Diffusion Gravity(8):
Asymmetric Near-Field Gravity in MOND

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Abstract

This report presents a Diffusion Gravity model for the MOdified Newtonian Dynamics (MOND) "standard" interpolating function through geometry of the Poisson equation of gravity, wherein we hypothesize additional gravity due to ***near-field*** *gravity* effects proximate to a star, i.e., between the star and its Lagrange point L1. That is, at the very large mass ratios ($\sim 10^{11}$) and distance ratios ($\sim 10^{20}$) of galaxies to stars, the L1 is very near the orbiting star. And at very large mass ratio's of $\sim 10^{11}$, resultant extreme asymmetry of the gravitational field gradient around the L1 point generates a ***near-field*** gravity potential $\phi_{\mathbf{NF}}$**,** analogous to the near-field of electromagnetism (EM), adding to the total gravitational acceleration between the star and its galaxy. This model uses the Dirac Large Numbers Hypothesis to suggest an asymmetric Newtonian force law $F=GMm/r_1r_2$ and near-field methods of EM to present a causal explanation for the constant velocity of stars within galaxies.

Introduction

Large Galactic Scaling Ratios, or GSR's, which are not observed in smaller scale solar system gravity, cause near-field inductive-reactive gravitational behavior of very dense virtual particle streams (Diffusion Gravity) in the near-field that adds to Newtonian gravity and corresponds to the MOND interpolating function. The model reflects an increased acceleration Δg, which is more commonly presented as

$$\mathbf{a}_{\dagger} = \sqrt{\mathbf{a}_0 \mathbf{a}_N} \tag{1}$$

where a_0 is a constant of value 1.2×10^{-10} m/sec^2 and a_N is the Newtonian gravity. Asymmetric Near-Field gravity (ASNF) proposes an alternative to the "dark matter" paradigm: i.e., the strong ***near-field*** gravity effect manifests as *constant velocity* of the star, independent of the distance from the center of the galaxy. Consider that gravity is normally a "weak" force that is 10^{-40} the magnitude of the EM force; this important difference was studied by the physicist P.A.M. Dirac, in his 1937 Large Numbers Hypothesis [36-38], wherein the magnitude difference of 10^{40} between electromagnetism and gravity is seemingly an "irreconcilable" challenge in terms of likening or comparing the two phenomena, let alone the measurement and control of gravity. The proposal is that in the extreme case of the L1 point being very near an orbiting star, we find compressed gravitational potential; sufficient enough to force the constant velocity of orbiting stars. Within the concentrated near-field gravity of the orbiting star, there is an extreme gradient, i.e., force. Large enough ratios of mass and distance ***boost*** the gravitational force out of a "weak" field regime to a strong localized near-field. This is expressed quantitatively as the product of the Galactic Scaling Ratio and the constant **G**:

$$F = G \times GSR = G \frac{Mm}{r_1 r_2} \tag{2}$$

Where G is the gravitational constant, M = Galactic mass inside Sun's orbit, m = Sun mass, r_1= distance to the center of the galaxy, and r_2 = distance from star to L1 with its galaxy. The Galactic Scaling Ratio (GSR) for our own Sun is thus obtained **~10^{71} /~10^{29}** which results in **~10^{42}**, using our best current estimates for masses and distances in the current literature. This suggests a modified *force law different* from the standard Newtonian gravity equation **$F = GMm/r^2$**. Equation (2) more properly expresses the extreme *asymmetry*, where we know that the distance r_2 to the L1 point will always remain extremely small relative to r_1. Moreover, this stronger *near-field* gravity enables each star to adjust its position relative to its L1 point [40], in accordance with the ***principle of least action***, or, the inductive-reactive near-field gravitational "impedance matching" near the L1 point (which is at zero potential). See Appendix 1 for calculations for this PoLA effect.

The proximity of the L1 point to the star (asymmetry) also has implications for *metric* theories of gravity: since the proximity of the zero-potential point will distort and obviate the applications such as idealized spherical metrics of Schwarzschild, resulting instead in the Sun as a gravitational multipole "radiator" that is highly influenced, i.e., essentially powered by the galaxy. Weyl attempted in 1918 [41] to "derate" EM by "forcing" it into GR, but that effort was deemed unsuccessful and "unphysical". We do not attempt to fit either EM or gravity into the other, but instead observe and apply near-field effects generally as nature presents to us.

Section 1 Asymmetric Near-Field Gravity with Respect to MOND

Researchers have proposed to explain constant velocity profiles of stars in their orbits within galaxies with "dark matter" (DM) searches, models, observations, and simulations. In parallel with that mainstream DM research, there are continuing Modified Gravity (MOG) efforts toward empirical characterization such as Milgrom [11] MOdified Newtonian Dynamics (MOND), supported by observations and investigations by McGaugh, et al. [12], which seek to adapt or modify Newtonian gravity. Related theories include relativistic MOND, the related Radial Acceleration Relation (RAR) [8], and attempts to reconcile MOND with general relativity (e.g. Weyl conformal gravity). These investigations strive to fit theory to the growing observational data that supports the empirical paradigm of the Baryonic Tully Fisher relation

$$v^4 = a_0 GM \tag{3}$$

where a_0 has been empirically established to be 1.2 x 10^{-10} m/sec^2. To support the different theories, investigators have built extensive observational databases to test statistical fits with their given theory or to propose new models. Research includes complex simulations that *post hoc* attempt to determine a model that describes dark matter, but these have not provided *predictive* models (McGaugh). MOND investigators continue to observe and characterize the acceleration "constant" a_0, for thousands of galaxies, along with the a_0 "radius" of a galaxy, at which point the rotational velocity of stars becomes *independent* of the radial distance from the galactic center. The *source* of the additional acceleration to maintain the constant velocity is so far ***unknown***, which inevitably has led to the dark matter paradigm in order to "salvage" the standard model of gravitation and cosmology. The *source* of the additional acceleration is the subject of this paper, wherein we propose a Diffusion Gravity model with a causal-mechanism for the observed *asymmetric equipotential-configurations (E-P)* of stars in their galactic orbits, through *near-field gravity* and the *principle of least action*.

The conceptual model for ASNF starts with the MOND "standard" interpolating function [1],

$$F_{MOND} = \sqrt{\frac{1}{2} + \frac{1}{2}\sqrt{1 + \left[\frac{2a_0}{|a_N|}\right]^2}} \tag{4}$$

This is the established mathematical description of the acceleration variation between close Newtonian gravity and deep-MOND regime gravitational acceleration; it is *only* a mathematical construct that describes and compensates for the acceleration difference quantitatively. In this current DG paper we propose the mechanism for **near-field** gravity, that gives physical reality-causality to that purely mathematical MOND interpolating function. The key to our approach is the enormous scale differences (ratios of $\mathbf{M_{GAL}/m_{STAR}}$ and $\mathbf{R_{GAL}/r_{STAR}}$, where r_{STAR} is the distance from the star to its L1 point with the galaxy). The Galactic Scaling Ratio (GSR) in turn causes the orbiting stars to be ***very near*** their respective L1 Lagrange points with their galaxy. It is from this disparity, or very large ratio, that we ascribe "asymmetry", to show the *reactive and inductive* effects on gravitation as caused by the extreme proximity, i.e., the compression in the gravitational potential "near-field" that *amplifies* the Newtonian gravitational field. We invoke the analogy between electromagnetism and gravity to describe a "near-field" gravitational effect that is NOT SEEN in our familiar "symmetric" Newtonian gravity configurations such as our solar system. This concept essentially suggests that the enormous scaling ratios generate an additional acceleration due to the proximity to the Star-Galaxy L1 point. This can and will be shown as a geometric model with the mathematical MOND "standard" interpolating function that translates to physical model of virtual particle flows. Specific experimental and observational events shall be used to support and validate the DG model, and will be covered in Section 4. The conclusion section 5 will summarize the ASNF gravity and the overall Diffusion Gravity theory, and the ASNF Gravity implications for prevailing or standard gravitational theories and evidence. The presentation follows a logical development of the concept-to-model for maximum clarity and ease of understanding:

Section 1 - Asymmetric Near Field Gravity Definition and L1 point proximity, Very Large Galactic Scaling Ratios

Section 1a Summary of Gravitational analogies to Electromagnetism

Section 2 Diffusion Gravity model correspondence to the MOND interpolating function and Poisson near-field gravity

Section 3 Mechanism of DG Near Field model application to MOND

Section 4 Evidence and observation examples supporting DG ASNF gravity and

Previous DG research papers [17-23] detail the virtual particle propagation (i.e., by diffusion) and interaction-annihilation between masses as the causal mechanism for gravity. Upon that DG foundational model we added subsequent models to address related phenomena of dynamic behaviours, including an exact quantum mechanical attraction mechanism, a conceptual alternative for dark matter to explain constant velocity orbits in galaxies, perihelion precession of planet Mercury, and deflection of light near the Sun. The basic concept of Diffusion Gravity is illustrated in Figure 8-1 as a review of the virtual particle model.

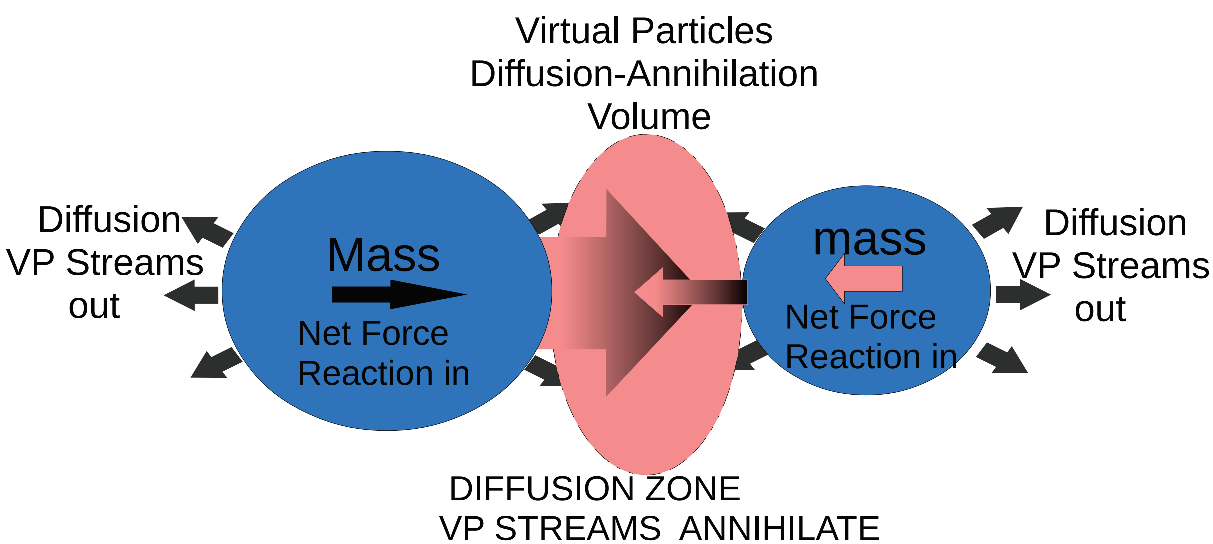


Figure 8-1 Concept Diagram of Diffusion Gravity Model

Galactic Scaling Ratios (GSRs) Equi-Potential Points and Asymmetry of the Near-Field

The prevailing science that **Newtonian gravity behaves equally at all scales** of mass and distance in galaxies is ***no more credible*** than the assumption that massive quantities of invisible, or “dark matter” make up large proportions of those galaxies. GSR’s can be calculated from observations and estimates for mass and distance; this enables researchers to determine the scale ratios for thousand of galaxies, and to characterize their constant velocity profiles. For example, the Sun in the Milky Way Galaxy (MWG) mass and distance scaling ratio (NO dark matter included)

Galactic Scaling Ratio = M/m

is estimated on the order of 10^{11} [NASA-]; the ratios for galaxies range from 10^8 for $M_☼$(for dwarf and ultra-diffuse) to $10^{12}{}_☼$ (for super-spirals). Distance scales (size) of galaxies range from dwarf size radius of ~10k light years to ~200k light years [ ]. By using Newtonian gravity potentials we find a star's L1 Lagrange or EquiPotential (E-P) balance point with its parent galaxy between the center of the galaxy and an orbiting star mass (e.g., see Zhao in [10]); we equate the two potentials (galactic and star) to find that point,

$$GM/R = Gm/r \tag{5}$$

Where M and m are masses of the galaxy and star, and R and r are the distances to the equal-potential gravitational point between them. As the ratio between M and m increases, so too will the ratio of R/r increase, as indicated by the simplified equation

$$M/m = R/r \tag{6}$$

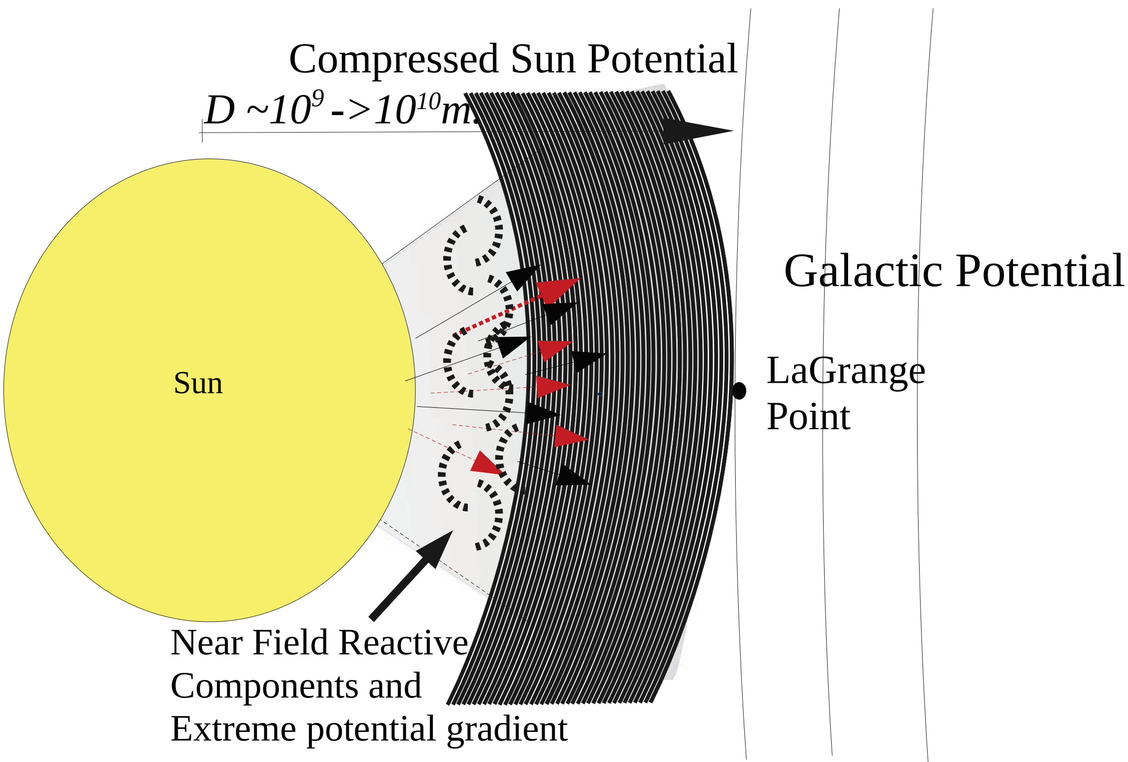
which then gives the *distance* of the L1 or E-P point to the orbiting star, for example, the Sun has an estimated mass ratio with the MWG (within the Sun's distance to the Galactic center) of ~ M/m = 10^{11} and ~R_{Gal} = 10^{20} meters/r, which yields **r_{L1} = 10^9 meters (one million kilometers)** in the direction of the Galaxy core. This ratio of the distances for the L1 point of the Sun/star will create a configuration of gravity that ***does not*** normally occur at our more familiar solar system experience scales. That is, the extreme ***proximity*** of the L1 point to the star (but **not** coincident upon it) causes a concentrated, high density gravitational potential as referenced to the L1 point between the star and the galaxy. This is analogous to the electromagnetic *"near-field"* in electromagnetic propagation, which is found within a small number of wavelengths (i.e., the Fraunhofer distance) of the emitter of the radiative field (antenna). This is illustrated in Figure 8-3, which shows an augmented or amplified Poisson volume model, which induces a local gravity effect. At the massive scaling ratio between the galactic central mass and the orbiting stars, the asymmetry of the *virtual particle flows* from the star will thereby add to the DG virtual particle attraction mechanism from the galactic core to augment the Newtonian acceleration. [Note: This is not related to the Yukawa potential, that has been disproven previously in the Eot-Wash experiments as source of MOND acceleration]. The implication is that galaxies are much more than a captive assemblage of stars; they are ***active dynamo's,*** that through the GSR drive the constant velocity of the stars in their orbits within those galaxies. This is normally expressed in the interpolating function [1] shown in equation (4), which will use as the geometric "wire-frame" model to express the ASNF mechanism. To put this into perspective, we first briefly provide a history of gravitation theory towards matching and attempts at combining gravity with electromagnetism.

Section 1a Summary of Electromagnetism-Gravity Analogy Theories

There have been extensive efforts to adapt Maxwell's electromagnetic field equations into an analogous set of gravitational field equations. In 1893, Oliver Heaviside presented a research article [16] on his work towards that end. Weyl in 1918 published his conformal gravity theory that attempted to unify general relativity with electrodynamics; he attempted to "derate" EM to "match" gravitation magnitude, which is completely incompatible and unphysical. Oleg Jefimenko revived Heaviside's work [15] by adding dynamic, time-based equations of gravity, in which two components correspond to both the **E** and **H** fields in electromagnetics. Jefimenko called the additional component "cogravity", that corresponds to the time dependent H-field of EM. A more recent study of the many researchers and their attempts to add this "cogravitation" term was published by Behera and Barik as a "vector" gravity that draws upon the works of both Maxwell and Heaviside, combining them into "Heaviside-Maxwell Gravity (HMG)". Fedosin and more recently Borodikhin have also proposed vector based gravity similar to HMG; many more researchers have published their theories and models as the Gravito-Electromagnetic or GEM theory of gravitation [44]. These theories attempt to modify the energy of the field by adding an analogous magnetic component coupled with motion to correspond with the EM field symmetry between the electric and magnetic field. The scalar-tensor theories such as Brans-Dicke, Scale-Invariant Dynamics (SIV), and others have had varying levels of success in retro-fitting GR and the consequent ΛCDM model with "fixative" mathematics. Closely related to the GEM approach is the correction to relativity in various ways, such as "*f(r)* gravity", "emergent gravity" and "conformal gravity". Another approach from an electromagnetic analogy perspective is that of "refractive gravity", wherein a modification of permittivity constant ε is used as a free parameter to invoke additional gravitational acceleration in vacuum. However, the effect would alter the vacuum in such a way that cannot be localized. There have also been revivals of Lesage and Nicolas Fatio de Duillier gravity that first appeared around 1690. The current incarnation of this idea is "impact gravity" by Wilhelm and Dwividi [17].

This research report will not review all these previous approaches in further detail, but will instead reference any relevant portions of their work to the current application of Diffusion Gravity.

The incongruities between EM and Gravity that prevent "unification" continue to be both **scale** (10^{40} magnitude difference) and **symmetry** (unipole vice multipole).



$$\Phi_{TOT_P} = \Phi_{Newton} + \Phi_{NearField}$$

Figure 8-2 The Concentrated Near-Field of Gravity

Section 2 The DG Model for MOND Corresponds to Virtual Particle Flows

The claim made in this research report is that gravity has a near-field special configuration (analogous to electromagnetic near-field) that is different from the familiar far-field of gravity. The model invokes the same principles as near-field electromagnetics to postulate a gravitational analogue, which is NOT detectable in most gravitational configurations. The near-field of gravity will ONLY occur in very large distance and mass ratios, as found in the galaxy scales, due to the disparity of mass between the central or core mass of the galaxy and the orbiting stars. Compression of the field (potential) gradient is the result, which induces an additional acceleration between the L1 and the orbiting star. The asymmetry of this configuration is diagrammed in **Figure 8-2**, where the potential contours are much denser inside the L1 point than outside.

With these foundation concepts in hand of near-field gravitation as an effect of asymmetry and the Galactic Scaling Ratios, now we proceed to show MOND correspondence to the geometry of near-field gravitation as an effect of asymmetric, GSR configurations that give rise to additional gravity. MOND shows that this effect occurs in galaxies beyond the "a_0 radius" where Newtonian acceleration equals the MOND acceleration constant $\mathbf{a_0 = a_{Newtonion}}$, or around 8K Light Years (ly) for the Milky Way Galaxy. Beyond the $\mathbf{a_0}$ radius, stars are not gravitationally "locked", i.e., $\nabla^2 \boldsymbol{\phi} \neq 0$ to their galaxy (see details in [29]), so the mechanism presented herein becomes increasingly prominent as the force of asymmetric gravity.

Having presented the MOND standard interpolating function, we can develop a model for the application to Diffusion Gravity and its virtual particle flows. The correspondence of the interpolating function as a mathematical construct is with the *steradian* geometry, and specifically the conical radiation pattern of virtual particles that emanate from star masses toward their L1. In this geometric model, the gravitational force will depend on the quantity of virtual particle flows out of the star/Sun, and that the flow will vary proportionally as the height of a cone of virtual particle flows toward the L1 point as shown in Figure 8-3. This connects interpolating equations to geometric steradial virtual particle flows from Diffusion Gravity[3], and to the scale ratios of galaxies. All of the virtual particles flowing through the steradian cone will arrive at the "lens cap" for annihilation by incoming galactic virtual particle flows; the volume of the "lens cap" is a steradial section of volume $R^3/3$ minus the volume of the cone, which is $R^3 - .617\, R^3/3 = .383\, R^3/3 = .128\, R^3$; this is a highly concentrated V.P. annihilation zone, which qualitatively indicates a strong force of attraction.

Diffusion Gravity shows in this model iteration how the geometry of the MOND force, $F_{MOND,}$ corresponds to the conical geometry of virtual particle flows; the geometric model mechanism shows how the added gravity applies to the Modified Newtonian Dynamics (MOND) as given by the "standard" interpolation function

$$F_{MOND} = \sqrt{\frac{1}{2} + \frac{1}{2}\sqrt{1 + \left[\frac{2a_0}{|a_N|}\right]^2}} \qquad (7)$$

which we can now *equate* to the equation for surface area of a cone [28]

$$S_{areacone} = \pi R^2 + \pi R^2 \sqrt{1 + \frac{h^2}{R^2}} \tag{8}$$

where the surface area of a cone is the area of the base of radius *R*, plus the area of the conical surface above the base, of height *h*.

The MOND acceleration is then calculated by the geometric application of the interpolating function

$$a_{MOND} = -\frac{GM}{(2R^2)} - \frac{GM}{(2R^2)} \sqrt{\left(1 + 4\frac{r^2}{R^2}\right)} \tag{9}$$

So, now the acceleration for MOND is visualized as the cone's surface; then acceleration for the interpolation function becomes

$$a_{MOND} = -\frac{GM}{R^2}\left[\frac{1}{2} + \frac{1}{2}\sqrt{\left(1 + 4\frac{r^2}{R^2}\right)}\right] \tag{10}$$

The cone in this case is a *steradian cone of gravitation* emanating from the star toward the Lagrange point as shown in Figure 8-3. This will translate to the Gaussian flux and will be shown in Section 3.

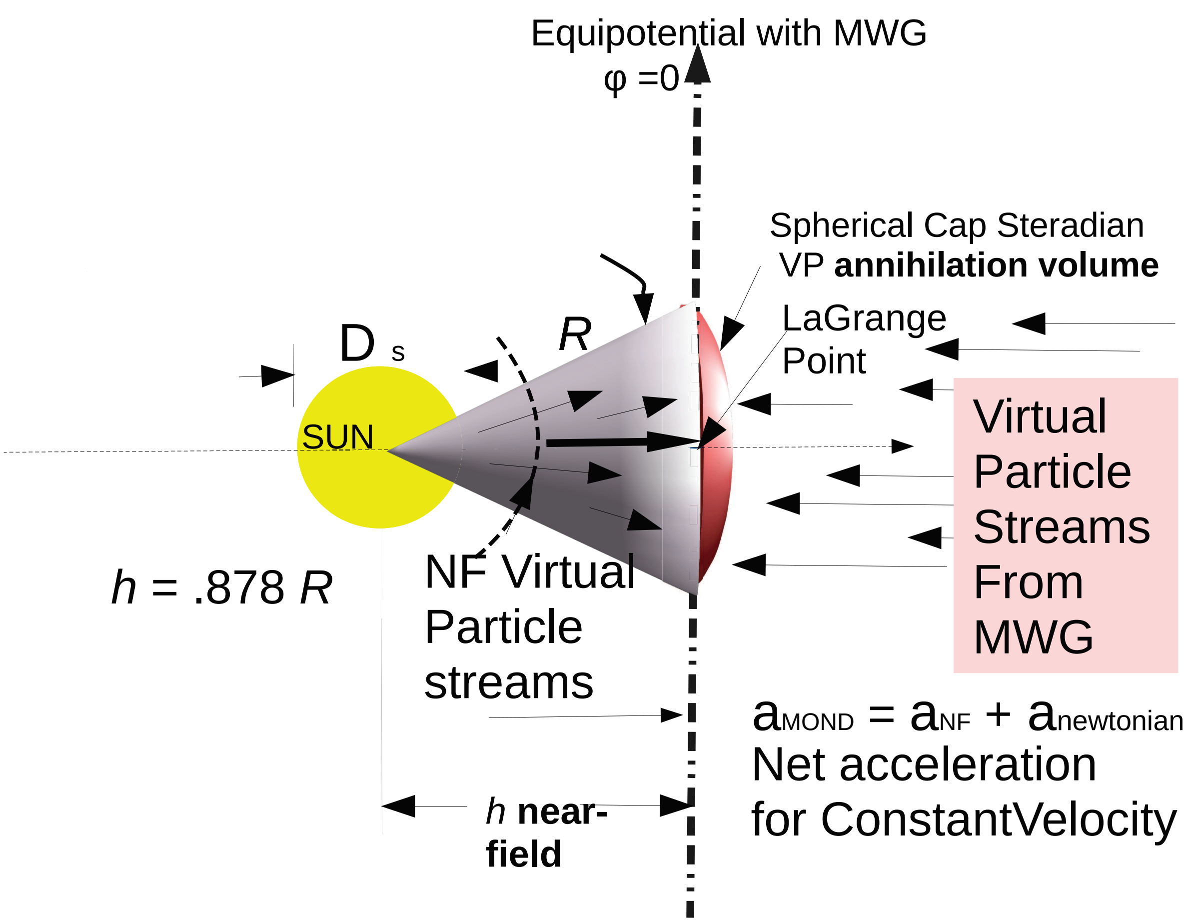


Figure 8-3 MOND geometric Virtual Particle Flows

where the resultant *additional* gravitational acceleration corrrespondingly enforces the ***principle of least action*** upon the orbiting star [see Appendix I], and thus can explain the galactic constant velocity of stars in galaxies. This model shows how the "compressed" and concentrated gravitational field between the star and Lagrange point actually *amplifies* acceleration for ALL stars that are outside the a_0 radius of the galaxy, and that we observe as the MOND phenomenon. In an analogy to EM, we can further use the terminology and methods of antenna engineering, defining the "near field" distance given by the analogous-EM Fraunhofer distance (for radiating dipole antenna) given by

$$d = \frac{2D^2}{\lambda} = 4D \qquad (11)$$

where D is the diameter of the star, and $\lambda = D/2$, which is the radius of the star (as estimates). This would be an EM near field simple model for a simple symmetric finite dipole antenna [13]. By using such an EM visualization, therefore, you can easily see that the distance *d* from a star to its L1 may increase to 4 diameters of the orbiting star and still be within the ***near-field*** gravity that is determined by the galactic scaling ratio given by

$$M_{GAL}/M_{sun} = 2 \times 10^{11}$$

as calculated by Burbidge [43] in 1975 using dwarf satellite galaxy dynamics. This has been confirmed and recently reaffirmed by Odenwald as 4×10^{11} solar masses from S. Odenwald and NASA [27].

This Diffusion Gravity model presented so far, then, provides causality of behavior for a star in the MOND regime, under "near field" gravitational influence, as created by the asymmetry of its near-field as compared to its galaxy. The empirical argument presented here can lead to a more rigorous mathematical model that can demonstrate and calculate the near-field reactive energy from this perspective. The GSR then, has provided us an environment, or laboratory, wherein we see the *gravitational field* on "par" with EM ($\sim 10^{40}$), such that we can use the tools developed over many years to analyze and control EM fields near antennae or any other energy radiating systems. In the next sections of this paper we briefly present the mathematical method of Multipole Expansion to show the gravitational near-field effect that is supplying the additional gravitation from the Sun, if we model the Sun as a radiator of gravitational energy in a concentrated near-field environment, as we might model an EM antenna system and its near-field energy.

Section 3 Equivalent Mechanism of the MOND Interpolating Function

Extensive work has refined the interpolating function that best describes the MOND behavior mathematically.   But, as N. Klein has stated [1], “It is important to note that no particular choice of the MOND interpolation function is outstanding with regards to any possible *physical* explanation of MOND effects...” The important objective in this paper is to propose the underlying physical mechanism that actually ***does*** connect the Interpolating (mathematical) Function (IF) of MOND to the constant-velocity galactic phenomenon. To do this we analyze the IF with respect to the basic Poisson equation and our near-field gravity theory close to a gravitating star. The cone-shaped function translates to the total *surface area* of a steradian volume, with the surface of the cone then translating through the Gauss theorem equivalent *flux* which radiates from the star to the cone lens cap where the L1 point lies. The highly compressed and concentrated flow of virtual particles is annihilated by the Diffusion Gravity mechanism within the “lens cap”, of the steradian volume around L1 point. The proof can be carried to the mathematical expression of the fields in the volume around the Sun and the L1 point (a “singularity” for $\phi = 0$). The approach is to treat the Sun as a multipole radiator, but with the a zero point at L1 on the surface of an ellipsoid shell at distance D from the center of the Sun. The mathematical model will yield a finite, real, positive value for the steradian flux generating near field out to L1.

Multipole Expansion approach to the ASNF

Extensive work has been done in EM to determine the characteristics and the energy in the near-field regime of multipole radiators.   More recently this has been refined into techniques for calculating the parameters using multipole expansion series, such as the Wilcox expansion and the Weyl expansion, which assists engineers in a practical way to determine near field reactive magnitudes and energies.   The general approach is to use the multipole expansion, from [21,23] for gravity

$$\Phi(r,\theta,\varphi) \;=\; \sum_{a=0}^{r} \delta\phi(ext) \;+\; \sum_{a=r}^{\infty} \delta\phi(nf) \tag{12}$$

Where the potential in spherical coordinates is comprised of both an external field and the near field as proposed by the model. The general case is for a single source radiator; however we develop this to include the influence of the amplified field, i.e., to include the “boosted” gravity in the near field between the star and L1 point (zero potential).   The above equation elaborates to

$$\Phi(r,\phi,\theta)=-4\pi G\sum_{l,m}^{\infty}\frac{Y_l^m(\theta,\phi)}{2l+1}\left(\frac{1}{r^l+1}\int_0^Y\rho_{lm}(a)a^{l+2}\ da\ +\ r^l\int_r^{\infty}\rho_{lm}\ \frac{da}{a^{l-1}}(a)\right) \tag{13}$$

with gravitational potential then as a summation of the multipole contribution approximations. The variables are **ρ** for mass density within a volume of radius **a**, with the multipole summation yielding the total potential **Φ** . Further details continue to be developed in subsequent research, to arrive at the quantitative aspects of the scalar acceleration increases. References are given in Jackson [14], and Binney [21]. Mikki and Antar [23] have recently done extensive development of multipole analysis using the Wilcox expansion to show the near-field is both *real and positive* valued, and clarify the ambiguities that have traditionally clouded the role and magnitude of the near-field reactive and inductive contributions to the overall energy of the field. This presentation has been for the purpose of qualitatively showing the absolute reality of the near-field in many applications heretofore, including the Thorne and Binney presentations on multipole expansion for gravity from the 1980's.

Section 4 Evidence Supporting ASNF; Experiments and Observations and Experiments Proposed for Validation and Verification of the ASNF Diffusion Gravity Model

The important factor in the DG model is the scaling ratio (mass and distance) that gives rise to the diffusion "prime mover" that is then amplified by the geometry and the reactive components to enforce the ***principle of least action*** in maintaining constant velocities for stars within galaxies. From the solar system limited perspective, it is apparent that astrophysical science does not have broad enough scope to formulate a theory that covers galactic and larger scales; hence the struggle with the MOND-type theories that are contradictory observationally to "accepted theory" and the ΛCDM standard model of cosmology. Four distinct classes of evidence now support the ASNF gravity model:

(1) The large database of observations of galaxies that display **constant velocity rotation curves** shows that an actual force-mechanism is operative which is not accounted for in either standard Newtonian mechanics, or in the general theory of relativity (GR), or even in MOND. The interpolating function implies a geometric additional acceleration that includes a_0 for orbiting stars relative to the core of the galaxy. The evidence shows that this is a universal phenomenon, that cannot be supported by *ad hoc* dark matter models, which fundamentally do not offer *material* evidence. DG offers the ASNF model of gravity to account for, through the interpolating function and a virtual particle flow model, which is due to the near-field effects and the GSR asymmetry to "*boost*" gravity to EM levels near the L1 point for each star.

(2) A second class of evidence has arisen from the measurement of flyby anomalies near the Sun by masses such as the recent U17 (Oumaumau) and similar anomalous acceleration of satellites that travel near the Sun. The recent flyby by the asteroid U17 Oumaumau gives a unique opportunity to demonstrate the hypothesis of ASNF gravity presented in this paper. There was a notable anomalous acceleration of 5.0 x 10^{-6} m/sec^2 [ ] as the object moved away from the Sun in this *very near* flyby of the Sun in 2017. Note that the object U17 came to within 10^{10} meters of the Sun, so ASNF gravity would certainly have added the acceleration by *near-field gravity* upon the U17 object at that range; i.e., it should be testable against the data set collected on the trajectory of the near-field encounter of that asteroid, to verify the likely near-field added gravitational acceleration during that portion of its hyperbolic trajectory. Measurement data and calculation for this particular object have been published in numerous articles and papers [19]. Our claim here is that the close flyby of the Sun at a peristasis of 3.75 x 10^{10} meters would place it within the near-field gravity between Oumaumau and the L1 with the galaxy.   This also can add supporting data that will help in construction of a more accurate DG model of the ASNF conical near-field gravity between the Sun center and the L1 point.

(3) A third class of evidence supporting our theory is that of ***counter-evidence***, or contrary evidence to support the DG near field model as provided by observations of dwarf satellite galaxies and ultra-diffuse galaxies (UDG) and their profiles and behaviors, that contradict the dark matter approach. Such galaxies as NGC 1052-DF2 and NGC 1052-DF4, are ultra-diffuse dwarf galaxies located in proximity to the elliptical galaxy NGC 1052; both DF2 and DF4 rotate at rates that follow closely Newton's laws of both motion and gravity. Various research reports have documented the recent observations [42] and the surprising absence of "dark matter" content in this group of small galaxies. The *cause* of these results in the range of small galaxy sizes and masses according to the ASNF gravity model could be due to the scaling ratio variations (GSRs) of these small ultra-diffuse galaxies; i.e., the "need or non-need" for dark matter may be a direct result of the mass or distance ratios being t*oo small in some cases*, such that they approach normal Newtonian, or symmetric gravity, and therefore do not have a *near-field* component in their structures and orbits. Data from dwarf satellite galaxies, ultra-diffuse galaxies (UDG) such as DF2 and DF4 adds to ASNF evidence that these may not have enough mass and size to generate the "boost" of ASNF, so they show the more *familiar Newtonian symmetric* mass-distance ratios. We claim that this *counter* evidence adds weight to the the galactic scaling ratio argument, and the fact that it obviates DM with and its "amplification" or non-amplification in small GSR's.

(4) A fourth class of evidence to support the ASNF is the ongoing measurement of the terrestrial Cavendish type experiments that have indicated some MOND-like acceleration [1]. The very fine detail and resolution of these experiments [6] show that "the choice of a particular MOND interpolating function is not motivated by any known physical mechanism. Therefore, the matching of the fitted interpolating function with the galaxy data does suggest - but not prove - that the observed deviations from Newtonian gravity have the same physical origin as the rotation curves of galaxies." These Cavendish experiments as summarized by Klein show that the MOND effect is measurable in terrestrial laboratories. However, at these extremely fine precision levels, the uncertainties are large in the methods and instrumentation. We propose that in the context of these measurements, a factor **not** considered in these measurements is the earth orbit around the Sun, i.e., half of the orbit in the solar system is away from the galactic center, (making the Sun predominant), while the other half, on the galactic side of the Lagrange point (L1) of the Sun in the galaxy, the galactic influence would have a measurable *differential* effect. This asymmetry has been presented and analyzed in the DG 5 paper [31] "Perihelion Precessions as Indicators of Galactic Gravity", wherein the precession of Mercury was proved to be partly the result of galactic torque, that was stronger on the galactic side of the Sun. Therefore the proposal from this is to repeat those very fine precision Cavendish terrestrial experiments to determine any differences at opposite times of the year (earth on galaxy side vice opposite in yearly orbit).

(5) A satellite mission by NASA must locate the exact location of the Sun's L1 point with the galaxy. This would be a search for and location of the equi-potential, or ZERO point of the gravitational potential between the Sun and the galaxy center. It may be very near the Sun, so a flyby mission may need to be as close as $\sim 10^9$ or 10^{10} meters (similar to U17 Oumaumau flyby). Since the L1 point is calculated to be very near the Sun ($\sim 10^{10}$ meters), this would provide refined estimates of true mass at the center of the Milky Way Galaxy, and also substantially confirm the our

DG model of ASNF gravity *is* the causal mechanism underlying MOND. Lacking that satellite mission, the earth based measurements or existing satellite and flyby asteroid data may hold the answer if re-analyzed specifically for that purpose.

Section 5 Conclusions and Further Research

This report has presented a model and its application to explain the constant velocity MOND phenomenon that has conjured the dark matter paradox and other such speculations. The approach used has applied Dirac's Large Numbers Hypothesis (LNH) to bring local star gravity to a "par" level (10^{40}) with EM, so the corresponding tools such as multipole expansions can be meaningfully applied to the galactic scale size and distances as expressed in the Galactic Scaling Ratio. Asymmetry of the concentrated near-field, including inductive and reactive gravity effects of the ASNF are directly analogous to the EM near-field model. We used the MOND Interpolating Function as a geometric "wire-frame" model to build the connection between our near-field gravity model virtual particle flows and the physical reality that produces the added acceleration of MOND.

The ASNF effect can be proven with several types of measurements (solar vicinity), re-analysis of existing data, and confirmed further in the Galactic Scaling Ratios by re-analysis of the select types of galaxies and their rotation curves. No dark matter is required; only the application of concepts of near-field gravitation as presented here that are unique to the vast scaling ratios of galaxies. MOND behavior can thus be ascribed a causal mechanism through addition of near-field gravity in close proximity to orbiting stars, near their L1 points where gravitational fields can be amplified upwards toward parity of magnitude with EM at ~10^{40}. Additional potential is the result of the proximity of the star's L1 point with the galaxy and the corresponding compression of potential created by that proximity. The ultimate *source* of the ASNF potential is the mass at the center of the galaxy, which causes the L1 to be very near the body of the star itself, causing asymmetry of potential gradient between the galaxy side of the star and the local side of the star. Even if the star is further out from the galaxy, out to 200k ly, the distance from the star to L1 is still ~10^{10} meters from the star, so it would be within range of the DG near-field gravity. This supports the GSR modified Newtonian force relation of

$$\boldsymbol{F=G\,Mm/r_1r_2} \qquad (14)$$

for ASNF gravity. Further work will develop the near-field gravity fields that must exist near our Sun in conjunction with the Lagrange L1 point with our galaxy. This paper has striven to show the physics of the constant velocity rotation curves of galaxies and how they ***absolutely*** control the local gravity and geometry of stars in their orbits. This is quite opposite the passive weak field gravity imposed by metric theories

Section 6 AfterWord: Implications for Metric Theories of Gravity; Setting the Record Straight

No attempt has been made to adapt this DG theory to general relativity or any other metric theory of gravity; quite the contrary, since many of the models presented here specifically disprove GR or endeavor to show a better alternative. Multiple research reports have been published by the author to show alternative explanations for the perihelion precession of Mercury, the deflection of light near the Sun, the Shapiro Effect, and the likely *causal* mechanism for gravity. All supporting “evidence” for GR is limited to *plausibility* arguments, and not uniquely or exclusively provable causality. The stunning lack of honesty in crediting other workers is without peer in the paper written by von Einstein in 1915, wherein he appropriates Paul Gerber’s equation from the 1898 published paper [45], and takes it for his own “derivation” of the perihelion precession of Mercury. When confronted in 1920, von Einstein’s defense was that Gerber’s derivation was not correct, “because it did not use General Relativity!” Which is the typical defense of a charlatan. Science must correct this travesty of history and other Intellectual Property Rights (IPR) violations, or science will become religion.

To Wit: All the work in this paper is my own: credit and references provided for all sources.

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Appendix 1

Calculations: Energy in Principle of Least Action Ratio

Alternative to Dark Matter

Addendum to Diffusion GravityProject 11/2019
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Section 1 The PoLA ratio and the Calculation of Sun "Deficit" Acceleration

The recent (11/2019) paper submitted for Diffusion Gravity has presented the conceptual framework and concepts for the Alternative to Dark Matter, including the *Principle of Least Action* and the gravitational Equipotential Surfaces that are the key to the assertion that Nature practices least expenditure of energy in the stellar orbits of galaxies. The calculations shown here are meant to compare *the energy* ***required*** *to keep a star in close proximity to the zero-potential trajectory* (orbit) **vice** *the energy of the orbiting star and its solar system mass. We designate this the* PoLA (Principle of Least Action) ratio:

$$\mathbf{PoLA} = \frac{\textbf{EP-energy of star}}{\textbf{Kinetic-energy of star}} = \frac{\mathbf{m a_{EP} r_{EP}}}{\mathbf{\tfrac{1}{2} m v^2}}$$

where

m is the mass of the star plus its solar system, as (wikipedia) 1.0014 solar mass=2.0028 x 10^{30} kg.
$\mathbf{a_{EP}}$ is the acceleration needed to keep the star near the zero-potential contour = to be calculated here.
$\mathbf{r_{EP}}$ is the radius distance from the star needed to keep it "on track" for the Least Action= .75x10^9 meters
v is the constant velocity of the star = 230 km/sec for the Sun and solar system

We are calculating the "deficit" acceleration as portrayed in the "Diffusion Gravity: An Alternative to Dark Matter" research paper. This is the difference between the apparent acceleration obtained from classical Newtonian mechanics:

$$ma = GMm/r^2$$

$$a_{NEWT} = GM/r^2$$

Now, comparing the two different calculations, assuming

G = Universal Gravitational Constant = 6.67 x 10^{-11} $m^3/kg\ m^2$
M = Mass Milky Way inside Sun radius = 9 x 10^{10} solar mass x 2.0028 10^{30} kg = 18.03 x 10^{40} kg (this is an estimate, since there is continuing uncertainty in the mass of Milky Way Galaxy) luminous matter in the Milky Way Galaxy, taken as 9x10^{10} solar masses, inside the Sun's radius.
m = Mass of the Sun/Solar System = 2.0028 x 10^{30} kg
r = Distance from Milky Way Center of Sun = 2.6 x 10^{20} m
v = Velocity of the Sun (average) in orbit of Milky Way Galaxy = 230 x10^3 m/sec

The Newtonian acceleration the Sun

$$= \sqrt{}(6.67 \times 10^{-11})(9 \times 10^{10} \text{ solar mass})(2.001 \times 10^{30} \text{ kg/solar-mass})/(2.6 \times 10^{20} \text{ m})^2$$

$$GM/r^2 = (12.09 \times 10^{30}/6.76 \times 10^{40})$$

$$a_{NEWT} = 1.78 \times 10^{-10} \text{ m/sec}^2$$

And the $ma = mv^2/r$ Kepler law gives observed centripetal accel $a_r = v^2/r = (230 \times 10^3 \text{ m/sec})^2 / 2.6 \times 10^{20}$ m

$$a_r = 5.29 \times 10^{10} / 2.6 \times 10^{-10} \text{ m/sec}^2$$

$$a_r = 2.03 \times 10^{-10} \text{ m/sec}^2$$

This gives the shortfall or deficit of acceleration from visible matter to the Keplerian observed centripetal acceleration to be

$$a_{deficit} = a_r - a_{NEWT} = 2.03 \times 10^{-10} - 1.78 \times 10^{-10} \text{ m/sec}^2$$

$$a_{deficit} = 0.25 \text{ m/sec}^2 \text{x } 10^{-10}$$

Comparing the two values gives an estimate based on widely available and accepted measured physical values and constants.

The above calculations are primarily meant to show (qualitatively) that there is a deficit, or shortfall of the acceleration from the estimates of visible matter provided by various sources (the “official” estimates contribute to have uncertainty). The number is likely conservative, and there are higher estimates now available for the mass of the Milky Way Galaxy, but these have not been verified to the extent of the 9×10^9 sm used here, and many contain dark matter estimates. The perceived shortfall of acceleration can be modelled and explained with possible alternatives to dark matter. The primary method for the Diffusion Gravity model is to apply the the *Principle of Least Action* and the Equipotential surface proximate to the Sun’s orbit to determine the amount of energy that is required to compensate for the shortfall. In the case of the Sun, we showed that the centripetal a_r “needed” to equal the Keplerian “required” by v^2/r (that is observed) may be in the 0.25×10^{-10} m/sec^2 range. Subsequent research will be provided that shows a near-field gravity mechanism that tunes the location of each star to enforce the PoLA.

Section 2 Applying Diffusion Gravity Principle of Least Action (PoLA) model to acceleration deficit using Energy Considerations

This section applies the DG Model with its PoLA assumption, wherein a mechanism shown in the research paper “Diffusion Gravity (4): An Alternative to Dark Matter” is used as an explanation for the perceived deficit of Newtonian acceleration as calculated in the previous section 1.

So we can now calculate the amount of energy per $.1 \times 10^{-10}$ m/sec^2 so we can use a linear model for the amount of energy to keep the Sun near the equipotential surface.

Force x Distance = Work = Energy

mass x acceleration x distance = energy needed to keep the Sun near the equipotential surface. Mass of the sun is 2.004 x 10^{30} kg; distance assumed [4] is the half diameter of the Sun = .75 x 10^9 m. So for each .1 x 10^{-10} increment of acceleration, the energy needed would be

$$(2.004 \times 10^{30}\,\text{kg})(.1 \times 10^{-10}\,\text{m/sec}^2)(.75 \times 10^9\,\text{m}) = .150 \times 10^{29}\ \text{joule}$$

If we compare that to the energy of the Sun moving in its orbit

$$\tfrac{1}{2} mv^2 = (1.002 \times 10^{30}\,\text{kg})(230\,\text{km/sec})^2 = 5.30 \times 10^{40}\ \text{joule}$$

So the ratio or fraction of the energy needed to keep the sun in a *least-action proximity* to the equipotential surface per 0.1 x 10^{-10} acceleration (to compensate for the shortfall due to "missing" matter) is

$$\frac{.150 \times 10^{29}}{5.30 \times 10^{40}} = \mathbf{.0283 \times 10^{-11} = 2.83 \times 10^{-13}} \quad \textbf{\sim 3 parts in ten trillion}$$

The importance is that it is a tiny amount required per "nudge" to keep the Sun (or any star) in it's minimal energy path. The constant velocity therefore can easily be maintained by this mechanism of "least action" that requires minimal energy. The Diffusion Gravity gradient provides the driving force to implement this "minimizer" energy function near the equipotential surface, as was portrayed in Section 2 in the work cited[4]. Even if a star required a "nudge" of .25 x 10^{-10} as we calculated in section 1 above, that would make a minute difference in the amount of energy needed as a percentage of the kinetic energy of the star. For the Sun in these calculations, .25/.1 = 2.5 x 2.83 x 10^{-13} will still amount only to about 9 parts in ten trillion. We conclude that the PoLA is very much likely in operation and an essential part of the dynamics of galactic rotation curves.

The increases in some velocity profiles suggest that the process of energy transfer from the kinetic to the transverse (centripetal) a_r and the reverse process also, where the Milky Way Galaxy may impart additional acceleration a to increase the velocity of the stars. The PoLA mechanism shown, therefore, may be symmetric, so that changes in a_r could change v, which suggests that the process may not be strictly entropic, but reversible. The galactic rotation profiles can be indicators then, of an energy exchange process that is operating to flatten or even increase the velocities of the stars in their orbits. This may be in the form of harmonic variations in a_r, or some similar mechanism that ensures a constant star velocity with a gravitational mechanism.

These model concepts for the Diffusion Gravity model show that there is a very viable alternative to dark matter through the Milky Way Galaxy dynamics, which does not depend on a halo of dark matter.

Section 3 Conclusion

These PoLA and Equipotential surface concepts and component model extensions of the Diffusion Gravity Model will be incorporated and integrated into the DG Theory in subsequent additional research papers. Nature practices extreme conservation and efficiency even at galactic scale.

Reference:

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