Diffusion Gravity (9) : Direct Evidence for MOND and Asymmetric Near-Field Gravity from the Solar Flyby of 1I/2017 U1

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Abstract

The observed anomalous acceleration in the hyperbolic trajectory of asteroid 1I/2017 U1 "Oumaumau" corresponds precisely to MOdified Newtonian Dynamics (MOND) acceleration near the Sun. This *direct* evidence also supports the Diffusion Gravity (DG) premise that galaxies generate *additional* control over their population of stars via Asymmetric Near-Field (ASNF) gravity, generated by the enormous "leverage" of galactic masses and distances, expressed through a *Galactic Scaling Ratio (GSR)* and the *Dirac Large Number Hypothesis (LNH)*, which together suggest a *near-field* radial acceleration for stars that orbit outside the MOND radius, $r_M=\sqrt{(GM/a_0)}$, where $a_0= 1.2 \times 10^{-10}$ m/sec^2. Asteroid 1I/2017 U1 as a "test particle" demonstrated the *physical* mechanism of MOND, with a putative corresponding conical geometric diffusion of virtual particles between the Sun and its L1 Lagrange point with the galaxy. NASA/JPL data from that orbit of the Sun by the asteroid Il/2017 U1, shows that the anomalous acceleration observed of ~4.92×10^{-6} m/sec^2 corresponds to a constant MOND acceleration applied to the asteroid in its hyperbolic trajectory approach asymptote, resulting in a modified departure asymptote from the Sun. This evidence suggests that the additional "leverage" of ASNF gravity may be the common element in MOND constant velocity rotation curves of galaxies. The results also confirm a galactic L1 point location for our Sun is likely ~4×10^{10} meters (40M km) from the Sun in the direction of the Milky Way galactic center, and inside the perihelion of planet Mercury (46M km).

Introduction

Extensive evidence for MOND [11, 4, 8, 12] exists in the large number of galactic rotation curves from various data bases (SPARC, GHASP Hα, et. al.); therefore our goal in this report is to link observational evidence for MOND to a *physical mechanism or model.* MOND correctly describes and predicts the rotation curves of galaxies, thereby obviating "dark matter" and its parent λ-CDM model. MOND behaviour is embodied in the MOND interpolation function [1,7], a mathematical device that correctly predicts galactic dynamics, whereas "dark matter" methodology does not. There is a crying need to provide viable alternatives to the "dark matter" hypothesis; valuable resources continue to be squandered on unending searches for nonexistent particles by armies of scientists; science cannot progress from the cul-de-sac of stasis and its "dark" paradigms (i.e., *unobservables*). The search must focus more on our understanding of gravity, particularly at very large scales. Our approach proposes "leverage" generated at very large masses and distances at galactic scales that operate via a galactic scaling ratio; we now support that proposal with a direct solar system example that nature has provided to us in a fortuitous event – an asteroid passage very near the Sun.

In this report, we first present the direct evidence of the trajectory of the asteroid 1I/2017 U1 in its hyperbolic orbit-transit of the Sun, to show that MOND acceleration was detected and measured within our solar system. To wit: The unique approach asymptote of 1I/2017 U1 took it directly through a "cone" of *near-field* gravity, which provided added acceleration corresponding to the MOND acceleration that is "required" to maintain the Sun at its constant orbital velocity of ~230 km/sec. As a "test particle" the asteroid was observed and analyzed by NASA/JPL to have an anomalous acceleration of ***~4.92 m/sec²*** in its transit [52]. We propose this is much needed evidence for MOND within the solar system that has been lacking [62], but now with this specific "live" instance of a test particle as it swept around the Sun, we have direct proof of MOND acceleration between the Sun and its Lagrange L1 point with the galaxy. The author introduced ASymmetric Near Field Gravity (ASNF) in a previous publication from April 2021[64] as an underlying mechanism for MOND; this report extends that work by adding behaviour of the asteroid to show not only that it corresponds to the MOND acceleration, but also that it localizes the effect into a conical volume of *"near field"* gravity in its close flyby of the Sun. Please refer to the summary and concept diagram Figure 9-1.

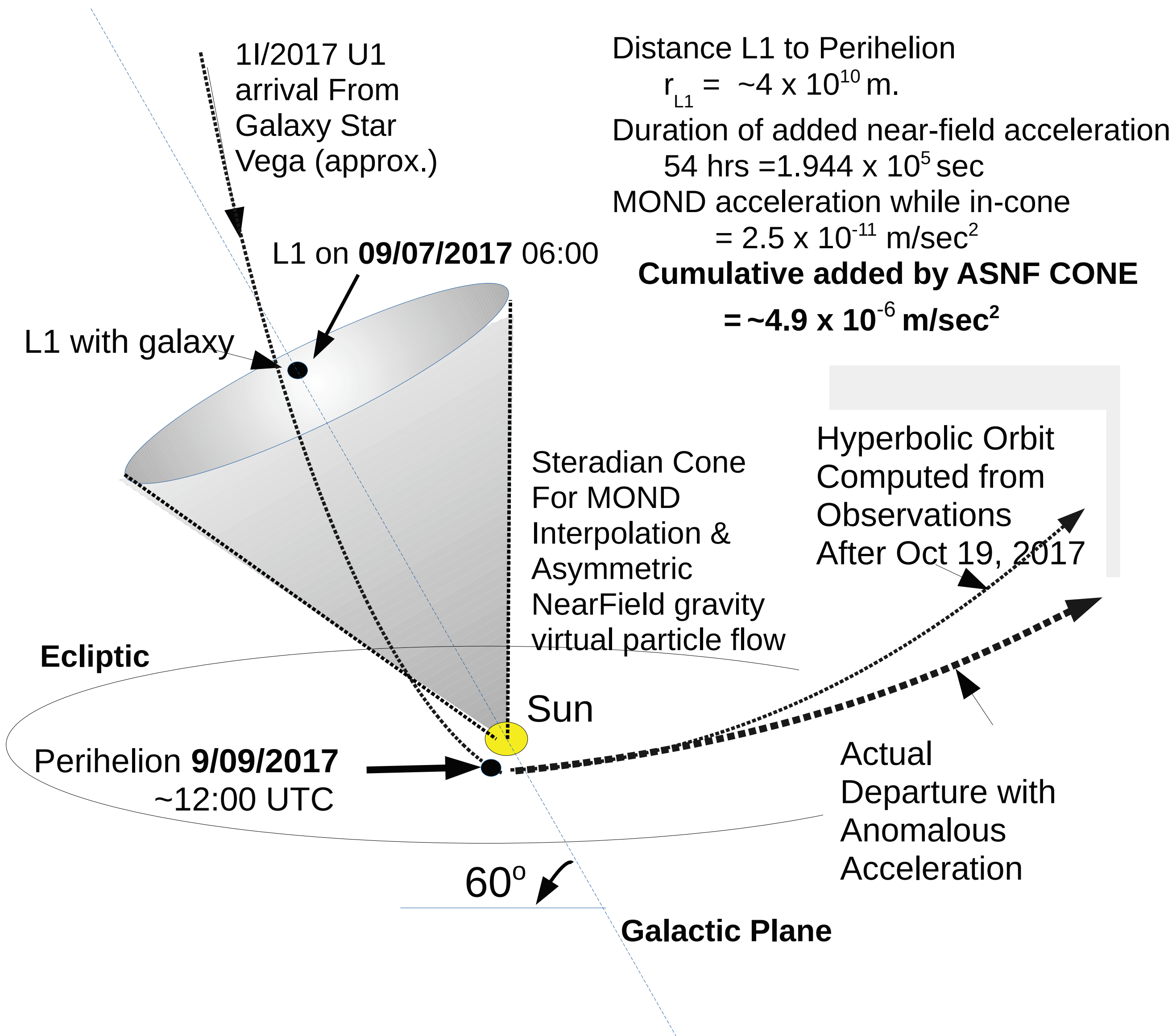

Figure 9-1 The Hyperbolic Orbit of U1l /2017 Anomalous Acceleration

Alhough recent works and publications [19, 50, 52, 61] have proposed some hypothetical alternatives for the anomalous acceleration of the asteroid, they lack overall probability or plausibility [47, 48, 50] as well as precise or direct data correlation and consistency between the orbit and possible sources of propulsion, i.e, there is little evidence for cometary activity, outgassing, the Yarkovsky effect, or radiation pressure.

These have been studied and mostly ruled out, or they are questionable and remain unverified, or worse, *unverifiable*. In the author's own words[50]: "We close by emphasizing that we have not fully solved the Oumuamua puzzle": an understatement, to be sure.

In contrast, therefore, we present direct evidence with data - to link MOND acceleration with the observed hyperbolic orbit data and calculations that link to the reported anomalous acceleration for the asteroid in Section 1. In Section 2, we show the direct linkage to MOND of the Diffusion Gravity model, and the passage through the *near-field* gravity cone as the causal mechanism for the anomalous acceleration of the asteroid. Section 3 indicates further examples and planned analyses of other candidate asteroids (such as asteroid PH_{27}) that will further substantiate this MOND-ASNF model. Section 4 will summarize the findings and present further hypotheses, such as a relationship of MOND-ASNF to precession and the extension to galactic cluster gravitational influences.

A diagram of the hyperbolic orbit is provided in Figure 9-2 which shows positions at various points of the orbit.

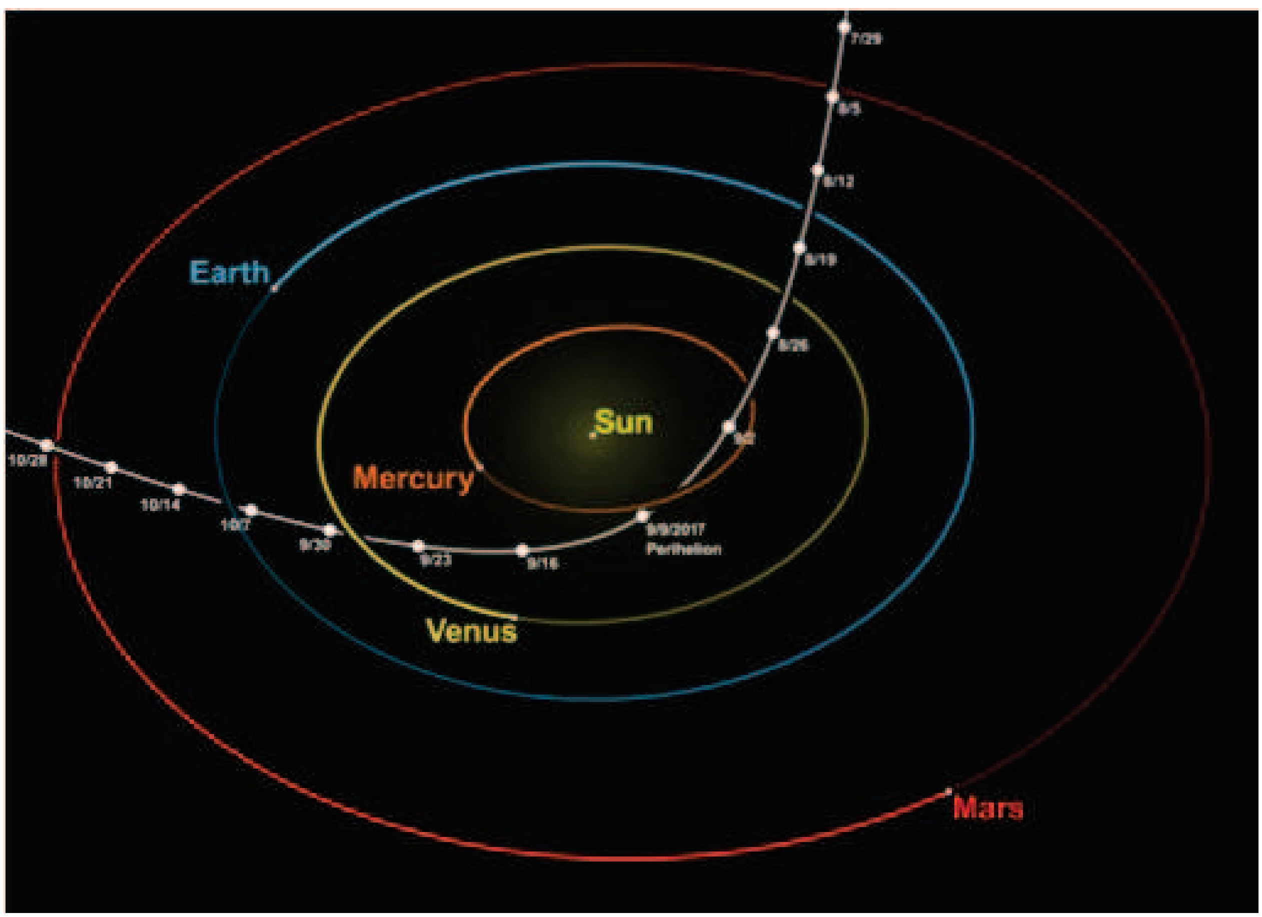

Figure 9-2 Hyperbolic Orbit Diagram of 1I/2017 U1 Asteroid NASA/JPL

The points were logged or calculated by NASA/JPL [54] from data collected beginning after discovery on October 14, 2017. The corresponding data is summarized in Table 9-1, with important points of perihelion and the likely galactic L1 point from our calculations.

Section 1 The Orbit of U1I/2017 and Anomalous Acceleration due to MOND-ASNF

The asteroid passage provided a dynamic real time test particle to demonstrate both MOND and the causal DG model of asymmetric near-field gravity. This is direct evidence to support both theories and their respective models and equations. The objective is to show why the anomalous acceleration was observed in the near-Sun flyby of Oumaumau. The detection of the asteroid did not occur until ***after*** perihelion, on October 14, 2017, when it was already 1.21 au away, and outbound from the Sun. Much of the trajectory therefore, was extrapolated from the data that was collected on or after that date. NASA/JPL posted the data and the trajectory at the NASA/JPL Small Body Database Browser[56]. This was a hyperbolic "fit" to the available data. For this analysis, therefore, we assume the data from NASA is sufficiently accurate to perform calculations and to draw conclusions about the dynamics of the asteroid. The important orbit position and time points for our analysis are summarized in Table 9-1, along with velocities as provided by NASA ephemerides, to which we add perihelion and our calculated L1 point distance from the Sun. From the reference cited, the resulting change in velocity during the period when it was near its closest approach to the Sun summed to about +17 m/sec [55], as a result of anomalous acceleration of ~4.9 x 10^{-6} m/sec [ ]. We calculate and compare this to our MOND based derivation of the "needed" acceleration for the Sun to maintain a constant velocity orbit in galaxy:

The Newtonian acceleration of the Sun in its galactic orbit:

$$a_{NEWT} = GM_{GAL} / r_{SUN}^2$$

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

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

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

where M is estimated mass of the galaxy (baryonic) and r_{SUN} is the distance of Sun to galactic center (no "dark matter" for M). Similarly, the mv^2/r Kepler law gives the *observed* centripetal acceleration of

$$a_{ROT} = v^2 / r = (230 \times 10^3 \text{ m/sec})^2 / 2.6 \times 10^{20} \text{ m}$$

Using v_{Sun} = 230 km/sec and r_{Sun} the distance of the Sun to the galactic center

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

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

This simple calculation then allows us to calculate the "deficit" of acceleration from visible matter to the Keplerian *observed* centripetal acceleration as

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

$$\mathbf{a_{deficit} = 0.25\ m/sec^2 x\ 10^{-10}} \qquad \mathbf{(1)}$$

The "Simple" MOND interpolation function can be used to calculate the MOND acceleration; it gives an equal value to that obtained in equation ***(1)***. If this MOND acceleration, as derived from Newtonian mechanics, is applied to the asteroid in its approach to the Sun through the "cone" of near-field gravity, as shown in Figure 9-1, for the 54 hours (Table 9-1), i.e., from the estimated L1 point with the galaxy to the perihelion, the summed acceleration over that time period is

$$\mathbf{0.25\ m/sec^2 \times 10^{-10} (1.944 \times 10^5 sec) = 4.86 \times 10^{-6} m/sec} \qquad \mathbf{(2)}$$

This MOND acceleration agrees very closely with the measured anomalous acceleration for Oumaumau quoted in reference Micheli, et al. [19, 52]:

$$\boldsymbol{4.92 \times 10^{-6} \pm 0.16\ m/sec^2}$$

From this straightforward analysis, therefore, we conclude that the asteroid *DID undergo MOND acceleration* in the near-field cone between the L1 point and the Sun. Furthermore, that acceleration was applied to the object during its transit into the perihelion and as an *injection velocity* into the hyperbolic orbit (ref.[46] pp 368-372), which resulted in a velocity increase of 17 m/sec as reported by NASA/JPL [55]. For the excess velocity, the application of acceleration into the perihelion:

$$\Delta v = \int a_{MOND} \cdot dt = +17\ m/sec \qquad (3)$$

Table 9-1 Asteroid 1I/ 2017 U1 Flyby Data Near Perihelion (From NASA JPL [54])

Date	Time UTC	Position in meters to Sun	Velocity km/sec	Info-Comments Way Points
		∞	26.62 km/sec	Estimate by JPL/NASA
08/01/2017	00:00	18.19×10^{10}	- 43.77	NASA/JPL calculated
09/03/2017	18:00	4.888×10^{10}	-37.56	
09/04/2017	12:00	4.655×10^{10}	-34.24	
09/05/2017	12:00	4.381×10^{10}	-28.95	
09/06/2017	12:00	4.157×10^{10}	-22.65	
09/07/2017	06:00	4.028×10^{10}	- 17.30	MOND /L1 point with galaxy
09/07/2017	12:00	3.992×10^{10}	- 15.41	54 hours L1->Perihelion 1.9440×10^5 sec
09/08/2017	12:00	3.893×10^{10}	-07.47	
09/09/2017	12:00	3.8305×10^{10}	0.783	PERIHELION
09/10/2017	12:00	3.906×10^{10}	8.905	
09/11/2017	12:00	4.016×10^{10}	16.482	
10/14/2017	12:00	16.45×10^{10}	45.179	DETECTION - PanSTARRS1
			26.33	Hyperbolic Excess velocity

The hyperbolic orbit was modified by the non-gravitational acceleration; the effect is diagrammed in Figure 9-3. Observations and analyses confirm the anomalous non-gravitational acceleration, therefore we claim that the very likely cause *was* the MOND near-field conical volume passage by the asteroid test particle. If MOND is the *empirical* indication of the added acceleration, we propose ASNF as the physical mechanism or *cause* of MOND.

Section 2 will establish an asymmetric near-field gravity model that is based upon the very large scale mass and distance ratios, i.e., Galactic Scaling Ratio's (GSR's), which we propose are responsible for the leverage of galaxies to control their star populations. We present how Diffusion Gravity can actually generate or amplify acceleration in the near field volume between stars and their L1 point with the galaxy.

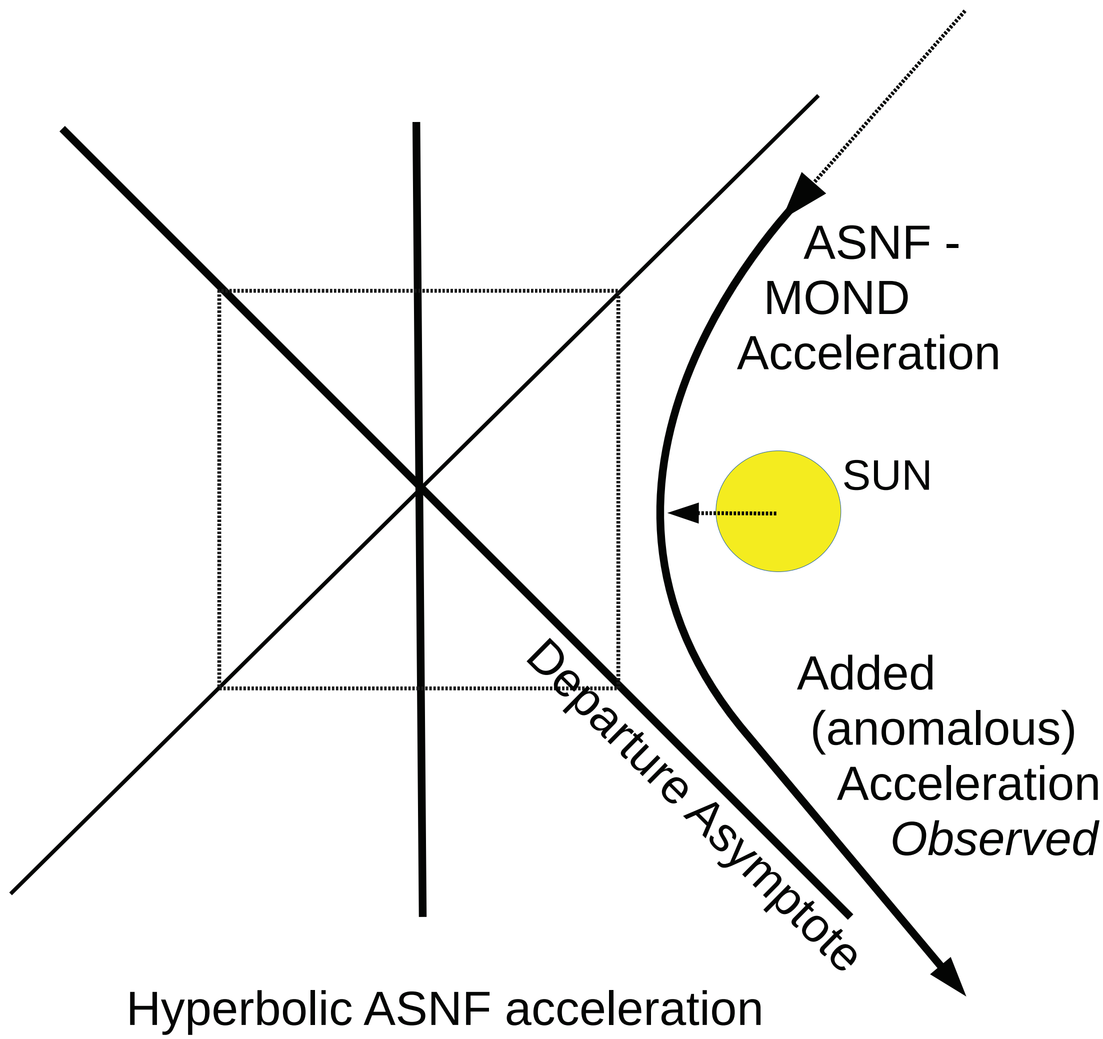

Figure 9-3 Hyperbolic trajectory change via anomalous acceleration

Section 2 Scaling Ratios and Dirac Large Number Hypothesis Implement Extreme Leverage

Now that we have presented the evidence that MOND actually *DID accelerate* a real test particle in a Sun flyby orbit, we discuss the Asymmetric Near-Field gravity model and how Diffusion Gravity explains MOND acceleration in the Sun's near-field. Ironically, the near-field model begins with the very large scales of galaxies. Consider that gravity is normally a "weak" force that is $\boldsymbol{10^{-40}}$ the magnitude of the EM force; this important difference was studied by the physicist P.A.M. Dirac, in his 1937 Large Number Hypothesis [36-38], wherein he noted the magnitude difference of $\boldsymbol{10^{40}}$ 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 herein is that in the extreme case of the L1 point being very near an orbiting star, we find a compressed gravitational potential sufficient to force the constant velocity of orbiting stars. Within the concentrated conical near-field gravity potential of the orbiting star, there is then an extreme gradient, i.e., force. Large enough ratios, i.e., leverage, of mass and distance ***boost*** the gravitational force out of a "weak" field regime to a strong localized near-field. This is expressed quantitatively through the *Galactic Scaling Ratio*:

$$\boldsymbol{GSR = \frac{Mm}{R_{Gal}\, r_{L1}}} \qquad \textbf{(4)}$$

Where M = Galactic mass inside the Sun's orbit, m = solar mass = ☼, R_{Gal}= distance to the center of the galaxy, and r_{L1} = distance from a star to L1 with its galaxy. The Galactic Scaling Ratio (GSR) for our own Sun is thus obtained $\sim\mathbf{10^{70}}$ **/**$\sim\mathbf{10^{30}}$ which results in $\sim\mathbf{10^{40}}$, using current estimates for masses and distances. This suggests a *modified force law at galactic scale,* **F** = **G(GSR)**, *with **G** the gravitational constant, that is different* from the standard Newtonian gravity equation $\mathbf{F = GMm/r^2}$. We propose, moreover, that Equation (4) more accurately expresses the extreme *asymmetry of mass and distance*, where we know that the distance r_{L1} to the L1 point will always remain extremely small relative to R_{Gal}. This stronger *near-field* gravity results in each star adjusting its position relative to its L1 point [40], in accordance with the ***principle of least action****,* i.e., the reactive near-field gravitational "least action" near the L1 point (which is at zero potential). Appendix 9-A-1 provides the calculations for the *PoLA effect* upon stars beyond the MOND radius.

GSR's can be calculated from observations and estimates for mass and distance; this will enable researchers to determine the scale ratios for thousands of galaxies, and to characterize their constant velocity profiles, which in turn can provide predictive characterization. For example, the Sun in the Milky Way Galaxy (MWG) mass scaling ratio (no "dark matter") is estimated to be on the order of $\mathbf{10^{10}}$ **M**☼solar mass [NASA], while galaxies generally range from $\mathbf{10^{8}}$ **M**☼(for dwarf and ultra-diffuse) to $\mathbf{10^{14}}$ **M**☼ (for largest super-spirals). Distance scales (size) of galaxies range from dwarf size radius of ~10k light years (10^{20} m) to ~400k light years (4 x 10^{21}) [63]. By using Newtonian gravity potentials we find a star's L1 Lagrange or EquiPotential (EP) balance point with its parent galaxy between the center of the galaxy and an orbiting star (e.g., see Zhao in [10]); we equate the two potentials (galactic and star) to find the point,

$$\mathrm{GM/R = Gm/r}$$

and

$$M/m = R/r_{L1}$$

$$Rm/M = r_{L1} \qquad (5)$$

which then gives the *distance* of the L1 as r_{L1} 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^{10} and R_{Gal} ~ 10^{20} meters/r, which roughly (order of magnitude) estimates $\mathbf{r_{L1} \sim 10^{10}}$ **meters** in the direction of the galaxy center. 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 a very asymmetric, *VERY LONG* lever arm in classical mechanics. This is illustrated in Figure 9-4, which shows an augmented or amplified gravity model which concentrates the local gravity effect. At the massive scaling ratio between the galactic central mass and the orbiting stars, the asymmetry (leverage) of concentrated *virtual particle flows* from the star will thereby add to the gravitational attraction 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 Eöt-Wash experiments as a source of MOND acceleration]. The implication is that galaxies are much more than a captive assemblage of stars; i.e., they ***actively*** "leverage" mass and distance to drive the constant velocity of the stars in their orbits within those galaxies. This is normally expressed in the MOND interpolating function shown in equation (6), which reflects the conic geometric model to describe the ASNF mechanism. The claim we make in this research report is that gravity has a near-field configuration (analogous to a lever arm with a fulcrum at the L1 point) that is very different from familiar far-field gravity. The model postulates a gravitational near-field that will ONLY occur at very large distance and mass ratios, as found in the galaxy scales, due to the disparity of mass between the 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 point and the orbiting star. The lever arm visualization reflects the GSR, where orders of magnitude are expressed, and the ratios indicate clearly the asymmetry that powers galactic gravity, which thereby maintains stars in their constant velocity configurations.

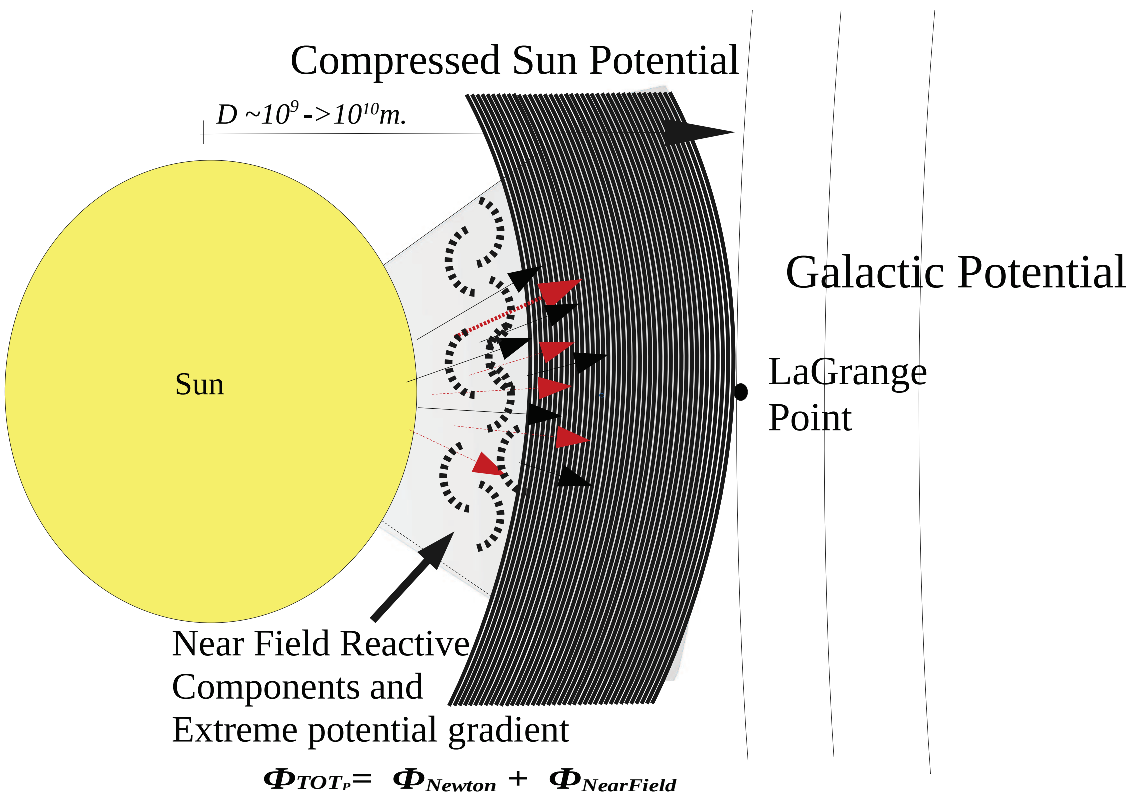

Figure 9-4 The Concentrated Near-Field of Gravity-Leverage

Diffusion Gravity shows in this model how the geometry of the MOND function, F_{MOND}, corresponds to the conical geometry of virtual particle flows; previous papers [66] have given the mechanism of attraction from these virtual particle flows and annihilation; the geometric model mechanism shows how the added gravity applies to the Modified Newtonian Dynamics (MOND) as given by the "simple" interpolation function, which we used to calculate the MOND acceleration in equation (1) :

$$F_{MONDsimple} = \left[\frac{1}{2} + \sqrt{\frac{1}{4} + \frac{a_0}{|a_N|}} \right] \quad (6)$$

Is the MOND Function that muliplies times a_{NEWT}. Then we *compare* that to the equation for surface area of a cone [28]

$$S_{areacone} = \pi R^2 + \pi R^2 \sqrt{1 + \frac{h^2}{R^2}} \quad (7)$$

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*, then we can see the same form of equation. This is the DG model basis as a steradian cone. The MOND function a_{MOND} is then calculated by the geometric application of the MOND "simple" interpolating function

$$a_{MOND} = -\frac{GM}{(2R^2)} - \frac{GM}{(2R^2)} \sqrt{\left(1 + 4\frac{r^2}{R^2}\right)} \quad (8)$$

Consider that the acceleration for MOND can be visualized as the cone's surface; then MOND acceleration from the interpolation function is re-written as

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

The cone in this case is a *steradian cone of gravitation* emanating from the star toward the Lagrange point as shown in Figure 9-5. This translates to the Gaussian flux through the application of Gauss' Law, where the radiated virtual particle flux (to the lens cap of the cone) is proportional to the central mass enclosed, and for a *steradian* volume:

$$\oint_{\partial V} \bar{g}(\bar{r}) \cdot d\bar{A} = -GM \quad (10)$$

The correspondence of the interpolating function to our model of near field gravity is expressed by *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, and that the flow will vary proportionally as the height of a cone of virtual particle flux toward the L1 point, shown as D in Figure 9-4. This connects interpolating functions to geometric steradial virtual particle flows from the Diffusion Gravity model to the scale ratios of galaxies. All of the virtual particles flowing through the steradian cone will concentrate at the "lens cap" for annihilation by incoming galactic virtual particle flows; the volume of the "lens cap" is $0.128\ R^3$, which is the Virtual Particle volume of the *annihilation zone*, that in turn provides a strong force of attraction [30] and also a zero potential point or "fulcrum" for the Galactic Scaling Ratio (GSR) leverage, or ***amplification*** that galaxies exert over their star populations as the radius grows beyond the MOND radius, given by

$$r_{MOND} = \sqrt{(GM/a_0)} \quad (11)$$

The GSR operates *only* beyond the MOND radius because it encapsulates the Lagrange point L1 with the galaxy into the ratio, such that the distance to the L1 point from a given star vanishes for stars inside the MOND radius. Conversely, the L1 distance r_{L1} grows as the distance increases outward from the MOND radius. The amplification via this GSR is actually a compression of potential between the star and the L1 point; this boosts the potential gradient within the radius $r_{L1,}$ so that it also boosts the acceleration within that zone. The GSR quantifies this "leverage" in orders of magnitude (powers of ten), as a simple mathematical relation of the mass and distance in galaxies

$$GSR = M_{GAL} m_{☼} / R_{\mathrm{Gal}} r_{\mathrm{L1}}$$

$$a_{MOND} = a_N \, F(a_N / a_0) \qquad (12)$$

The interpolation function provides mathematical descriptions for the behaviour, but they do not explain it. Note: $a_0 = 1.2 \times 10^{-10}$ m/sec^2 has been proposed as a fundamental constant.

GSR provides a *Newtonian-Like* gravity at galactic scale that *incorporates* the *asymmetic* nature of gravity at that very large scale via the Lagrange point L1 distance, which beyond the MOND radius remains very small relative to R_{Gal}. It is different from the Newtonian force law $F = GMm/r^2$, due to the *asymmetry* of size and distances. When computed for the galaxy values individually, the GSR provides an exponential magnitude that varies closely around 10^{40} as the model baseline indicator for *near-field* gravity "ideal" amplification, as has been specified in the Baryonic Tully-Fisher Relation (BTFR) [51]

$$v^4 = \sqrt{(a_0 a_N)}$$

When scaled with a *".1"* proportionality constant, the GSR may provide a measure of leverage and the BTFR slope of those galaxies, i.e., mass to velocity. Examples of this suggest that the optimal ***10^{40}*** reduces to the "sharpest" galaxy rotation curve (small dispersion) with the slope of ~4 as expressed in the BTFR. Recall that the Galactic Scaling Ratio embodies the Dirac Large Number Hypothesis ratio of 10^{40}, which translates physically into larger-scale force effect (amplification) of gravity that is operative at increasing galaxy size and scale. Therefore, $F = GMm/Rr$ should apply for all stars beyond the a_0 radius ("MOND" radius) of any given galaxy.

This correlation of the GSR to the rotation curves may imply the mechanism at work in MOND and in ASNF to produce these rotation curves. The Baryonic Tully-Fisher Relation (BTFR) and similar Faber Jackson relations with the $V^{\alpha} \; \alpha \; L$ can be modified to suggest another relation, where the exponent of velocity α is derived from the GSR as

$$v^{\alpha} \;\; \alpha \;\; (0.1) \log_{10} GSR \qquad (13)$$

such that the 10^{40} GSR ratio for gravity provides the linkage between the velocity, which is constant at r, and the baryonic mass. The significance of this linkage is contained in the GSR for each galaxy, that provides the essential "motive power" as amplified gravity from the *near-field* at each star in the galaxy; the "quality" of that ratio and its variance from 10^{40} would therefore determine the *velocity dispersion* for each galaxy. An expression of this quality factor is that of the difference from a baseline value of 10^{40}, and its commensurate Baryonic Tully-Fisher slope of $4 \pm \Delta_{GSR}$, and specifically, $-\Delta_{GSR}$, which is the due to any "shortfall" of additional gravity (dwarf and diffuse galaxies) to maintain the constant velocity of orbiting stars. The velocity dispersion may be linked through the relation to the GSR

$$-\Delta_{GSR} \;\; \alpha \;\; v_{Dispersion} \qquad (14)$$

where the Δ_{GSR} translates to acceleration from GSR, and to velocity variation from a galactic mean velocity. Section 2 has presented the DG Model and its linkage to MOND; the subsequent sections will provide future directions in substantiation of the model and further confirmation of MOND.

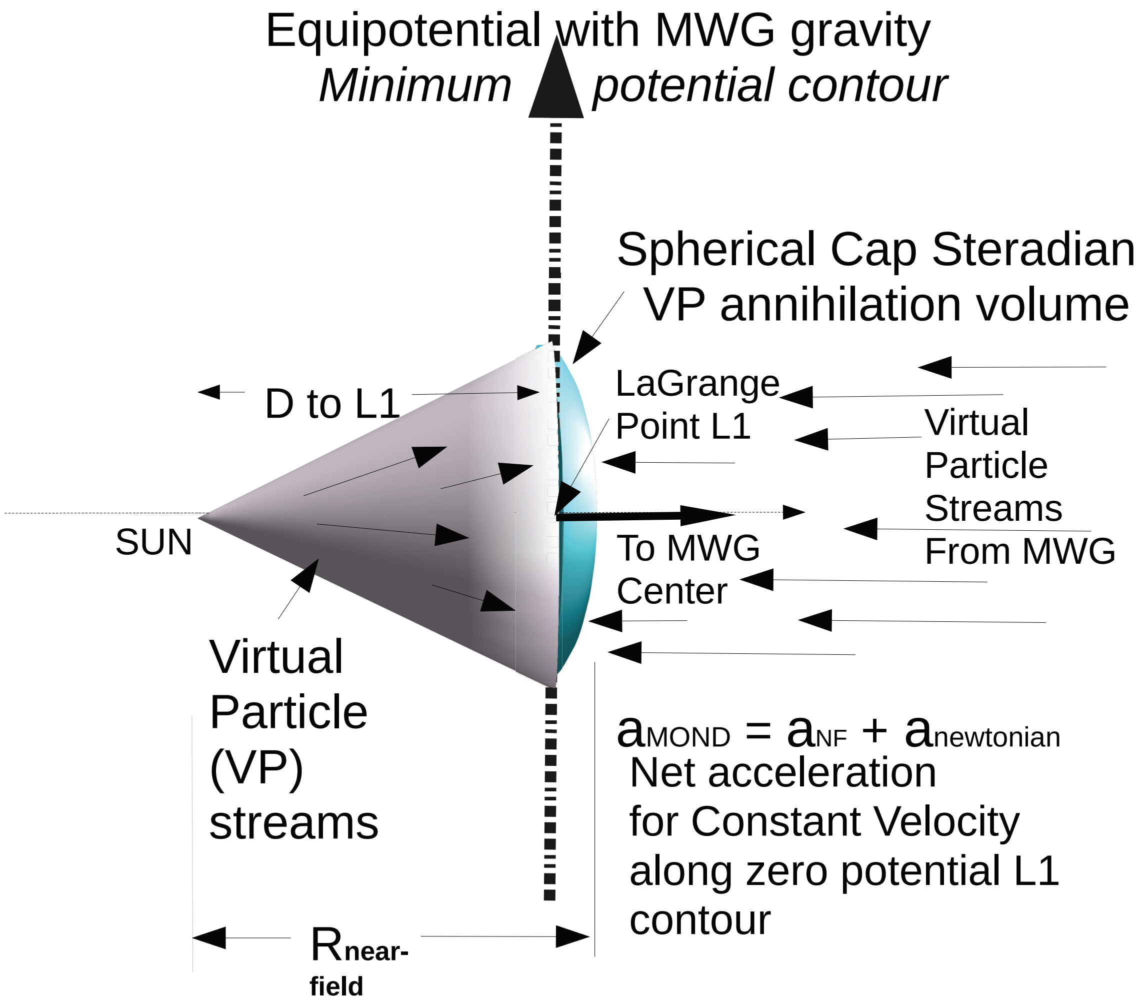

Figure 9-5 Steradian Cone Model for Diffusion Gravity

Section 3 Application of the ASNF to other Planetoids, Galaxy Groups and Clusters

The model presented in this report reflects and integrates the actual event of the asteroid flyby of the Sun; more instances of this type of dynamic interaction are required to provide further confirmation and refinement of the model. Specifically, the near-field gravity effect must be verified through analysis of other close encounters by asteroids with our Sun. Such data and opportunities do exist, but they are not common, since the focus has traditionally been on general relativity "confirmation" and precession of known solar system planetoids, e.g., planet Mercury and asteroid Icarus. Our previous research report has postulated the galactic effects on precession of planet Mercury[31], but now the DG model can be applied to other near-encounters of the Sun by asteroids and spacecraft. In the near term, we will include the recently discovered asteroid PH_{27} that is in elliptical orbit around the Sun, with perihelion on October 7, 2021 at 0.1331 au, or approximately 2 x 10^{10} meters. This distance, if aligned at some favourable angle to the L1 point to the galaxy, may provide another opportunity to confirm near-field gravity within the MOND-ASNF cone; it should cause a change in the orbit or precession that is unexpected. Other asteroids may provide similar orbits that take them through these near-field conical volumes, which then affects their orbits. Confirmation of MOND in the solar system helps to further confirm DG-ASNF gravity.

As a side note, Cavendish experiments on earth have attempted to detect and corroborate MOND for galactic gravity effects[1]. Such measurements offer varying interpretation and confirmation, but may show rather that ASNF gravity as the cause of MOND would only be detectable in the near-field of the Sun and not generally as a background acceleration in the solar system.

Galactic Clusters and MOND-ASNF

Future research will explore the same GSR mechanism to explain galactic cluster dynamics that have so far eluded the current MOND paradigm; this must consistently explain even larger scales than galactic MOND, such that the GSR can operate in the same general "leverage" way. Mass and distance increase for the ratio at group and cluster scales, such that

$$GSR = Mm/Rr = 10^{15} \cdot 10^{1} \cdot 10^{60} / 10^{23} \cdot 10^{10} \ \sim= \mathbf{10^{40+}} \qquad (15)$$

Values for mass and distance are taken from reference [63]. This shows that the scaling ratio holds even at these larger scales, and should result in the corresponding amplification leverage that can provide the same near-field gravity as in galaxies, even as the distance to L1 for inter-galaxy distance increases. As reported by McGaugh and others, MOND suffers from a "missing mass" problem in groups and clusters of galaxies (57, 58, 59; 60). Those configurations show higher-than-expected velocities as velocities shift away from the line representing MOND. This is a generic effect that is illustrated dramatically by the particular case of the bullet cluster, which has been called 'direct proof' of "dark matter". Our explanation of this apparent "deviation" or "disproof" of MOND is that due to the increasing GSR, which ranges above $\mathbf{10^{43}}$, there could result in even greater leverage to concentrate gravity, and therefore with greater velocities, requiring a modification of the Tully-Fisher relation at the larger scales as discussed and suggested in Section 2.

All these questions will be answered through analyses of data and the increasing capability in observations and experiments. The scaling ratio, GSR, should hold up to any level, since it reflects physics of nature and may help to explain unexpected coherence of galaxies and clusters.

Section 4 Summary of Evidence and Conclusions

Diffusion Gravity has provided a model to suggest causality for the MOND paradigm, and the evidence to support that model. To recapitulate the main points of discovery and presentation from this work:

1) A singular flyby of U1I/2017 U1 afforded an ideal path and unique circumstance to confirm MOND in the solar near-field with the observed anomalous acceleration of 4.9 x 10^{-6} m/sec^2, which then caused a measurable injected velocity of +17 m/sec that changed the hyperbolic departure asymptote trajectory. MOND acceleration *equalled* the NASA/JPL reported anomalous acceleration.

2) The asteroid data provides very strong support to the Diffusion Gravity asymmetric near-field model (ASNF) as a causality for MOND.

3) The L1 point to the Milky Way Galaxy is near the sun, at approximately 40M kilometers, which generates a near-field steradian "cone" that links to the MOND equation – which we know as the simple interpolation function. This L1 point location was calculated and improved by this flyby event, to approximately 40M kilometers from the Sun.

4) The leverage of galaxies over their star populations is embodied in MOND and in the Diffusion Gravity model for Asymmetric Near-Field gravity. We invoked the simple classical mechanical analogy of a lever arm with the fulcrum at the L1 point, and the applied leverage of the galaxy exerted in the near-field cone between the Sun and its L1 point.

5) Leverage expressed by the GSR can form a product with *G*, and provide a "Newtonian-Like" large scale force, that directly reflects the very large scale asymmetries as a quantitative measure of the ASNF gravity. The PoLA is the "governor" that is highly efficient to keep the star at constant velocity in its orbit. The GSR can provide a further linkage to the Baryonic Tully Fisher Relation (BTFR) that links the leverage and MOND to velocity and dispersion.

6) The anomalous "Non-Gravitational Acceleration" (NGA) as reported by NASA/JPL and various observers, was injected during the approach asymptote of the hyperbolic orbit of the asteroid 1I/2017 U1, by MOND-ASNF acceleration between L1 and the perihelion, as explained in Section 1 and 2.

The equation we have developed is the galactic scaling ratio, or GSR, as a means of quantifying the leverage of the galaxy over its stars. When the leverage achieves $\sim 10^{40}$, then near field amplification occurs, as defined by the Dirac Large Number Hypothesis. In conjunction with the Principle of Least Action, there will actually be a surplus of acceleration needed to keep a star at constant velocity in its galactic orbit. Galactic velocity dispersions may be the result of the GSR $< 10^{40}$; further investigation is planned. Galaxy clusters should be further examined for applicability of the GSR relation.

Conclusion

This research shows a very definite correlation between anomalous acceleration of 1I/2017 U1 asteroid and MOND-Asymmetric Near-Field gravity model, in its flyby of the Sun. The matching of NASA/JPL data to the MOND acceleration is undeniable, and contradicts the alternative hypotheses of cometary activity, radiation pressure, outgassing, etc. More examples will show further evidence as they are analyzed to test for the same MOND acceleration of objects passing through the near-field gravity of the Sun. These will be presented in future research reports, with the overall objective of proving both MOND and the Diffusion Gravity-Asymmetric Near-Field Gravity model as an alternative explanation to "dark matter", which cannot be shown to exist. Further work will also continue to confirm the Galactic Scaling Ratio ***leverage*** applicability up to the galactic cluster level, and may include other enhancements to the DG model. As a final note, we assert that the prevailing science that "Newtonian gravity behaves uniformly at very large 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.

The work included in this report is the original work and intellectual property of the author; all references have been cited and credited; the author affiliation is professional membership in IEEE.

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Appendix 9-A-1 Calculations for Energy in Principle of Least Action
Asymmetric Near-Field Gravity
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:

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

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

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

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

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

The above calculations are only 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 $9\text{x}10^9$ 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.

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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