic extension and scalability to the cosmic acceleration of expansion and explanations for theoretical "dark energy".

8. Conclusion

Diffusion Gravity combines classical as well as quantum physical principles into a quasi-deterministic model of motion, energy, and gravity. The original objective of the DG model was to provide a clearly defined mechanism and causality for gravity, which was achieved, and in conjunction with that effort, some other mechanical and functional models were generated and incorporated into the DG overall theory as Diffusion Gravity Dynamics. The virtual particle vacuum as the *reactive* agent ("reagent") combines with the *active* virtual particles outflowing from a mass object by diffusion between the outflow and ambient virtual particles to provide a model for inertia and constant velocity, a model for acceleration, and a model of kinetic energy of a moving mass. Energy is conserved by the matching of outflows of VP's at any velocity $u \rightarrow c$, by the ambient VP's that combine with them to give the total kinetic energy, and even the total energy mc^2 for mass objects. The derivations and models presented have substantiated the Diffusion Gravity Dynamics model for moving masses, and their energy consistent with Newtonian mechanics, as demonstrated by assumptions and equations of the original Diffusion Gravity model. In a similar way, constant velocity and an acceleration model as derived from the Diffusion Gravity model were shown as the interaction of virtual particles of the ambient vacuum with the outflow of VP's from a mass object, to provide the "current" or default state of the object, without requiring *a priori* Newtonian "work" derivations. The motion component models provided here were developed together with or deriving from those of the first Diffusion Gravity research article[1] as published in March, 2019. Further research and experiment or observations should refine or confirm the implications for local and for larger scales of astrophysics, such as the flattening of the galactic rotation curves as shown in section 5. as well as other theories relating to gravitation as it applies to larger scales of the universe. Dark Matter may be "accounted for" by the relative mass diffusion between objects and the variable ambient vacuum. Further models will provide similar accounting for the dark energy "requirement". Future development will continue with design of experiments and observations towards confirmation of the underlying gravity mechanisms and their applications. This Diffusion Gravity project continues its heuristic development trajectory, with incremental model additions for dynamics, scalability to astrophysics and cosmology, and the further broadening of its scope.

References:

1. DH Fulton, *Diffusion Gravity: An Heuristic Model.* ResearchGate Preprint, March 2019.

2. Casimir, H. B. G. *On the attraction between two perfectly conducting plates*. *Proc. K. Ned. Akad. Wet.* **51**, 793–795 (1948).

3. Urban, Marcel; Couchot, F.;Sarazin, X; Djannati-Atai, A *The Quantum Vacuum as the Origin of the Speed of Light* arxiv: 1302.6165v1.

4. Welty, Wicks, Wilson, **Fundamentals of Momentum, Heat, and Mass Transfer**, Wiley, 1969.

5. E.L. Cussler, **Diffusion and Mass Transfer**, Cambridge, 1984.

6. Rafelski, Johann; Birrell, Jeremiah. *Dynamical Emergence of the Universe into the False Vacuum*. ArXiv: 1510.05001v2.

7. Rafelski, Johann; Labun, Lance; Hadad, Yaron, Chen, Pisin. *Quantum Vacuum Structure and Cosmology* ArXiv: 0909 2989v1 16 September 2009.

8. Sasso, D. *Gravitational Casimir Effect: From the Virtual Quantum Vacuum to the Physical Vacuum*. Researchgate Article, May 2016.