How Dark Energy Can Cause Both Antigravitation And Gravitation

Roger W. Seiler

February 2004

Contents

Acknowledgments	i
The Dynama-Opacity Theory	1
Background On A Galactic Puzzle	2
Dynama	3
Universal Expansion	4
Laboratory Results	4
Galaxy Mass, Cluster Mass & Sun Mass Calculations	5
The Opacity Of Matter	8
The Quantum Roots Of The Gravitational Constant	9
A Compression Limit Clue - Density Limit Of Matter	11
Dynama At The Quantum Level	12
The Shadow Of Opacity	13
How Dynama And Opacity Move The Universe	14
Gravitational Constant G_2	16
The Sun/Earth Test	17
Antigravitation	18
The Rest Of The Universe And A New Constant	19
Converting Volume-Opacity To Mass	20
Accounting For Antigravitation F_2	20
The Dark Matter Requirement Greatly Shrinks	22
Add Or Subtract Antigravitation?	23
The Perspective Factor From Increasing Distance	23
The Complete Dynama-Opacity Formula	25
Transformation Of Volume-Opacity To Mass	26
Find Mass Of The Sun, A Galaxy Or A Cluster Of Galaxies	27
Find Orbital Velocity Of A Spacecraft, Planet, Star Or Galaxy	28
Summary	29
Questions and Answers	30
Definitions	36
Appendix	
Physical Constants & Planck Dimensional Units	A-1
Constant Size Relationships	A-2
How To Use The Galactic Gravitation Calculator	A-5
Taking The Demo Tour Of The Program	A-5
Contacting Leadership Software Or The Author	A-11
Bibliography	A-12
CD-ROM: Galactic Gravitation Calculator software	Back Cover

ACKNOWLEDGEMENTS

Within the Galactic Gravitation and Mass Calculator software database, data from Vera Rubin are used with her permission, as published in her Scientific American and Science magazine articles in 1983. As noted in the database, additional data is included on each database row, consisting of conversions to cm. units of some of her data, for the computer's convenience in doing calculations. Also, numeric representations have been made from data she originally presented in graphic format. So if there are errors in any of this, they are the author's, not Dr. Rubin's.

One row of data concerning the Andromeda galaxy, M31, is adapted from *Realm Of The Universe*, by George O. Abell, as is data about the Coma Berenices galactic cluster and our Local Group galactic cluster. Planetary orbital data included in the database are common to both Abell's book and *Wanderers in Space Exploration & Discovery In The Solar System* by Kenneth R. Lang and Charles A. Whitney.

The cover photo of the galaxy M100 is used courtesy of NASA.

The author acknowledges with gratitude those who in one way or another contributed - often unknowingly - to the development of this theory: the late Southern California architect, Wallace Neff, who in 1961 planted the original seed of this theory when he told the author that he thought gravity might actually be a repulsive rather than an attractive force - a force that pushes things down onto the earth rather than one that attracts objects toward the earth; the visionary educator Lucien L. Nunn, founder of Deep Springs College - one of the most challenging educational experiences in America; the astronomer Halton C. Arp, who in 1962, kindly and thoughtfully wrote the author with words of critique, advice and encouragement; physicist John A. Wheeler, who in 1986 confirmed to the author the validity of the relationship between the Planck units and the gravitational constant; the author's patient family, who without complaint, endured the endless hours of his distraction with the development of this theory; and of course, the work of the many great scientists that created the foundation of knowledge and observational data upon which this theory has been built.

How Dark Energy Can Cause Both Antigravitation And Gravitation

(with CD-ROM: Galactic Gravitation Calculator - experiments software - on back cover)

Roger W. Seiler
5 Berachah Avenue
Nyack, NY 10960
February 17, 2004

Abstract

Gravitational theory is faced with puzzles regarding the motion of objects in large scale space - the space of galactic and intergalactic distances - which challenge conventional gravitation theory for explanations. Recent astronomical observations suggesting an accelerating expansion of the universe have refocused attention on the possibility that *dark energy* may exist.[3] In the Dynama-Opacity Theory explained here, this single form of energy, named *dynama* in this theory, accounts for both gravitational and antigravitational phenomena.

Two separate ideas by Max Planck and Paul Dirac,[4] which they abandoned before the concepts could be fully explored, have been combined with an analytical hypothesis based on current astronomical data, resulting in the Dynama-Opacity Theory of Gravitation. A purpose of this theory is to demonstrate how the orbital velocities of objects seen in spiral galaxies and of galaxies within galactic clusters, can occur without enormous amounts of dark *matter* (not dark energy) and how this can be accounted for with a general gravitational force formula that functions accurately at all scales of space from the sub-atomic to the intergalactic. Thus, a Dynama-Opacity gravitational formula is shown here, incorporating a connection between quantum mechanics and gravitation, plus the gravitational influence of the total mass of the universe since the Big Bang

---

[3] "New Evidence That Expansion Of Universe Is Accelerating"; George Efstathion; Monthly Notices, Royal Astronomical Society; Vol. 330, No. 2; February 21, 2002
[4] As explained more fully in the text to follow, Planck's concept regarded the connection between quantum units of measure and the gravitational constant; Dirac's idea concerned the way the universe is expanding.

February 17, 2003

How Dark Energy Can Cause Both
Antigravitation And Gravitation

by R. W. Seiler

The Dynama-Opacity Theory

The hypothesis presented here, designed to explain galactic and extra-galactic orbits without needing enormous amounts of dark matter, is based on five main premises:

1. All gravitational interactions occur at the quantum scale of matter and are primarily measurable in terms of the Planck units for mass, time and length.

2. There is a single form of energy, called "dynama,"[5] that exists throughout all space - within all objects and between all objects of the universe. It is the source of a pervasive antigravitational force that paradoxically also causes all gravitational effects. (Some refer to this type of energy in the vast expanses of space as "dark energy,"[6] and in a 1962 paper on gravitation it was called "Constant Irrepressible Universal Energy."[7])

3. All space, between all objects and within all objects (including elementary particles), is expanding as a consequence of the action of dynama. But due to the simultaneous expansion of all systems of measure, this expansion is not perceived as such.

---

[5] Pronounced "die-NAM-uh" and which means animating energy. This terminology first used in "Beyond Equivalence: The Connection Between General Relativity and Quantum Mechanics"; Roger W. Seiler; Vantage Communications Inc.; Nyack, NY; May 7, 1984

[6] "Supernova Observations Bolster 'Dark Energy' Theory"; Kathy Sawyer; The Washington Post; April 3, 2001

[7] "Theory On Constant Irrepressible Universal Energy - a theory on gravitation"; Roger W. Seiler, Deep Springs College, February, 1962

4. All matter, at its smallest and most basic scale, is composed of elementary particles (or elementary vibrating strings) that are indivisible and impenetrable and therefore opaque to the energy of dynama from outside. This characteristic of opacity causes both a compression limit and density limit to apply to all matter.

5. In addition to the masses of any two bodies observed in a gravitational relationship, the gravitational force acting between them also involves a relationship between these two masses and the entire mass of the universe.

Based on these premises, a Dynama-Opacity Theory of Gravitation has evolved with a gravitational force formula that applies to all scales of space, large and small. Per premise 5, it portrays the gravitation between two objects as involving three players: object 1, object 2 and the rest of the universe - all gravitationally connected since being together at the Big Bang. A computer program, the Galactic Gravitation Calculator,[8] was specially created to experimentally test, refine and demonstrate both the formula and the theory.

The new gravitational force formula is more complex and less intuitive than Newton's $F = MmG/d^2$, because galactic and intergalactic space is much more complicated than the space analyzed by Kepler and Newton in the relatively Lilliputian scale of our solar system. The Dynama-Opacity based formula for gravitational force, incorporating all five of the premises listed above, is as follows:

(1)

$$F = (V_1O_1 \cdot V_2O_2)(G_2/d^2 + V_uO_u \cdot G_3 d/[1 + d^2/\{nLimit\}])$$

with lower limit of $d = \text{CubeRoot}\{ (V_1O_1 + V_2O_2)/ 4/3\ \pi \}$ (Due to a compression limit of matter.)

where:

V = volume of object in cm^3 ($_1$ = 1st object; $_2$ = 2nd object; $_u$ = universe)

O = opacity, a decimal fraction derived: object's density divided by density limit of matter

(Below, M_p = Planck Mass; T_p = Planck Time; L_p = Planck Length; values for each in appendix.)

$G_2 = M_p/L_p^3T_p^2 = 4.4958418 \times 10^{178}\ gr/cm^3sec^2$ (2nd grav. constant translator - 1st is Newton's G)

$G_3 = M_p/L_p^2T_p^2(1cm^7) = 1.82119 \times 10^{146}\ gr/cm^9sec^2$ (3rd grav. constant translator)

d = distance between the centers of mass of objects 1 and 2

$\{nLimit\}$ = diminishing perspective factor = $166.894\ cm^2 \times 10^{44}$

(value of {nLimit} is for estimated mass of universe $M_u = 1.4476 \times 10^{56}$ gr; section to follow explains the derivation of {nLimit})

The volume-opacity based force formula shows *how* gravity works, not just *what* happens. Of course, this formula is incomprehensible without knowing its underlying principles, an explanation of which will follow one piece at a time.

Background On A Galactic Puzzle

Long ago, Johannes Kepler deduced his three laws of planetary motion from Tycho Brahe's[9] detailed observations of the motions of the planets in our solar system. Among Kepler's laws was the principle that planets move in elliptical orbits, and that the farther an orbit is from the center of mass of the Sun, the less

---

8 "The Galactic Gravitation Calculator"; Roger W. Seiler; Leadership Software Corp.; June 23, 1999. (Free download available from www.leadersoft.com .)

9 Eric M. Rogers, Physics for the Inquiring Mind; Princeton U. Press; NJ, 1960; p. 243

velocity is required to maintain the orbit. Vera Rubin and other astronomers have observed orbital velocities of objects in many spiral galaxies that do not follow the Keplerian pattern.[10] In these galaxies, typical of spiral galaxies, orbital velocities were found to be relatively constant from about 1/3 of the visible radius of the galaxy outwards, instead of decreasing with distance from the galactic core. Also, it was found that the velocities of many galaxies in galactic clusters are so great that they should overcome the gravitational attraction of the cluster, and yet the clusters don't seem to be flying apart.

Following on Kepler's insights, Isaac Newton revealed the basic law of gravitation. When the math of Newton's law is applied to the orbital velocities seen in the outer reaches of galaxies, and to galaxies orbiting around the center of mass of a galactic cluster, far more mass than is visible seems to be required to account for the high orbital velocities. This has given rise to the theory of dark matter - that most of the matter in the universe must be dark and unseen in order to account for the observed high orbital velocities in galactic and extra-galactic space. Efforts to detect dark matter - which should exist everywhere - have only found indications of it in such small quantities as to be inconclusive regarding its relation to the galactic orbits.[11]

Another possible explanation for galactic orbits, proposed many years ago,[12] is that Keplerian and Newtonian principles of gravitation, based solely on observations within the relatively small space of our solar system, may not be complete regarding gravitation in large scale galactic space.[13] The MOND (Modified Newtonian Dynamics) theory suggests a modification of Newtonian gravitation that yields about the same results in large scale space as the Dynama-Opacity (D-O) theory. But some find it hard to accept MOND because it doesn't explain what causes the different behavior of gravity in large-scale space. D-O theory does.

In the large scale space of galaxies and galactic clusters, the theory of dynama suggests that the distance between objects (from the core of a galaxy to stars on its outer edges) is so great that the dynama acting between them is significant enough to create antigravitational influences that account for orbital motions that would otherwise require dark matter to explain.

Dynama

In this theory, there is a form of antigravitational energy acting in space to push things apart, here named “dynama,”[14] that interacts with the opacity of matter (opaqueness to dynama according to matter's density). The two factors together account for how gravity functions at all scales of space. Dynama acts in the space between the ultimate or elementary particles[15] (or strings[16]) of matter at the quantum scale, seeking to push the particles apart. As the energy called dynama in this theory expands space everywhere, though it pushes apart large objects that are widely separated (like galaxies) the dynama acting between the rest of the

---

[10] "Dark Matter in Spiral Galaxies"; Vera C. Rubin; Scientific American, June, 1983, pp 96-108
"The Rotation Of Spiral Galaxies"; Vera C. Rubin; Science, June 24, 1983, p. 1339-44

[11] "Direct Detection of Galactic Halo Dark Matter"; Ben R. Oppenheimer, N.C. Hambly, A.P. Digby, S.T. Hodgkin, D. Saumon; Science Magazine; March 22, 2001; 10.1126

[12] "Dark matter..."; Rubin; re: Joel E. Tohline of Louisiana State U., and M. Milgrom and J. Beckstein of the Weizmann Institute of Science; p 102.

[13] “Does Dark Matter Really Exist?”; Mordehai Milgrom; Scientific American; August 2002; p 42.

[14] Dynama is pronounced die-NAM-uh and is defined as: basic animating energy. It is the name given to dark energy in "Beyond Equivalence…" by the current author in 1984, replacing the cumbersome name he gave it in his 1962 paper, which was in the title of that thesis, "Theory On *Constant Irrepressible Universal Energy*."

[15] The search for an "ultimate particle" that would be the indivisible building block of quarks and electrons is described throughout The Key to the Universe, by Nigel Calder; Penguin Books; NY; 1978

[16] "The Theory of Strings: A Detailed Introduction"; Sumil Mukhi; TATA Inst. Of Fundamental Research, Mumbai, India; http://theory.tifr.res.in/~mukhi/physics/string2.html ; Oct. 1999

universe and any two objects that are *near* each other, *pushes together* these two objects according to the strength of their opacity *shadows* projected three dimensionally into space by the two objects. This shadow factor is how an expansive energy, dynama, besides *pushing things apart*, can paradoxically also *push things together* - it is how antigravity can also be gravity. An opacity shadow is based on there being three players in every gravitational interaction between any two objects. They are the two objects and the rest of the universe.

Universal Expansion

This theory is quite similar to one briefly advanced by the late physicist Paul Dirac in 1938.[17] A few years before, Edwin Hubble's discovery of the redshift of far away galaxies[18] led to the concept of an expanding universe. Dirac suggested that not only was space expanding *between* things but that the space *within* objects may also be expanding. Then he thought this would probably require the gravitational constant to change over time. Dirac apparently abandoned this concept of universal expansion due to a lack of evidence of a drift in the gravitational constant. However, the similar theory of Dynama-Opacity, can accommodate Dirac's type of universal expansion without any drift of the gravitational constant.

One way to visualize the action of dynama is to think of the often used analogy of a balloon being inflated with ink spots on its surface. As the balloon inflates, the space between the spots becomes greater, but the spots also get bigger. However, dynama appears to be a relatively weak form of energy, requiring enormous spatial distances for it to have much effect. This, of course, is just the opposite of what one might expect from Newton's gravitational force formula, which says that the *smaller the space* between two objects, the greater the gravitational force between them. But Newton was addressing *force*, not *energy*.

As the energy of dynama expands space, due to the continuum of space and time discovered by Einstein, dynama expands time as well as space. Time passes because of dynama, and can be thought of as *spacetime dynama*. Without it, the universe would likely be frozen like a still photo, and perhaps could never have even gotten started moving at the time of the Big Bang.

Laboratory Results

Experimentation with many different configurations of this theory, using the Galactic Gravitation Calculator (GGC) software as a laboratory testbed, has demonstrated that the particular configuration presented here yields a gravitational formula that predicts exactly the kind of gravitational phenomena observed in the near space of our solar system, in the middle sized space of our galaxy, and in the largeness of intergalactic space. It is able to predict this phenomena without needing huge amounts of unseen dark matter, though it may not completely eliminate the need for it.[19]

---

[17] P.A.M. Dirac; "New Basis For Cosmology"; Proceedings of the Royal Astronomical Society of London; 1938; A165:199

[18] George O. Abell; *Realm Of The Universe - Second Edition;* Saunders College/HRW; Phil.; 1980; p 368

[19] Another gravitational force component to be considered in a galaxy is the influence of all the energy that has been radiated from the galaxy. General Relativity shows that the path through space of energy, such as light, is influenced by a gravitational field (see Gravitation; by Charles W. Misner, Kip S. Thorne and John A. Wheeler; W.H Freeman & Co.; San Francisco; 1973; p. 431). Conversely, radiant energy can also influence a gravitational field, as can be seen by applying the equivalence of mass and energy from $E = mc^2$ to Newton's gravitational force equation, $F = MmG/d^2$. By transposition of $E = mc^2$, $m = E/c^2$, which can apply to either M or m in the gravitational force formula, so that M can be replaced there with the result: $F = EmG/c^2d^2$. This latter formula represents the gravitational influence on a galaxy's star of a specific amount of energy emitted by the galaxy. Due to division by c^2, a very large number, the amount of gravitational force focused toward the center of the galaxy on account of radiant energy tends to be so small as to be insignificant. There are several issues regarding how to determine the amount of energy to be considered. Due

Galaxy and Cluster Mass: Calculation Examples

For an idea of how greatly different the results are between using the Newtonian and Dynama-Opacity methods for inferring the masses of galaxies and of galactic clusters, the following tables of GGC calculation results are shown. The formulas used in these calculations will be fully explained later.

I. Mass Of A Galaxy

Prior to the findings by Vera Rubin regarding the higher than expected orbital velocities in the outer reaches of spiral galaxies,[8] the masses of galaxies were estimated to be much less than Rubin's higher velocities seemed to indicate. For example, in 1980 the astronomer George O. Abell[20] published the mass of the M31 Andromeda galaxy as 30 X 10^{10} Solar Masses and of the Milky Way as 20 X 10^{10} Solar Masses. Three years later, Issac Asimov authored a compilation of astronomical data that were generally accepted at that time, in *The Measure Of The Universe*,[22] where the mass of Andromeda galaxy M31 was indicated to be 36.7 X 10^{10} Solar Masses, and the Milky Way's mass was equivalent to 15.8 X 10^{10} Solar Masses. Though different from Abell's numbers, Asimov's galactic masses are roughly similar, especially when these two sets of numbers are compared with the vastly greater estimates published in mid 1983 by Rubin and subsequently by others. In 2000, N.W. Evans and M.I. Wilkinson calculated a mass for the halo of Andromeda to be 123 X 10^{10} Solar Masses, and the halo of the Milky Way to be 190 X 10^{10} Solar Masses, with dark matter expected to be the main contributor to these hugely larger masses than the earlier estimates for total galactic mass. (Notice that in these last numbers, Milky Way is portrayed as the more massive galaxy, whereas previously the reverse was the case.) The Dynama-Opacity gravitational formula, on the other hand, provides total mass calculations much closer to the earlier estimates - about 33 X 10^{10} Solar Masses for Andromeda and about 35 X 10^{10} Solar Masses for the Milky Way (as shown in Table 1 below), which are masses relatively near what can be accounted for by ordinary visible matter.

Table 1 shows how in the Dynama-Opacity theory, the calculated mass of spiral galaxies and galactic clusters is consistently much less than indicated by Newtonian calculations, when measured farther than 1/3 of the distance from core to visible edge. For the D-O results, three different test values are used for the mass of the universe, to see how it effects the amount of mass needed in a galaxy or galactic cluster in order to account for each orbital velocity. The results columns are:

A. Mass of the galaxy according to standard Newtonian gravitational mathematics.

B. Mass via dynama-opacity formula, using a test value for mass of universe, 1.4476 X 10^{56}gr, which requires the addition of a relatively small amount of dark matter to visible matter to account for orbital velocities, and which agrees with Newtonian calculations of the galaxy mass to about 1/3 of the way out from the core of a spiral galaxy toward its visible edge.

C. Mass via dynama-opacity, using a minimal test value for mass of the universe, 0.5 X 10^{56}gr, which requires a much higher amount of dark matter to account for orbital velocities than has been observed.

---

to special relativity, the energy to consider appears to be only that reaching an orbiting star from within the orbit at any given moment, an amount of energy which is negligible.

[20] George O. Abell, *Realm Of The Universe*, Saunders College/HRW; Philadelphia; 1980, pg. 417

D. Mass via dynama-opacity, using a maximal test value for universe mass of 5.0 X 10^{56}gr, which would not only completely eliminate the need for any dark matter to be involved, but would also eliminate the gravitational role of some of the visible matter - a very unlikely scenario.

Table 1

Galaxy	Orbiter	Orb. Velocity Km/sec.	Radius Kpc	A. Std. Gal. Mass X 10^{10} Solar masses	B. D-O Gal. Mass X 10^{10} sol. ms. w/ Mu = 1.4476 X 10^{56} gr.		C. D-O Gal. Mass X 10^{10} sol. ms. w/ Mu = .5 X 10^{56} gr.	D. D-O Gal. Mass X 10^{10} sol. ms. w/ Mu = 5.0 X 10^{56} gr.
Andr. M31	Star/Gas Cl.	266	24.5	40.0	33.76		36.92	25.22
Milky Way	Sun	220	8	8.9	8.91		8.97	8.70
	Cb. Mono. Cl.	250	18	26.0	23.70		24.17	20.16
	Glob. Clst. 1	250	30	43.6	31.71		37.70	22.93
	Cl. of Mag. 1	250	55	80.0	35.04		48.38	23.23
	Glob. Clst. 2	250	60	87.0	35.10		49.03	23.24
	Cl. of Mag. 2	250	70	102.0	35.12		49.72	23.29
	Satel. Gals.	250	80	116.0	35.13		49.98	23.37
NGC 2998	Star/Gas Cl.	87	0.5	.088	.088		.088	.088
	Star/Gas Cl.	102	1	.24	.24		.24	.24
	Star/Gas Cl.	126	2	.74	.74		.74	.74
	Star/Gas Cl.	142	3	1.40	1.41		1.41	1.40
	Star/Gas Cl.	182	5	3.90	3.84		3.85	3.82
	Star/Gas Cl.	204	8	7.70	7.66		7.71	7.48
	Star/Gas Cl.	214	20	21.0	18.73		20.23	15.41
	Star/Gas Cl.	214	30	32.0	23.24		27.62	16.80

(Milky Way and NGC 2998 data in first five columns of Table 1 are from Vera Rubin, used with permission.)

Table headings abbreviations: *Orb.* = Orbital; *km/sec* = kilometers per second; *kpc* = kilo-parsecs; *Std. Gal. Mass* = Standard Newtonian calculation of galactic mass; *D-O Gal. Mass* = dynama-opacity calculation of galactic mass; *w/* M_u = with mass of universe; *sol. ms.* = solar masses (mass of the Sun); *gr.* = grams. **Orbiter abbreviations:** *Cb. Mono Cl.* = Carbon Monoxide Clouds; *Glob. Clst.* = Globular Clusters; *Cl. of Mag.* = Clouds of Magellan; *Satel. Gals.* = Satellite Galaxies; *Gas Cl.* = Gas Cloud.

Among the three test values for mass of the universe shown above (with the GGC, any value can be tested between 0.5 and 6.0 X 10^{56} gr), 1.4476 X 10^{56} gr seems to be the more likely choice based on current astronomical observations. The specificity of the "1.4476" value used in column B comes from GGC calculations with a series of approximations for universal mass, where results with this quantity most closely matched Newtonian mass calculations for spiral galaxies from the core outward to about 1/3 of the visible radius of the galaxy. This is where orbital motion appears Keplerian and thus is where the two calculation methods should agree.

These examples show how, in the D-O theory, the total mass of the universe greatly effects the amount of mass needed in a galactic system in order to account for observed orbital velocities. And again, this table shows how in D-O theory's column B, the masses of galaxies are close to the pre-1983 estimates that relied mostly on visible matter. One can see for oneself how these results are obtained via the Galactic Gravitation Calculator (GGC) software accompanying this paper (and also available for free Internet download).

II. Mass Of A Galactic Cluster

The observations of Fritz Zwicky and later Allan Sandage,[19a] regarding the velocities of galaxies moving within galactic clusters, indicate that their orbits (assuming the galaxies are in orbit) are not circular, but are instead highly eccentric ellipses, similar in shape to the orbits of comets within our solar system. In relation to the period of any of these orbits, the slice of time within which one observes the motions of these galaxies is so tiny that one can't specifically map the true orbital tracks. In essence, for each galaxy observed, one has a snapshot of its motion at just one single point along its huge orbit, but many snapshots are needed at several well separated points along the orbit to be able to accurately draw the orbit and determine its average velocity. Thus, statistical averaging from the observations of a great many galaxies within a cluster is used to roughly approximate the average velocity and radius of a galaxy's orbit.

Two galactic clusters are shown in the table below, the Local Group of which our own Milky Way galaxy is a member, and the Coma cluster in the Coma Berenices constellation. In the case of the Coma cluster, hypothetical orbiting galaxies are used because the *average* orbital velocities of specific galaxies within the cluster are not known. Instead, based on the motions noted of several galaxies within the cluster at various distances from its center, orbital velocities have been statistically inferred as a function of the distance from the center. This velocity function varies between clusters as their overall mass varies. And so, using this function observed for Coma, the example uses X1, a hypothetical galaxy 4 million LY from Coma's center (1227 kpc), and X2, another galaxy 5 million LY from the center (1533.7 kpc).

Table 2

Gal. Cluster	Orbiting Galaxy	Orb. Velocity km/sec.	Radius Kpc	A. Std. Clst. Mass X 10^{12} solar masses	B. D-O Clst. Mass X 10^{12} sol. Ms. w/ Mu = 1.4476 X 10^{56} gr.		C. D-O Clst. Mass X 10^{12} sol. ms. w/ Mu = .5 X 10^{56} gr.	D. D-O Clst. Mass X 10^{12} sol. ms. w/ Mu = 5.0 X 10^{56} gr.
Local Grp.	Milky Way	346.6	358	9.99	0.71		1.00	0.48
	Andromeda M31	347.5	322	9.04	0.72		1.00	0.48
Coma Ber.	X1 (hypothetical)	629.41	1227	112.96	2.45		3.47	1.63
	X2 (hypothetical)	710.10	1533.7	179.72	3.14		4.44	2.08

A comparison of column A and Columns B, C and D of this table shows that the Dynama-Opacity based calculation of mass, using any of the three test values for mass of the universe, results in a calculated mass of the galactic cluster that is a fraction of the mass inferred via the standard Newtonian method of calculation. Comparing column B to column A, the D-O calculations result in masses that are between 2% and 8% of that calculated by the Newtonian method. This approaches the estimates of the amount of *ordinary matter* contained in these clusters, which is generally calculated to be about 2% of the mass inferred by the Newtonian method,[21] the latter method implying that nearly 98% of a cluster's mass must consist of dark matter. Again, the reader can confirm these findings by experimenting with the GGC.

[19a] Allan Sandage, Properties Of Galaxies In Groups And Clusters, from "Clusters of Galaxies," eds. W.R. Oegerle, et al, 1990; I'net: http://nedwww.ipac.caltech.edu/level5/Sandage3/Sand_contents.html

[21] Fritz Zwicky, *On The Masses Of Nebulae And Of Clusters Of Nebulae,* The Astrophysical Journal, American Astronomical Society, vol. 86 no. 3, p 217, Oct 1937.
Also: Fritz Zwicky, On The Clustering Of Nebulae, The Astrophysical Journal, American Astronomical Society, vol 95, p.555, 1942.

III. Mass Of The Sun

Now, moving from gigantic space to the relatively small scale and well ordered space of our solar system, the table below shows how the dynama-opacity formula works between planets and the Sun.

Table 3

Star	Planet	Orb. Vel. km/sec.	Radius X 10^6 km	A. Std. Sun Mass X 10^{33} gr	B. D-O Sun Mass X 10^{33} gr w/ Mu = 1.4476 X 10^{56} gr.	kg of mass D-O mass is less than Std mass
Sun	Mercury	47.87	57.91	1.9888	1.9888	.28
	Venus	35.02	108.21	1.9889	1.9889	1.79
	Earth	29.78	149.60	1.9883	1.9883	4.69
	Mars	24.13	227.92	1.9889	1.9889	16.39
	Jupiter	13.07	778.57	1.9932	1.9932	492.89
	Saturn	9.64	1427.00	1.9874	1.9874	1857.70
	Neptune	6.81	2872.46	1.9964	1.9964	5684.26
	Uranus	5.43	4495.06	1.9863	1.9863	9827.77
	Pluto	4.72	5869.66	1.9598	1.9598	13074.04

At the solar system scale, the Dynama-Opacity formula for deducing the mass of the Sun from the orbital velocity and distance from the Sun of a planet, yields nearly identical results as compared to the Newtonian formula. This pattern is a bit obscured in the table above because of a slight lack of precision in the available orbital data -- which has the same effect on both the Newtonian and D-O calculations. Any real difference in results is found about 30 places to the right of the decimal point, which is probably too small to allow measurement by current technology. This difference is shown in the last column, and on Earth, at 4.69 kg (equal to about 10 lbs), it is about the mass of a couple of laptop computers. As far out as Pluto, the difference (13,074 kg or 14.4 tons) equals the mass of nine Taurus sedans. This difference means that at the orbital radius and velocity selected, the Dynama-Opacity Theory requires slightly less mass inside the loop of the orbit to account for the velocity than the Newtonian theory. It does not mean that the mass of the Sun seems less the farther out you go, which would be absurd. The mass inside the orbital loop includes the mass of all closer-in orbiting bodies as well, which keep adding more mass to the total from other planets inside the orbit, the further out one goes. And so if the orbital velocity-radius numbers used are correct at each step outward, then with both the Newtonian and Dynama-Opacity (D-O) formulas, the total mass interior to the orbit will increase -- but with D-O increasing not quite as much as with the Newtonian formula.

The important thing to notice in this table is that for any given planet, the standard and dynama-opacity calculations match (unless one looks 30 decimal places to the right, which there isn't room to show here). So the same dynama-opacity gravitational formula used to deduce mass interior to an orbit at three greatly different scales of space -- galactic cluster, galaxy, and solar system -- has been demonstrated here to closely conform to the data of the universe that so far has been actually visible. Dark matter probably plays a role in Dynama-Opacity based gravitation, but far less of a role than suggested by Newtonian gravitation.

The Opacity Of Matter

The mathematical expression above in Formula (1) depends upon the concept of mass opacity. This theory envisions incompressible elementary particles that result in a compression limit for all matter. This limit's reciprocal value functions as a density limit for matter. Imagine a handful of marbles spread across the top of a table. Push these marbles toward each other, closer and closer, until they all touch. At that point, there is no more give - the batch of marbles is then incompressible. According to this theory, matter that has been squeezed to the compression limit, is absolutely opaque to any form of energy trying to pass through it. But any matter that is not packed to the compression limit of matter would not be completely opaque to energy trying to pass through it, and would have an opacity that could be expressed as a percentage of total opacity.

In this theory, the opacity of an object is found by dividing its mass density by the density limit of matter, which is proposed here to be equal to Planck mass divided by Planck length cubed (M_P/L_P^3) or 8.208394 X 10^{92} gr/cm^3 . This density limit is black hole density, which in this theory, as can be seen here, is an extremely large number at the 92nd power of 10. If this density limit does in fact exist, and in this particular value, then it will help explain a lot of observations of the universe that are otherwise quite puzzling.

The amount of dynama acting between any two particles of matter is a function of the amount of space between them, so that the strength of dynama's push is proportional to the distance between any two particles it seeks to push apart - the greater this distance, the greater is the energy exerting a force between the particles. Conversely, the opacity of matter radiates a gravitational "shadow" in space that causes things to get pushed together by dynama – to gravitate towards each other – as dynama acts between all objects in the universe. How this works in detail is progressively clarified here.

Examples of opacity in our solar system are as follows. The density of planet Earth is 5.4988 gr/cm^3 so if one divides that by the density limit of matter, then the opacity of Earth is 6.699 X 10^{-93} - a very small number because the density of Earth was divided by such a huge number. Thus it seems that Earth is not very opaque, but it is actually far more dense and thus far more opaque than most objects in our solar system. For example, more opacities are, Sun: 1.715774 X 10^{-93} and Neptune: 2.8019 X 10^{-93} .

And what does an opacity characteristic of matter have to do with gravitation? Newton found that the amount of gravitational force acting between two objects is directly dependent on the amount of mass in the objects. This is where opacity is involved, because it is determined by an object's density of mass. It is the opacity of an object's mass that, in this theory, directly accounts for part of the observational evidence of how gravitational force works.

The strength (degree of dynama vacuum) of an object's opacity shadow depends on both the object's opacity and its volume. Multiply these two characteristics of an object and one has a value representing the amount of dynama vacuum that the opacity of a mass is projecting into the space around it. So V_1O_1 represents the volume of object 1 times the opacity of object 1. Put the object into proximity with object 2, and their opacity shadows - dynama vacuums - combine. But vacuums of what dynama? Vacuums created by the blocking by these objects of some of the dynama acting between all the other objects in the universe and these two objects. This gives $V_1O_1 \cdot V_2O_2$. However, the strength of this shadow - dynama vacuum - falls off according to the square of the distance between the centers of mass of the objects, resulting in the formula $V_1O_1 \cdot V_2O_2/d^2$. But another ingredient is needed: a gravitational constant to convert this formula into units of force - dynes. That constant will be proposed below, though first it is necessary to see the relationship between the Newtonian gravitational constant and quantum mechanics.

The Quantum Roots Of The Gravitational Constant

The quantum relationships encoded in the gravitational constant provide the key to the Dynama-Opacity theory's analysis of gravitational phenomena. Max Planck's formulations for the basic quantum values for length, time and mass that he discovered, are known as Planck length (L_p), Planck time (T_p) and Planck mass (M_p). They are intimately involved in quantum mechanics, and in Planck's formulas that define each of these values, the Newtonian gravitational constant "G" is involved. Also involved, are Planck's Constant "h" for Quantum of Action and the constant for the speed of light "c". Common handbook values[19b] for these constants, in centimeter-gram-second (cgs) units of measure, are:

$G = 6.67259 \text{ X } 10^{-8}$ dyne·cm²/gr²
$h = 6.6260755 \text{ X } 10^{-27}$ erg·sec/cycle
$c = 2.99792458 \text{ X } 10^{10}$ cm/sec

Each of Planck's quantum units of measure are derived from these three constants as follows (per Appendix A-1):

Planck length (L_p) $= (Gh/c^3)^{1/2} = 4.0508331 \text{ X } 10^{-33}$ cm/cycle
Planck time (T_p) $= (Gh/c^5)^{1/2} = 1.3512124 \text{ X } 10^{-43}$ sec/cycle
Planck mass (M_p) $= (ch/G)^{1/2} = 5.456213 \text{ X } 10^{-5}$ gr/cycle

With G involved in all three derivations, is it possible that G could be defined in terms of Planck length, time and mass? Yes, as Max Planck apparently found[22] while exploring the relationships between his values for quantum length, time and mass. Such a definition is developed below. The clue as to how this relationship could exist lies in the cgs units of measure incorporated in G. A dyne is 1 cm·gr/sec² so that the cgs units of measure of G resolves as follows:

$$\text{dyne} \cdot \text{cm}^2/\text{gr}^2 = \text{cm}\cdot\text{gr}/\text{sec}^2 \cdot \text{cm}^2/\text{gr}^2 = \text{cm}^3/\text{gr}\cdot\text{sec}^2$$

If cm³/gr·sec² hints at how to combine Planck length/time/mass to derive G, then one could try this: Does $G = L_p^3/M_pT_p^2$?

In fact, this is a valid equation. A calculation of the numerical values involved works out exactly equal to the handbook value of G, as shown here:

$$G = L_p^3/M_pT_p^2$$

$$G = (4.0508331 \text{ X } 10^{-33} \text{ cm/cycle})^3 / 5.456213 \text{ X } 10^{-5} \text{ gr/cycle} \cdot (1.3512124 \text{ X } 10^{-43} \text{ sec/cycle})^2$$

$$G = 66.471124 \text{ X } 10^{-99} \text{ cm}^3/\text{cycle}^3 \ / \ 5.456213 \text{ X } 10^{-5} \text{ gr/cycle} \cdot 1.8257749 \text{ X } 10^{-86} \text{ sec}^2/\text{cycle}^2$$

$$G = 66.471124 \text{ X } 10^{-99} \text{ cm}^3/\text{cycle}^3 \ / \ 9.9618167 \text{ X } 10^{-86} \text{ gr}\cdot\text{sec}^2/\text{cycle}^3$$

$G = 6.67259 \text{ X } 10^{-8}$ cm³/gr·sec² *or* cm·gr/sec² · cm²/gr² *or* dyne·cm²/gr² so that...

$G = 6.67259 \text{ X } 10^{-8}$ dyne·cm²/gr² (exactly the same as the handbook value shown above)

The study of quantum mechanics and sub-atomic particles, with which the spin of the particle makes angular momentum a key factor, led to the discovery of a second tier of Planck values, based on the "bar-h" version of Planck's Constant, where $\hbar = h/2\pi = 1.0545726 \text{ X } 10^{-27}$ erg·sec/cycle:

$L^* = \hbar$ Planck length $= (G\hbar/c^3)^{1/2} = 1.6160485 \text{ X } 10^{-33}$ cm/cycle

---

[19b] 1986 Adjustments of the Fundamental Physical Constants; Pergamon Press; 1986.
[22] Heinz R. Pagels; Perfect Symmetry; Simon & Schuster; NY; 1985; p. 274

$T^* = \hbar$ Planck time $= (G\hbar/c^5)^{1/2} = .5390556 \times 10^{-43}$ sec/cycle
$M^* = \hbar$ Planck mass $= (c\hbar/G)^{1/2} = 2.1767138 \times 10^{-5}$ gr/cycle

Calculation with the above values confirms this functional relationship:

$$G = L_p^3/M_pT_p^2 = L^{*3}/M^*T^{*2}$$

Thus, for the gravitational constant G, it makes no difference whether it is derived from the "quantum of action h" or "quantum of angular momentum ħ " versions of Planck's basic quantum values for length, time and mass, because in the latter case, the "/2π" part of ħ cancels out due to there being the same number of ħ involved in the dividend as in the divisor of the formula defining G.

There are two questions that now arise in considering this way of deriving the gravitational constant:

1. Is this just a circular exercise in redefining constants in terms of each other that has no real meaning - an empty tautology?

2. Is there a clue in this relationship between the gravitational constant and quantum values that points to how gravity works at the quantum level of reality?

In answer to the first of these questions, if the Planck values for length, time and mass are actually absolute units of measure inherent in the functional characteristics of matter at the quantum level, then those units are more elementary than the constant for gravitation that we see operating in our size scale of reality, and so it would seem proper to define it in terms of them. Put another way, from a human observer's point of view, because one can more readily directly measure c and G and h, one might think of them as the primary constants and the Planck units as derived. But space, time and mass are basic commodities of the universe and it is really at the quantum level where they interact. From a truly quantum functional standpoint (that is, from the point of view of the elementary particles or strings where the action really is), it is the Planck units that are fundamental and it is c, G and h (constants of convenience at the human scale) that depend on *them.* Thus, from the quantum point of view, this derivation of the gravitational constant is not a tautology. Perhaps this can be better understood by using an analogy. In response to the question, "What came first, the seed or the tree?" a much stronger argument can be made for the seed because the existence of a tree depends on the seed from which it came, but the existence of the seed does not depend on the particular tree that will grow from it.

In answer to the second question above, there is indeed a clue imbedded in the nature of Newton's gravitational constant.

A Compression Limit Clue Suggests A Density Limit Of Matter

So, how does gravity work at the quantum level? One can look for a clue in the nature of the units of measure that are inherent in the gravitational constant: $cm^3/gr{\cdot}sec^2$. If one looks at what is happening here during just one unit of time, then the time factor can be removed from this relationship, so that just cm^3/gr is left. This seems to suggest the possibility of a compression limit to matter that may determine how gravity works. If so, that compression limit (C_L), based on the Planck values for length and mass would be: $C_L = L_P^3/M_P = 1.218265 \times 10^{-93}$ cm^3/gr , an extremely small space. Its reciprocal is Planck mass divided by Planck length cubed (M_P/L_P^3), which suggests a density limit of matter (D_L). Such a density limit would pack an extremely large amount of mass into a very small space: $D_L = M_P/L_P^3 = 8.208394 \times 10^{92}$ gr/cm^3. According to black hole theory,[23] this would be matter of the density at the core of a black hole. It would be matter packed so tightly as to be absolutely opaque – nothing, no form of energy, could pass through it. However, this amount of matter probably could not actually be compressed into a cubic centimeter, because 10^{92} gr is far more matter than is believed to exist in the entire universe - which is generally estimated to have a total mass in the range of 10^{56} gr. [footnote 22]

A compression limit of matter, if it exists, would prevent a black hole from compressing to a singularity. It would establish an upper limit to gravitational force in the super dense and tiny confines of a black hole. If the entire mass of the universe is about 10^{56} grams, as is often estimated,[24] then if compressed to the compression limit, the mass of the entire universe (M_u) would fit within 10^{-37} cubic centimeters, a very tiny space[25] with a diameter of about 10^{-13} centimeters, which is comparable to the diameter of a neutron.[21]

Newton's gravitational force formula, $F = MmG/d^2$, suggests that as the distance between two centers of mass approaches zero, the gravitational force approaches infinity. But a compression limit of matter would require a revised gravitational formula with a force limit based on the compression limit, and that is what is shown above in Formula (1). Of course, such a formula must be valid at both extreme ends of the range of distances with which the formula must deal, and a wide variety of tests with the GGC has shown this to be true for Formula (1) and its derivatives.

Dynama At The Quantum Level

Again, elementary particles of matter are conceived here as incompressible and totally opaque to dynama. The opacity concept proposes that at the subatomic level of matter, as matter is broken down into smaller and smaller more basic particles like quarks, ultimately indivisible elementary particles (or "strings") exist that are the basic building blocks of all matter.[13] These elementary particles are not necessarily identical, but there is a likely symmetry between different types, which may all be about the same size. In this theory, elementary particles are a conceptual device[26] that have an outer *boundary*, like a skin that is infinitely thin but impenetrable. This may fit the concept of string theory's closed loop strings.[27] The dynama within the particle is incompressible and keeps expanding the particle, but can't get out. Dynama pushing between any two particles cannot pierce the particle's skin and get inside, so it just pushes the two particles apart. Because the particle skin is infinitely thin, it is infinitely expandable, so that there is no limit to its ability to keep expanding under the expansive pressure of the incompressible dynama within. It is convenient to visualize the elementary particles as spherical, but that is not necessary - any shape works the same.

The energy of dynama likely has an extremely short wavelength in order to fit inside an elementary particle. If the length or diameter of an elementary particle is around Planck length, and if the amplitude of

---

[23] "The Search for Black Holes"; Kip S. Thorne; Scientific American, Dec. 1974; also in: Cosmology +1; W.H. Freeman Co.; San Francisco; 1977; p. 63

[24] Isaac Asimov; The Measure of the Universe; Harper & Row; NY; 1983; 339p

[25] This is the result if one multiplies the mass of the universe by the compression limit of matter, so that the volume of a fully compressed universe = M_u X $C_L = 10^{56}$ X $10^{-93} = 10^{-37}$

[26] This "conceptual device" serves as a place marker for whatever turns out to be the real thing. Using such a device has enabled the development of this theory to move forward and deal with galactic observational data, without having to wait for the subatomic issues to be settled.

[27] The potential harmony or discord between this theory and string theory has not yet been thoroughly explored for two reasons: a) string theory is still very much a moving target, and b) development of the Dynama-Opacity Theory has been focused mostly on large scale space. A more intensive exploration of how this theory works in relation to the almost purely theoretical realm of strings remains to be done. Until then, this theory uses the classical concept of elementary particles.

dynama fits within this size, this could put the frequency of the energy of dynama at around 10^{43} - extremely high, the reciprocal of Planck time. Conceivably, due to the very short wavelength of the energy of dynama, with a smaller amplitude than the profile of the particle so as to fit within it, a beam of dynama outside could not bend around an elementary particle to get past it. The beam could only push against the particle, and if there were another particle at the other end of the beam, the beam would act to push them apart.

The Shadow Of Opacity

The characteristics of incompressibility and impenetrability make an elementary particle totally opaque to dynama outside of it - external dynama cannot pass through it. An object built of elementary particles that are put together in a densely packed structure, will be much more opaque to external dynama than a less dense object. Every material object casts a three dimensional gravitational *shadow* in space, insofar as it prevents the energy of dynama acting between an object and everything else in the universe from passing through the object as a consequence of the object's opacity. As this shadow of an object's mass opacity is propagated through space, it falls off in intensity *according to the square of the distance* from the object. The shadow is propagated just like illumination is propagated from a point source of light. (Fig. 1) So what is perceived as gravity is really the absence of antigravity from dynama. Due to the shadow, Newton's principle applies: the gravitational attraction toward a massive object falls off according to the *square* of the distance from the object.

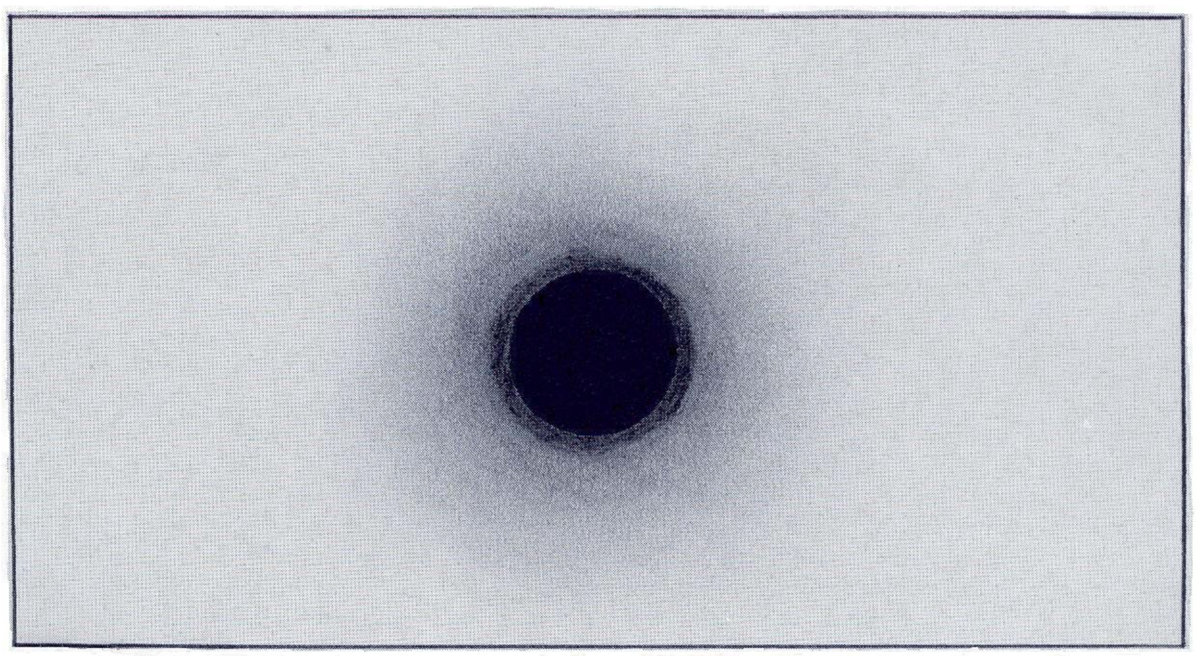


Fig. 1 The Gravitational Shadow

It is because opacity is intimately involved in gravitational interactions that the compression limit is needed in the gravitational constant in order to relate our arbitrary cgs units of measure to the quantum realm where opacity and gravitation actually operate. The enhanced gravitational force formula developed to represent the Dynama-Opacity functionality, Formula (1) shown earlier, yields results coinciding exactly with observational evidence of gravitational phenomena at all scales of space. Interestingly, in order to function correctly, it requires a compression limit of the exact value mentioned earlier.

How Dynama And Opacity Move The Universe

• *Moon and Planet*

Imagine a moon-sized object floating in intergalactic space by itself - no parent planet, no sun-star, and no home galaxy, but at great distances from this object, there are all the other objects of the universe. The pressure from antigravitational dynama acting between the moon-like-object and all the distant objects of the entire universe would be equally applied to all sides of the moon, because the quantity of mass opacity and the average distance of the surrounding universe is about equal in every direction. So in relation to the rest of the universe, the moon, sitting by itself, would tend to be at rest, because there would be no more pressure from dynama pushing on one side than on any other side.

Now put a planet in space near the moon, and the situation is different. From the point of view of the relatively small moon, the energy of dynama in the space between it and the planet results in a force that acts to push the planet and the moon apart. But because the force resulting from the energy of dynama is *proportional to the distance* between two objects, the separating force acting between the planet and the moon is tiny compared to the separating force resulting from dynama that is acting between the moon and all other objects of the rest of the universe, which are enormously distant.

One might think that the effect of dynama on an object is like that of water pressure on something suspended in a deep body of water, and in one sense that analogy is apt, but in another not. The opacity of the elementary particles of the massive planet casts a dynama-shadow in all directions, including toward the moon. The "shadow" is due to the straight line quality of dynama - it cannot bend to pass around objects, due to its short wavelength. In the case of an object submerged in deep water, the water pressure equalizes around the object so that there is no "shadow effect" of water pressure, but in the case of an object in space, dynama's short wave length causes it to cast a shadow beyond an object, just as light casts a shadow beyond an object.

The opacity of the planet prevents some of the dynama from acting between the moon and the part of the universe that is on the opposite side of the planet from the moon. The result is an imbalance in the pressure of dynama acting on the moon between it and the rest of the universe. The blocking by the planet's opacity of long-distance dynama that would otherwise press on the moon, coming from the universe on the other side of the planet from the moon, causes a relative dynama vacuum to exist between the planet and the moon. (Fig. 2) The dynama acting between the planet and the moon is very slight because the distance is so small in relation to the astronomical distances of the rest of the universe, so that this small separating pressure is insignificant compared to the relative dynama vacuum caused by the planet's opacity. So, the moon falls toward the planet, pushed by dynama pressing against the opposite side of the moon from the planet.

(See illustration, next page.)

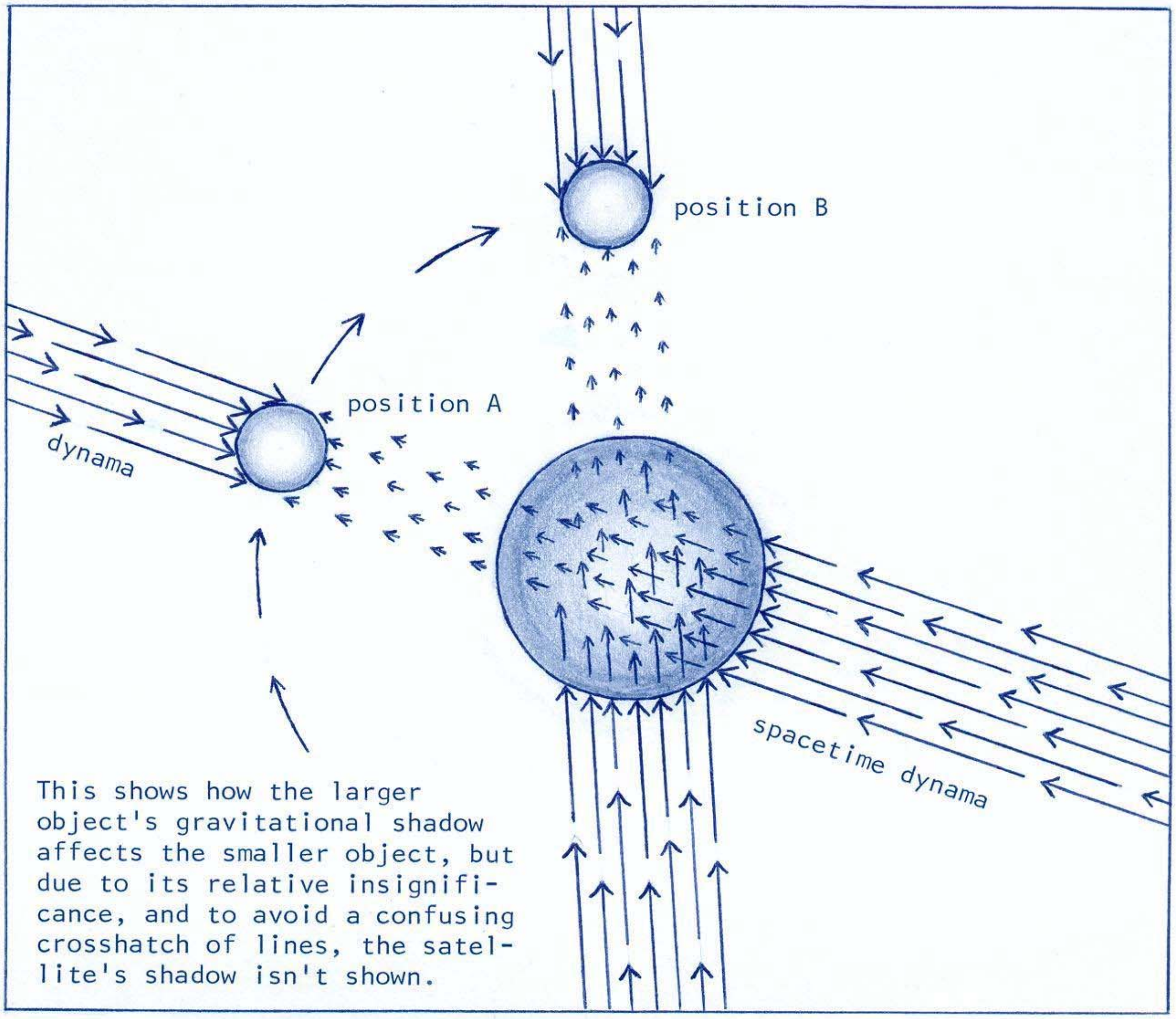


FIGURE 2 A satellite's orbit in the gravitational shadow

• *Planet and Sun*

Now put a star like the Sun in the picture at a distance of about 8 light minutes from the planet. The planet starts to fall toward the star due to the same opacity shadow factors that caused the moon to start falling toward the planet. This causes the planet to move from where it was when the moon started falling toward it. And relative to the planet's motion toward the star, the moon then falls behind the planet. As the planet's opacity shadow moves with the planet, the direction toward which the moon is falling changes, causing it to eventually assume a looping orbit around the planet, like a polka dancer swinging around his or her partner, as the planet falls toward the Sun.

The path of travel of a moon orbiting a planet, in relation to a Sun that both the planet and the moon are orbiting, is not a series of circles, but is like a continuous series of very flat sine waves bent into an orbital ellipse around the Sun. As one views and analyzes this kind of action, it becomes apparent that the motion of a moon around a planet involves two kinds of motion with respect to the planet: vertical and horizontal. The vertical motion is centripetal - the moon falling toward the planet due to gravitational attraction. But when the moon is lined up with the planet and the Sun, on one side or other of the planet, then the planet moves perpendicular to the direction of the fall, so the vertical falling then becomes modified into a sidewise fall, giving the moon's motion a horizontal component - perpendicular to a line drawn from the moon to the planet.

A paradox here is that depending on one's point of view, the orbit of the moon around the planet will appear as a circular ellipse if seen from the planet, or as a flat sine wave as seen from somewhere above the Sun. So which is the correct shape of the moon's orbit? Perhaps strangely, each is absolutely true relative to the observer's inertial frame of reference, and nothing favors the veracity of one point of view over the other.

• *Sun and Galaxy*

If the home galaxy is put in the picture, the massive core of the galaxy projects a dynama shadow, and the Sun falls toward it. Now the Sun isn't where it was when the planet started falling toward it, and as the Sun's dynama shadow keeps moving with it, the direction of the planet's fall into it also keeps moving in a rotating fashion, evolving into an orbit around the Sun. As the Sun falls toward the core of the galaxy, the galaxy is moving within a cluster of galaxies, causing the galaxy's core to shift from where it was when the sun started falling toward it, and this causes the Sun's "falling" track to also be modified into an orbit. So there are loops within loops within loops.

Thus, the opacity-shadow influence of a hierarchy of progressively more massive bodies tends to put things in motion, and once the motion is started, these motions evolve into looping orbits at each level of the hierarchy.

Gravitational Constant G_2

Returning to the Dynama-Opacity formula (1) above for gravitational force, the formula requires two constants of proportionality to relate the interaction between volume, opacity and distance, to force. As already demonstrated, it has been found that the regular Newtonian gravitational constant can be resolved into Planck units of measure. Based on this observation, one can try to build the first of these new gravitational constants from Planck units and see if a useful value emerges. First, one needs to find out what units of measure are missing that are needed to convert the result to dynes. The units of measure of a dyne of force are: gm · cm / sec^2. $V_1O_1 \cdot V_2O_2/d^2$ gives cm^3 · cm^3 / cm^2 ...or cm^4 . So one needs to multiply by gm / cm^3 · sec^2 to get a result in the units of measure for a dyne. This will occur if one multiplies by: Planck mass divided by the product of Planck length cubed and Planck time squared, or $M_P/L_P^3 \cdot T_P^2$, which results in 4.4958418 X 10^{178} gm / cm^3 · sec^2 for this new gravitational constant of proportionality, which is called G_2 to distinguish it from the Newtonian gravitational constant. So the formula is now $V_1O_1 \cdot V_2O_2 \cdot G_2/d^2$. As shown in the test results section below, tests of this part of formula (1) yield the same results for gravitational force as the Newtonian formula within the spatial scale of the solar system.[28] (The second part of formula (1) adds a negligible force at this scale of space.)

---

[28] Originally, this part of the formula was $V_1O_1 \cdot V_2O_2 \cdot V_uO_u \cdot (G_2/ M_uC_l)/d^2$ to reflect the involvement of all of the matter of the universe in the gravitational relationship between any two objects. The V_uO_u in the first section is equivalent to M_uC_l below the divisor in the next section, so these two elements cancel each other out. Essentially, this canceling-out is because the influence of the mass of the universe is being applied equally on all sides of the two objects being studied. However, this doesn't mean that the mass of the universe plays no role in the gravitation between the two study objects. Gravitational force depends on the strength ("darkness") of the gravitational shadow, which is determined by the ratio between the pressure being applied by dynama on one side of both objects and the pressure of dynama that is able to pass through both objects into the space between them. This ratio depends only on the

The Sun/Earth Test

• *Newtonian Version*

First, here is the familiar Newtonian gravitational force formula: $F = MmG/d^2$, where M is the mass of the first of two objects, m is the mass of the second object, G is the gravitational constant 6.67259×10^{-8} $dyne \cdot cm^2/gr^2$. The units of a dyne are $gr \cdot cm/sec^2$, so for simplicity, the units of G are resolved to $cm^3/gr \cdot sec^2$. Now, to calculate the gravitational force between the Earth and the Sun at the Earth's average orbital radius from the Sun, here is the basic data:

Sun: mass 1.989×10^{32} gr
Earth: mass 5.976×10^{27} gr; average orbital radius from Sun 1.49596×10^{13} cm

So that…

$$F = 1.989 \times 10^{32}\ gr \cdot 5.976 \times 10^{27}\ gr \cdot 6.67259 \times 10^{-8}\ cm^3/gr \cdot sec^2 / (1.49596 \times 10^{13}\ cm)^2$$

$$F = 79.31 \times 10^{51}\ gr \cdot cm^3/sec^2\ / 2.2379 \times 10^{26}\ cm^2$$

$$F = 35.4 \times 10^{25}\ gr \cdot cm/sec^2$$

$F = 3.54 \times 10^{26}$ dynes - the gravitational force between Earth and Sun, Newtonian calculation.

• *Dynama-Opacity Version*

Now the dynama-opacity calculation can be tested. However, one must keep in mind that a building-block approach is being used here to explain the workings of the dynama-opacity formula. The calculation above does not yet include a component to handle the separating antigravitational action of dynama that becomes effective in large scale galactic space - that part will be examined later. Nor does it include a component to handle the gravitational compression limit, which rules in small scale sub-atomic space - that part is irrelevant in this larger scale of space. The above calculation only includes the part of the dynama-opacity force formula to handle our familiar scale of experience - the scale of the solar system. Gradually, components to handle larger scales of space will be added in this building-block method, and demonstrated at each stage to show how each component works. Again, the portion of the Dynama-Opacity gravitational force formula that most directly applies to the solar system scale of space is: $F = V_1O_1 \cdot V_2O_2 \cdot G_2/d^2$.

---

relationship between V_1O_1 and V_2O_2 because it is only their masses that creates the shadow that causes gravitation, even though the source of most of the antigravitational pressure (which gets shadowed, thereby causing gravitation) is the dynama acting between the rest of the universe and the two objects. Another way of saying this is that this first part of the formula is measuring just gravitation, not antigravitation, and though the rest of the universe is involved by providing the antigravitation that pushes the two objects together, it is only the two objects that are creating the gravitational shadow that is the immediate source of the gravitational attraction between these objects.

The basic data is:

Sun (object 1): volume 1.4122653×10^{33} cm^3 opacity 1.715774×10^{-93}

Earth (object 2): volume 1.08678×10^{27} cm^3 opacity 6.699×10^{-93}

$G_2 = 4.4958418 \times 10^{178}$ gm/cm$^3\cdot$sec^2 - calculated above.

So that…

$$F = V_1O_1 \cdot V_2O_2 \cdot G_2/d^2$$

$$F = 1.4122653 \times 10^{33} \text{ cm}^3 \cdot 1.715774 \times 10^{-93} \cdot 1.08678 \times 10^{27} \text{ cm}^3 \cdot 6.699 \times 10^{-93} \cdot 4.4958418 \times 10^{178} \text{ gm/cm}^3\cdot\text{sec}^2 / (1.49596 \times 10^{13} \text{ cm})^2$$

$$F = 17.641 \times 10^{126} \text{ cm}^6 \cdot 4.4958418 \times 10^{178} \text{ gm/cm}^3\cdot\text{sec}^2 / 2.2379 \times 10^{26} \text{ cm}^2$$

$$F = 79.31 \times 10^{51} \text{ gr}\cdot\text{cm}^3/\text{sec}^2 / 2.2379 \times 10^{26} \text{ cm}^2$$

$$F = 35.4 \times 10^{25} \text{ gr}\cdot\text{cm/sec}^2$$

$F = 3.54 \times 10^{26}$ dynes - the gravitational force between Earth and Sun, dynama calculation.

One can see here that so far the Dynama-Opacity calculation results in the same force value as the standard Newtonian formula. It is also apparent from this that volume-opacity values can be converted to mass values and vice versa, with the help of an appropriate constant of proportionality. This is useful, because the data needed for mass-based calculations are easier to acquire than the volume and density data needed for volume-opacity calculations. On the other hand, the advantage of the volume-opacity formula, versus the standard mass-based formula, is that it shows how dynama interacts with the dynama-shadow resulting from opacity to create a gravitational field of attraction in the vicinity of a massive object.

Antigravitation

The effect of the antigravitational component of Formula (1) will now be examined. In the part of the formula shown above, an accounting is only given for the gravitational effect of the dynama-opacity shadow, and not for the antigravitational effect of dynama acting between objects to push them apart. Because dynama is so weak, but adds up over distance, it takes an enormous expanse of space before it becomes a significant factor in pushing things apart antigravitationally. In a spiral galaxy the size of the Milky Way, an orbiting object would have to be about 1/3 of the way out from the galactic core before the spreading effect of dynama, acting to expand the universe, has a measurable effect on the orbital motion of the object around the core. From there on out, the force acting on the object from the spreading-apart effect of dynama is being added at about the same rate as the "attraction" from the core's dynama-opacity shadow is dissipating, so that the net orbital velocity remains nearly constant for objects at all distances further out from the core. Here is how this works.

Dynama and mass opacity result in forces being applied in two ways to a star orbiting a galaxy. First, there is the force from the shadow effect emanating from the core of the galaxy, superimposed on the shadow effect emanating from a star similar to the Sun in our solar system. This force is represented as F_1, so that:

$F_1 = V_1O_1 \cdot V_2O_2 \cdot G_2/d^2$

The second force resulting from dynama's expansion of space between the core of the galaxy and the star, one can call F_2, the antigravitational force, and the first part of its calculation is similar to that of F_1, but with an additional element. The volume-opacities of the two objects are now multiplied by the volume-opacity of the universe, representing all the other objects in the universe at great distance from the two foreground objects, and which have antigravitational dynama acting between them and the two objects. The product of these volumes and opacities is multiplied by the distance between the centers of mass of the first two objects and also by an additional gravitational constant of proportionality, G_3:

$F_2 = V_1O_1 \cdot V_2O_2 \cdot V_uO_u \cdot G_3 \cdot d$

The multiplication of the volumes and opacities by the distance between the objects is done because the force caused by the energy of dynama increases in direct proportion to the increase in the amount of space between the objects. Dynama is everywhere in space, and along a line between two objects, it increases proportionately as the distance increases.

The Rest Of The Universe And A New Constant

Note that here is where the Dynama-Opacity theory includes *the rest of the universe* as a third player in any gravitational interaction between two objects. Dynama acts between the rest of the universe and the two objects being considered, thereby providing the antigravitational pressure that is being shadowed by the opacities of the two objects, resulting in the gravitational attraction within the overlapping dynama-shadows of these objects.

As with all gravitational and antigravitational calculations, a constant of proportionality is needed to convert the result of the F_2 part of Formula (1) from the quantum level of activity into the dynes of force method of measurement used at the human scale of space.

Again, one can rely on the Planck units of measure to point toward the value of this third gravitational constant because gravitational and antigravitational interactions actually occur at the quantum level of existence, where Planck units of measure rule. As suggested before, to find the value for such a constant, one first has to determine what units of measure are missing in order to give the formula's result in dynes. Then one can use those missing units to indicate a combination of the Planck units that may give the constant needed. In this case, the missing units are $gm/cm^9 \cdot sec^2$.

Deciphering the required combination of Planck units needed to provide the value of the constant isn't straight forward, and requires including an empty dimensional factor, $1cm^7$ to make the accounting for measurement units work out. When the Planck units and the empty dimensional factor are inserted into the missing units above, the result is $M_P/L_P^2 \cdot T_P^2 \cdot (1cm^7)$ which works out to: 1.82119×10^{146} $gr/cm^9 \cdot sec^2$. In another version of this formula used later, in which all of the volume-opacities are converted to mass, then the gravitational constant will change to one in which no empty dimensional factor will be needed. One should keep in mind that the purpose of gravitational constants in all gravitational calculations is to translate the arbitrary human-scale units of measure – centimeters, grams and seconds - into the apparently real and ultimate units of measure of the quantum scale of existence, which is where observational evidence says that most things really happen.

Converting Volume-Opacity To Mass

However, there is a problem with this antigravitational part of Formula (1). On the one hand, it shows how dynama works in the far reaches of space. On the other hand, it is impractical because there is currently only a very vague notion as to the volume of the universe, and just a rough approximation of its average density upon which to base a calculation of the universe's opacity. But there is a reasonable fix for this problem. One can convert volume-opacity into mass multiplied by a constant (the compression limit of matter) as follows: $VO = m \cdot C_L$ where m is mass. Using this relationship, a conversion can be made of the two vaguely known values $V_u O_u$ into a nearly-known value (the mass of the universe) and a constant. Actually, according to conservation of matter and energy, the mass of the universe is also believed to be nearly a constant,[29] though its exact value isn't yet known. By making this transformation, the F_2 formula for antigravitation is now:

$F_2 = V_1O_1 \cdot V_2O_2 \cdot M_uC_L \cdot G_3 \cdot d$ where M_u is the mass of the universe and C_L is the compression limit of matter.

As mentioned above, the principle of conservation of matter and energy suggests that the mass of the universe is approximately constant. Based on the universe seen by astronomers so far, various estimates of the total mass of the universe range between of 10^{55} to 10^{56} grams. During experimental work on this theory, calculations of the mass of a spiral galaxy using various trial values for the mass of the universe pointed to 1.4476 X 10^{56} grams as a likely value, because at 1/3 the distance from the center (the edge of the radius where orbits appear Keplerian), it resulted in about the same mass for the galaxy as obtained via the Newtonian method. It seems reasonable to assume that where the orbits are Keplerian, the Newtonian and D-O calculations for galactic mass should match. So this 1.4476 X 10^{56} grams value [footnote 30] is used here for the mass of the universe even though it may eventually have to be revised. In any case, it's close enough for the purposes of the following calculations.

It may be noticed that in all calculations at every scale of space, the measurement units used are centimeters, grams and seconds, rather than kilometers or kilo parsecs, or light years, or kilograms or solar masses. This is to maintain consistency of measurement units for all scales of space. There seems to be no real advantage here in using the large scale types of units as long as the correct exponents are shown – especially when programming a computer to do the calculating. In fact, the exponents readily show in which scale of space one is operating.

Accounting For Antigravitation F_2

Now, one can see how insignificant F_2 antigravitation is within the relatively tiny spatial realm of the solar system, and then how big its role becomes in the large space of a spiral galaxy. First, the calculation of antigravitational F_2 for Earth and Sun is shown.

$F_2 = V_1O_1 \cdot V_2O_2 \cdot M_uC_L \cdot G_3 \cdot d$

Sun (object 1): volume 1.4122653 X 10^{33} cm^3 ; opacity 1.715774 X 10^{-93}

---

[29] Because $E = mc^2$ matter can be converted into energy, and vice versa. So the mass of the universe could vary to the degree that the conversion of mass into energy and of energy into mass throughout the universe are not equal. But it is expected that these processes are in approximate equilibrium.

[30] Centimeters, grams and seconds are often used in calculations shown here - instead of solar units, kiloparsecs and light years - to enable direct comparisons between measurements at solar system, galactic and intergalactic scales of space by using the same measurement system.

Earth (object 2): volume 1.08678×10^{27} cm^3 ; opacity 6.699×10^{-93}

Mass of the universe: 1.4476×10^{56} gr

Compression limit of matter: 1.218265×10^{-93} cm^3/gr

Gravitational constant G_3: 1.82119×10^{146} gr/cm^9·sec^2

Average distance between Sun and Earth: 1.49596×10^{13} cm

$F_2 = 1.4122653 \times 10^{33}$ cm^3 ·1.715774×10^{-93} ·1.08678×10^{27} cm^3 · 6.699×10^{-93} · >>>
1.4476×10^{56} gr ·1.218265×10^{-93} cm^3/gr ·1.82119×10^{146} gr/cm^9·sec^2 ·1.49596×10^{13} cm
(the symbol >>> means that the formula continues on the next line)

$F_2 = 84.7605 \times 10^{-4}$ dynes or if the decimal is moved left one space: 8.47605×10^{-3} dynes.

As can be seen here, within the solar system's scale of space, the amount of F_2 antigravitational force involved between the Sun and the Earth is much less than the amount of force involved in a handshake. Such a tiny force between Sun and Earth is unmeasurable. Even at the much larger distance between Sun and Pluto, it would barely be measurable. So this force plays no significant role in preventing a planet from falling into the Sun - that role is performed by the planet's orbital velocity and momentum, on a track essentially perpendicular to the direction from the planet to the Sun.

But the strength of the F_2 antigravitational force increases with the expanse of space, due to the distance multiplier in the formula. So at the vast reaches of space between the core of a spiral galaxy and its outlying orbiting stars, this antigravitational component of dynama-opacity becomes a very significant force, as shall now be shown. This example is for a star in a galaxy like the Milky Way, orbiting near the galaxy's outer visible edge at 18 kpc.

$F_2 = V_1O_1 \cdot V_2O_2 \cdot M_uC_L \cdot G_3 \cdot d$

Galaxy within star orbit (object 1): volume 7.166639×10^{68} cm^3 ; opacity 8.01275×10^{-118}
Given a star orbiting at 18 kpc and an average density for the galaxy of 6.577×10^{-25} gr/ cm^3

Star (object 2): volume 1.4122653×10^{33} cm^3 ; opacity 1.715774×10^{-93}

Mass of the universe: 1.4476×10^{56} gr

Compression limit of matter: 1.218265×10^{-93} cm^3/gr

Gravitational constant G_3: 1.82119×10^{146} gr/cm^9·sec^2

Average distance between the Star and galactic core: 5.55156×10^{22} cm (= 18 kiloparsecs)

$F_2 = 7.166639 \times 10^{68}$ cm^3 · 8.01275×10^{-118} ·1.4122653×10^{33} cm^3 · 1.715774×10^{-93} · >>>
1.4476×10^{56} gr ·1.218265×10^{-93} cm^3/gr ·1.82119×10^{146} gr/cm^9·sec^2 ·5.55156×10^{22} cm
(>>> means that the formula continues on the next line)

F_2 = 2481.042 X 10^{21} dynes or if one moves the decimal left three spaces: 2.481042 X 10^{24} dynes.

This is equal to about 1% of the total gravitational force acting between the Earth and the Sun. So F_2 is still a minor part of the combined gravitational and antigravitational force between the galaxy and the star, but a force that is beginning to be significant at this distance from the galactic core, and that continues to increase the farther one gets from the core because the separating action of dynama increases with distance. Meanwhile, the attraction from the gravitational shadow of the galaxy continues to diminish as distance from the core increases. So just how significant is this increasing antigravitational F_2 at an 18 kiloparsec distance from the core in relation to diminishing gravitational F_1? (For a sense of scale, a single kiloparsec is equal to a distance of 3,260 light years or 3.0842 X 10^{21} cm, so that 18 kpc is equal to 58,680 light years or 5.55156 X 10^{22} cm.) A calculation of F_1 shows as follows.

$F_1 = V_1O_1 \cdot V_2O_2 \cdot G_2/d^2$

Galaxy within star orbit (object 1): volume 7.166639 X 10^{68} cm^3 ; opacity 8.01275 X 10^{-118}

Star (object 2): volume 1.4122653 X 10^{33} cm^3 ; opacity 1.715774 X 10^{-93} ;
distance 5.55156 X 10^{22} cm (equal to 18 kpc)

G_2 = 4.4958418 X 10^{178} $gm/cm^3 \cdot sec^2$

F_1 = 7.166639 X 10^{68} cm^3 · 8.01275 X 10^{-118} ·1.4122653 X 10^{33} cm^3 · 1.715774 X 10^{-93} · >>>
4.4958418 X 10^{178} $gm/cm^3 \cdot sec^2$ / (5.55156 X 10^{22} cm$)^2$

F_1 = 625.5823875 X 10^{68} $gr \cdot cm^3/sec^2$ / 30.8198 X 10^{44} cm^2

F_1 = 20.298 X 10^{24} dynes

Compare this to the antigravitational separating force, calculated by the same method above, whereby F_2 = 2.481042 X 10^{24} dynes, which is 10% as strong as the F_1 force at this distance. Very significant indeed. But then there is the question of why doesn't the F_2 force cause the star to exit the galaxy in an outward-bound spiral? The answer is that it is exactly synchronized with the expansion of space by dynama. If space were not expanding, then of course the star would escape the galaxy. But the constant expansion of space from the action of dynama has caused the galaxy to enlarge outward, exactly at the same pace that F_2 is pushing the star outward, so the star doesn't escape. This enlargement cannot be sensed by an observer because all standards of measure are also expanding at the same rate.

The Dark Matter Requirement Greatly Shrinks

Now for a look at what F_1 and F_2 are at a distance of 28 kilo parsecs or 8.63576 X 10^{22} cm from the galactic core, and with a visible galactic mass inside the star's orbit of 30.9 X 10^{10} solar masses, or 6.1375 X 10^{44} gr. If the Newtonian gravitational formula is used to calculate the galaxy's mass inside the orbit based on the orbit's radius and velocity, then a mass of 40.6678 X 10^{10} solar masses is inferred, requiring the assumption that a huge amount of unseen mass exists within the orbit. But because the dynama-opacity theory does not require huge amounts of dark matter to account for orbital velocities, the mass value used here corresponds mostly to the matter that can actually be seen. Some dark matter, however, may still be required. From the values V_1 = 2.6977 X 10^{69} cm^3 and O_1 = 2.772 X 10^{-118}, and using the same formulas as demonstrated above, at this distance F_1 is 1.092 X 10^{25} dynes and F_2 is 5.0258 X 10^{24} dynes. This indicates that F_2 continues to increase while F_1 decreases as the distance from the galactic core increases, and so here F_2 is now 46 % as strong as F_1.

Add Or Subtract Antigravitation?

F_1 and F_2 push on the star from opposite sides, implying that the net gravitational and antigravitational force acting on the star would be equal to F_1 minus F_2. Not necessarily. Imagine a plastic 2 liter sized soda bottle filled with water, on its side and strapped to a table. Imagine taking the cap removed from the mouth of the bottle, and water starting to dribble out. Press between straps on one side of the bottle and water squirts out of the mouth vigorously. Then, at the same time, press on the other side of the bottle so it is getting squeezed from opposite sides at once. Does the water flow stop because opposing forces are canceling each other? No. The water shoots out even more vigorously because twice the total force is being applied, even though the two forces involved are being applied to opposite sides of the bottle. Granted, this is not an exact analogy. But it does show how two opposing forces can be additive in a direction that is perpendicular to the application of the forces.

The gravitational (F_1) and antigravitational (F_2) forces acting on a body are generally additive, and the sum of these forces is the total measurable force resulting from dynama on the body. (The key word here is "measurable," as will be seen.) But this is counterintuitive with respect to classical physics, where forces are usually treated as vector quantities - acting toward a particular direction. The problem here is that as dynama pushes space outward between the core of a galaxy and an outlying star, the effect on the star has two force components, one that can be seen and one which is invisible to us. The one that can be seen is the force component acting in the direction of the star's orbital movement. The invisible component is acting directly outward from the galaxy's core - but it can't be seen by us because it is what causes the entire galaxy to expand outward in time-size. And again, because we, our space, and all our systems of measure are expanding into the fourth dimension (time) in exact synchronization with the galaxy's expansion, we can't directly measure or sense its expansion. So again, that is why the outward pushing action of dynama doesn't appear to make the star move in an outward spiraling escape path.

As dynama pushes the star outward from the center of the galaxy, the spaces within and between every ultimate particle of the star and the galaxy are expanding in lock step. As dynama pushes the star out, the galaxy expands outward, so that an orbital path, which in the absence of such expansion into the fourth dimension would trace an outward spiral in three dimensional space, instead appears as a circular orbit in 3-D space. (See Appendix p. A-2, "Constant Size Relationships," for a more detailed explanation of how size relationships are maintained as the universe expands within and between all things.)

But the force component from antigravitational dynama acting in the direction of the star's orbit *is* acting just in three dimensional space, allowing us to see and measure it, and this is the F_2 antigravitational force of the Dynama-Opacity Theory. Because the F_2 force acts in the same direction as the F_1 force, it adds to the F_1 force, which accounts for the star's greater-than-Keplerian orbital velocity.

The Perspective Factor From Increasing Distance

Experimentation with the GGC showed that there had to be a diminishing rate of increase in force F_2 as distance from the center of a galaxy increased. Otherwise, the calculated increase in mass of the galaxy with distance from the core would not proceed along a smoothly changing curve. In earlier versions of this theory, it was proposed that a curvature of space throughout the universe would account for this effect. But later, it was found that this diminishing rate is more likely due to the narrowing of the perspective view of the inner bulk of the galaxy as one's point of view moves farther out from the core. In this case, the curvature of overall space is not a necessary requirement. As object A and object B get farther apart from each other - perhaps a spiral galaxy and an outlying star orbiting around it - the silhouette image of each gets smaller in the sky of the other, and as this occurs, the lines of dynama acting between them progressively overlap. Two overlapped lines act as one, because the action of dynama between objects is between the elementary particles of those objects. As the objects get farther apart, the visibility of the elementary particles of one object to the other object becomes more restricted by perspective parallax, like the effect of looking down a straight set of railroad tracks where one sees the rails seem to come together.

The elementary particles of object A, when viewed close up from object B, appear separate and distinct with a lot of space between them. But as the distance increases between A and B, the elementary particles of A as seen from B begin to cover each other up, and the apparent space between the particles seems to decrease toward vanishing. Eventually, with enough distance, the silhouette of object A as seen from B would be equal to the silhouette of a single elementary particle as seen on object B, so that only a single line of dynama would be acting between A and each of the elementary particles of B over this enormous distance.

A factor was introduced into the theory of dynama to account for this decreasing increase of the antigravitational effect of dynama. The distance between objects A and B would be divided by this factor, a distance divisor, which is the *{nPerspective}* sub-formula shown here in its entirety:

$$1 + d^2/([\text{mass of universe}/\{.1453 \cdot \text{mass of universe}^{1.666}\}] \cdot \pi^3 \text{ X } 10^{44}\text{ cm}^2)$$

|____________________ {nLimit} ____________________________|

|______________________ {nPerspective} __________________________|

In the Galactic Gravitation Calculator's programming, the result of the *portion* of this sub-formula that is within regular parentheses ( ) is symbolized as *{nLimit}*, and the result of the *whole* sub-formula is called *{nPerspective}*. Division of d by {nPerspective} has practically no effect when the distance is less than 20 kpc, but above that distance, its effect increases, moderating F_2, until eventually, it prevents any further increase in F_2.

The .1453 and $^{1.666}$ values of {nLimit} were found via an essentially two step process. First, the dynama-opacity formula for gravitational force was transposed into a formula for finding the mass of a galaxy (this is shown in a later section where this process is explored in more detail), incorporating {nPerspective} and its subsidiary {nLimit} factor. Then GGC experiments were done with different test values of {nLimit} for each possible value of the mass of the universe between .5 X 10^{56} grams and 5 X 10^{56} gr, at intervals of .5 . In each case, a value of nLimit was identified that provided smoothly increasing calculations for the mass of a spiral galaxy at 29 kpc and 73 kpc. It was apparent that the successful values for {nLimit} increased by about 30 with every integer increase in the test value for the mass of the universe. If the mass increased by 5 X 10^{56} gr, then {nLimit} increased by about 30, which is close to Pi cubed. Second step: the results of this table of values were entered into the KaleidaGraph program,[31] which can convert sequential data into a mathematical formula, and this resulted in the .1453 · mass of universe$^{1.666}$ part of the {nLimit} formula. The rest of the formula was deduced as follows. First, there is the scale of space in which the data is working: 10^{22} cm, which when squared (related to the silhouette of the distant object) is at the scale of 10^{44} cm^2; again, Pi cubed, which is about 30, is used due to the discovery that {nLimit} increases by about 30 with every integer increase in tested mass of the universe X 10^{56} gr; and of course, the mass of the universe is involved because that is the assumed independent variable in the calculation of {nLimit}.

---

[31] The work with KaleidaGraph was performed by Winston M. Seiler.

To review this concept: When applied to d, as in d/[1 + (d · d/{nLimit})], the {nPerspective} distance divisor - the part of this formula between [ ] brackets - means that if the distance is small, then it is essentially divided by 1, causing no decrease in the effect of the first d. But if the distance is large, then within the parenthesis, d is multiplied by a percentage resulting from dividing d by the limit factor. This percentage of d is then added to 1, and the larger the number resulting from this sum, then the less effect the first d will have. This entire divisor limits the maximum value of the antigravitational F_2 formula.

With the addition of {nPerspective} to the F_2 formula that calculates the antigravitational separating force acting between two objects as the distance between them increases, the formula becomes:

$$F_2 = V_1O_1 \cdot V_2O_2 \cdot V_uO_u \cdot G_3 d / \underbrace{[\ 1 + d^2/\{nLimit\}\ ]}_{nPerspective}$$

Earlier, it was shown that the primary gravitational force resulting from the opacity-dynama shadow effect is represented by:

$$F_1 = V_1O_1 \cdot V_2O_2 \cdot G_2/d^2$$

The Complete Dynama-Opacity Formula

The complete gravitational force equation,[32] based on Dynama-Opacity and the $F = F_1 + F_2$ concept, prior to mathematical simplification and where V = volume and O = opacity, is:

$$F = V_1O_1 \cdot V_2O_2 \cdot G_2/d^2 + V_1O_1 \cdot V_2O_2 \cdot V_uO_u \cdot G_3 d/[\ 1 + d^2/\{nLimit\}\ ]$$
with lower limit of d = CubeRoot{ ($V_1O_1 + V_2O_2$)/ 4/3 π } (explained on next page)

Then, if restated in a mathematically more simplified form:

(1)

$$F = (\ V_1O_1 \cdot V_2O_2)(\ G_2/d^2 + V_uO_u \cdot G_3 d/\overbrace{[\ 1 + d^2/\{nLimit\}\ ]}^{nPerspective}\ )$$
with lower limit of d = CubeRoot{ ($V_1O_1 + V_2O_2$)/ 4/3 π }

where:

V = volume of object in cm^3 ($_1$ = 1st object; $_2$ = 2nd object; $_u$ = universe)
O = opacity, a decimal fraction derived: object's density divided by density limit of matter
$G_2 = M_p/T_p^2L_p^3 = 4.4958418 \times 10^{178}$ gr/sec^{2}cm^3 (2nd grav. constant translator)
$G_3 = M_p/L_p^2T_p^2(1cm^7) = 1.82119 \times 10^{146}$ gr/cm^{9}sec^2 (3rd grav. constant translator)
d = distance between the centers of mass of objects 1 and 2
{nLimit} = expansion rate limiter = 166.798 cm^2 X 10^{44} (for $M_u = 1.4476 \times 10^{56}$gr)
= [mass of universe/{.1453 · mass of universe$^{1.666}$}] · Pi^3 X 10^{44} cm^2

[32] The action-at-a-distance relativity problem of gravitation is treated thus: because all matter was once connected at the Big Bang, the field of elastic spacetime expanding in and between all particles has maintained a gravitational connection ever since, but with decreasing immediacy (as to a change in one body affecting another) over distance. So a calculated gravitational force between two objects is accurate with regard to a particular spacetime point of reference from which the variables were observed.

The *lower limit* to gravitational force operates at the quantum level of spatial dimensions, as the distance between the centers of mass of two objects approaches the sum of their radii, if both objects (now compressed to tiny spheres) have been compressed to the compression limit of matter.

This formula shows how gravity works in dynama theory's opacity-based system: the force of gravity depends on an interaction between the volumes and opacities of object 1, object 2, and the rest of the universe. This involves the gravitational shadows from opacities between objects 1 and 2 (at G_2), and the separating action of dynama between objects 1 and 2 (at G_3). But this is a difficult formula to work with because the volume and opacity of the universe are presently unknown. However, by substitution of the relationship VO = mass *times* the compression limit of matter, C_L , a mass value can be used with regard to the universe. This way it is only necessary to estimate the mass of the universe M_u -- easier than having to estimate both its volume and density. Thus:

(2)
$F = (V_1O_1 \cdot V_2O_2)(G_2/d^2 + M_uC_L \cdot G_3d/[1 + d^2/\{nLimit\}])$
with lower limit of $d = CubeRoot\{ (V_1O_1 + V_2O_2)/ 4/3 \pi \}$

$C_L = 1.218265 \times 10^{-93}$ cm^3/gr (compression limit of matter = L_p^3/M_p)
$M_u = 1.4476 \times 10^{56}$ gr (an estimated mass of the universe - other values may be used)

Transformation Of Volume-Opacity To Mass

Again, the volume-opacity based force formula shows *how* gravity works, not just *what* happens. But a problem with it is that it is a nuisance to calculate - you have to know the volume and opacity (density of object divided by maximum possible density) of each of the three objects involved in order to do the calculation. Using the analogy of a car engine, the opacity formula is like having to hand crank the engine in order to start it versus just putting a key in the ignition switch and turning it to "start." The hand crank method demonstrates *how* the engine actually starts, whereas the key-in-the-ignition method does *what* is desired without bothering with the details of *how*.

The Newtonian gravitational force formula is a *what's* happening not a *how* it's happening formula. The problem with it, when considering large scale galactic and intergalactic space, is that it is incomplete, and until seeing *how* gravity works, one can't really see what is missing from the Newtonian approach. The opacity based gravitational force formula shows *how* gravity works, and so now one can complete the Newtonian formula so that it will apply not only within the space of the solar system but in all larger scales of space as well. This is done via a transformation of volume and opacity elements of the opacity based formula to mass. The key to this transformation, mentioned earlier, is that $VO = m \cdot C_L$ where m is mass and C_L is the D-O Theory's compression limit of matter = L_p^3/M_p . Thus $VO = mL_p^3/M_p$. So here is the transformation...

(3) Starting with the revised opacity based formula (2) from above:

$F = (V_1O_1 \cdot V_2O_2)(G_2/d^2 + M_uC_LG_3d/[1 + d^2/\{nLimit\}])$
with lower limit of $d = CubeRoot\{ (V_1O_1 + V_2O_2)/ 4/3 \pi \}$
(See values defined above on p. 24.)

(4) Replace "VO" components, and translate constants into their Planck functional values to facilitate the resolving of like terms (the constants G_2, G_3 and G_f are noted in the space above their translations):

$$\overset{G_2:}{} \qquad\qquad\qquad \overset{G_3:}{}$$
$$F = (M \cdot L_p^3/M_p \cdot m \cdot L_p^3/M_p)(M_p/T_p^2 L_p^3/d^2 + M_u \cdot L_p^3/M_p \cdot M_p/L_p^2 T_p^2 (1cm^7) \cdot d/[1 + d^2/\{nLimit\}])$$
$$G_f:$$
$$F = Mm(G/d^2 + M_u \cdot (L_p^3/M_p)^3 \cdot L_p^3/M_p \cdot M_p/L_p^2 T_p^2 (1cm^7) \cdot d/(1 + d^2/\{nLimit\}))$$

with lower limit of $d = CubeRoot\{ (M \cdot L_p^3/M_p + m \cdot L_p^3/M_p)/ 4/3\ \pi \}$

(see comment below in (5) explaining G_f)

(5) Thus:

$$F = Mm(G/d^2 + M_u G_f d/[1 + d^2/\{nLimit\}])$$

with lower limit of $d = CubeRoot\{ ((M + m) \cdot L_p^3/M_p)/ 4/3\ \pi \} = CubeRoot\{((M + m) \cdot C_L)/ 4/3\ \pi\}$

where:

$$G = L_p^3/M_p T_p^2$$
$$G_f = (L_p^3/M_p)^3 \cdot M_p/L_p^2 T_p^2 = 3.2929162 \text{ X } 10^{-133} /gr^2sec^2$$ (the far grav. constant translator)

Regarding G_f : note that the L_p^3/M_p (or C_L) factor just after M_u was cubed as a result of the transformation, and then combined with G_3 to result in G_f.

Formula (5) is exactly equivalent to the opacity-based formula. This Newtonian transformation of the opacity-based formula for gravitational force greatly simplifies the job of calculating gravitational interactions from the size scale of the solar system through the scale of galactic clusters, in comparison with the opacity-based formula. It is easier because mass-based data is much more accessible, and so it is this transformation formula that is used as the basis for the Galactic Gravitation Calculator.

In order for the calculator program to calculate results other than gravitational force, such as to find the mass of a galaxy, or the velocity of a satellite, further transformations based on formula (5) are required, as shown below...

Find Mass Of The Sun, A Galaxy Or A Cluster Of Galaxies

Finding **M** for a galaxy is facilitated by equating the gravitational force **F** of an orbiting object **m** to the centrifugal reaction (often called centrifugal "force," though technically it is not truly a force[33]).

(6)

$F = Mm(G/d^2 + M_u C_L^3 G_3 d/[1 + d^2/\{nLimit\}]) = v^2 m/d$ ...(centrifugal reaction)

Note: v = velocity here, *not* volume; lower limit dropped because using large distances.

Because $C_L^3 G_3$ above are constants with known values, they can be combined into one constant G_f . So...

$M = v^2 m / d(m(G/d^2 + M_u G_f d/[1 + d^2/\{nLimit\}]))$ ... (where v = velocity, *not* volume)

(7) $M = v^2 /(G/d + M_u G_f d^2/[1 + d^2/\{nLimit\}])$

Notice that in the above transformation, multiplying by d in G/d^2 changes $/d^2$ to /d , and also changes the $G_f d$ to $G_f d^2$, which of course is counter intuitive in Newtonian terms, though mathematically correct.

---

[33] George O. Abell, Realm Of The Universe; Saunders College; Philadelphia; 1980; "The Fable of 'Centrifugal Force'" p. 38

{nLimit}limits the maximum of the "G_f" part of this formula, according to the diminishing perspective principle.

See the tables 1 and 2, shown earlier, for examples of results from this formula in calculating the masses of galaxies and galactic clusters.

Find Orbital Velocity Of A Spacecraft, Planet, Star Or Galaxy

This formula is just a transformation of formula (7) above.

(8) $v = \text{SquareRoot}\{ M(G/d + M_u G_f d^2/[1 + d^2/\{nLimit\}]) \}$

Summary

The main concepts of this theory are as follows:

1. The standard gravitational constant G, 6.67259 X 10^{-8} $cm^3/gr \cdot sec^2$, is dependent on the independent constants of Planck length, Planck mass and Planck time, according to the relationship $G = L_p^3/M_p T_p^2$. This constant G serves to relate gravitational calculations to the quantum mechanical action where gravitation occurs. Consequently, gravitational constants used in other types of gravitational calculations are defined by quantum relationships in terms of the Planck units of measurement.

2. Gravitation and the passage of time result from the continuous infusion of an energetic time dynama into all spacetime everywhere. In three dimensional terms, the result of the infusion of time dynama is as if space were expanding both within all objects and between all objects.

3. Matter has a compression limit of L_p^3/M_p and a corresponding reciprocal density limit of M_p/L_p^3. The boundary of an ultimate particle of matter is impenetrable, but elastic in time, so that time dynama acts to expand such objects as it is infused within, and acts to push them apart with a force that is proportional to distance as time dynama is infused into the space between them. However, because ultimate particles are impenetrable by dynama, any massive object constructed from ultimate particles presents a barrier to the passage of dynama through it. Thus, the massive object casts an opacity shadow in all directions, the effect of which lessens according to the square of the distance from the center of the massive object. The mass shadow, together with the dynama directed toward the mass from the direction of the rest of the universe, creates the effect of a gravitational field in the vicinity of the mass that behaves according to the field equations of General Relativity.

4. A general gravitational force formula based on the spacetime dynama and mass opacity concepts, and which applies to all scales of space from subatomic to extragalactic, is as follows:

$F = (V_1 O_1 \cdot V_2 O_2)(G_2/d^2 + V_u O_u \cdot G_3 d/[1 + d^2/\{nLimit\}])$
with lower limit of $d = \text{CubeRoot}\{ (V_1 O_1 + V_2 O_2)/ 4/3 \pi \}$ *(Definitions of terms given earlier.)*

So dark energy, or dynama, permeates all space in the universe, within things as well as between things, and it is the source of a pervasive anti-gravitational force. It is an inherently weak force at short distances, but it becomes a great force when acting between objects that are separated by an immense distance, tending to push them apart. This force is blocked by the presence of any mass, in proportion to the amount of mass. But the strength of this three-dimensional mass shadow falls off by the square of its distance from the mass. So gravitation is actually the result of this anti-gravity blocking effect of the mass of matter.

Generally, it is expected that the mathematical answers to great physics questions will be supremely elegant. At first viewing, the principal formula of the D-O theory, above, may look like a Rube Goldberg contraption. But it works, as the GGC readily demonstrates with observational data. Though the underlying principles of D-O are relatively simple, the cumbersome appearance of the formula is because their application in a very complex and huge universe is necessarily complicated.

This theory has two great strengths to recommend it:

1) the Galactic Gravitation Calculator, which is the experimental laboratory for testing and demonstrating this theory, indeed works correctly. As anyone can see, it works very well with standard astronomical data to give results that are consistent with the universe that one can actually see.

2) the mathematical roles played in the Dynama-Opacity based gravitational equations by the Planck units of measure, being that these roles are interwoven in such a complex yet rational pattern, would seem to be beyond coincidence, thereby enhancing the probability that these equations are correct.

Questions & Answers

Most of the following questions and answers are excerpted and condensed from some of the author's prior writings on the Dynama-Opacity theory of gravitation and on the Galactic Gravitation Calculator (GGC).

Q: *How compatible is this theory with Newton's Law of Universal Gravitation?*

A: The first requirement of Newton's Law is complied with by this theory, and may be easily demonstrated. This requirement is that two objects will attract each other with a force that is directly proportional to the product of their masses. It has already been explained how the interplay between dynama and the ultimate particles causes various objects dropped from the same height -- regardless of their mass, size or shape -- to all fall toward the earth at the same rate of acceleration. Also, they will all strike the earth at the same time and velocity. However, though the velocity, moment of impact, and acceleration for all these objects is the same if released from the same height at the same time, the force with which they each strike the ground will vary according to the difference in their masses. This is because -- based on Newton's laws of motion -- force is expressed as the product of mass and acceleration. Having already established that the acceleration of all the objects is identical, just mass is left to determine the difference in force. And the masses of both a falling object and the earth mutually determine this gravitational force, because the density of the earth's mass creates the blockage of dynama flow (or gravitational shadow) that sucks the smaller object toward the earth, while the density of the smaller object provides substance for the dynama from space to push toward the earth. Thus, the gravitational force between any object and the earth is directly proportional to the product of their respective masses.

The second requirement of Newton's law, that the gravitational force between two objects is inversely proportional to the square of their distance apart, is also met by this theory. As is apparent in figure 7, the gravitational shadow cast out into space by any massive object grows weaker according to the square of the distance from the object. Also, due to the nature of the dynama between two objects, the farther they are from each other the more separating force exists between them, tending to further push them apart.

This theory does suggest, however, a modification of Newton's gravitational force formula as it would apply in the extreme densities of black holes due to the D-O theory's compression limit of matter. This modification also appears to suggest somewhat different black hole results than the field equations of general relativity.

Q: *Einstein saw a problem with considering the entire universe as being involved in every gravitational action, because instantaneous action at a great distance would be contrary to the speed limit of light. How does the theory of dynama deal with this issue?*

A: The gravitational effect of the rest of the universe is not really at a distance. This effect occurs because both distant and nearby objects were in contact at the beginning of the universe's expansion, at which time they were gravitationally bound. The binding is via gravitational shadows projected through space in the light of dynama, stretched out between things since the big bang, and acting as a field in the vicinity of any massive object, as in Einstein's General Relativity.

Q: *How does this theory account for the observation that gravitational force and acceleration vary on the earth's surface due to variations of mass in the internal structure of the earth?*

A: This is caused by variations in the separating force acting between these uneven mass concentrations and objects on the earth's surface. Naturally, areas of high mass concentration have a higher density of ultimate particles than less massive areas. Where an area has a relatively higher density of particles in comparison with other areas, it also has less distance between the particles than the less dense areas. Thus, there is less free space through which dynama can travel, causing the projection of a greater shadow effect from the dense area, as mentioned earlier. Thus a surface object directly over this high density mass concentration, will experience more apparent gravitational force and acceleration due to less separating dynama acting on it through the dense mass concentration from the direction of the earth's center to offset dynama acting from the skyward side, in comparison with other places on the earth's surface.

Q: *How does this theory account for the advance of perihelion in the orbit of Mercury?*

A: As Mercury races toward the sun on the downslope of its orbit, in accordance with Kepler's second law of planetary motion, it gains velocity. That increase in velocity causes a temporary small increase in the planet's mass, in keeping with relativity, which in turn causes a temporary small increase in the gravitational force acting between Mercury and the sun. This increased gravitation causes the major axis of Mercury's elliptical orbit to shift around ever so slightly during each trip around the sun, so that in a century the axis advances a total angle of 43".

Here is the role dynama plays in this. When Mercury's mass temporarily increases from increased velocity, its shape becomes slightly foreshortened or flattened along an axis aligned with its direction of travel. Within this foreshortened profile, the ultimate particles have become slightly enlarged due to their slight increase in mass, while the space between them has become slightly less. Thus Mercury becomes more opaque to dynama trying to pass through it while at the same time its temporarily enlarged ultimate particles present a larger surface area for dynama to push against. All of this causes more space-time pressure from dynama on the outboard side of the planet than exists between Mercury and the sun. Thus, there is more apparent gravitational force between them until Mercury slows down on its "uphill" swing and sheds its extra mass gain.

A similar situation may explain the small increases in gravitational force noticed with the Voyager 10 and 11 and the Galileo spacecraft.

Q: *How does this theory account for the bending of light by gravitational fields?*

A: In the historic 1919 test of General Relativity during an eclipse of the sun -- just as Einstein predicted -- it was found that the strong gravitational field near the sun bent light rays passing through the field, so that the stars from which the light came appeared slightly displaced. The reason light rays are bent by strong gravitational fields is that the disturbance in the field caused by the presence of a massive object actually represents a shadow in the space-time field of dynama. Just as any other particle traveling through the field surrounding a massive object would be pushed toward the object by dynama flowing toward the object, photons move likewise.

Q: *What explanation does this theory offer for the gravitational redshift of light wavelengths?*

A: The redshift of light wavelength as it flies directly away from a massive object with a strong gravitational field is a similar effect to the bending of light rays from gravitational influence. The cause is the same, and the difference in the two effects is due to the direction of the photons' passage relative to the gravitational mass. Light travels at a constant speed and reacts to changes in the shape of space-time dynama by changing direction or/and wavelength depending on the alignment of its direction of travel relative to the massive object. Again, the gravitational field is the result of the massive object casting a "shadow" in space-time dynama. This shadow subjects light flying away from the object to greater pressure from spacetime dynama from the direction ahead and opposite the object, than from the object's direction due to its shielding the photons from dynama pressing in from the other side of the object. Light must continue to travel at the same speed, so it just "bends into the wind" and proceeds with a longer wavelength. In other words, some of the light's energy that would have gone toward a higher frequency with a shorter wavelength is instead used to maintain its speed against gravity, thereby causing a lower frequency with a longer wavelength.

A rough analogy is a car being driven with a cruise control device set to automatically maintain the car's speed at 55 mph. As the road passes over hill and dale, the pitch of the engine noise varies though the car's speed always remains at 55 mph. Going uphill, the engine labors more to maintain speed, and its sound develops a deep throaty pitch. Then down the other side of the hill, the engine idles with a high pitch hum as the car mostly coasts.

Q: *This theory portrays dynama as a continuously increasing type of energy. What about the law of the conservation of mass and energy, which holds that the total amount of combined mass and energy in the universe is constant, and can neither be created or destroyed?*

A: Mass can be converted into energy, and the reverse, but in total their quantity remains constant. The catch to that law is that detection of any increase in total mass + energy depends on our systems of measure, which as mentioned earlier are expanded by dynama as it expands the universe. If there was an absolute standard of measure available, then we'd be able to measure the increase in the energy of dynama. But since dynama controls the standards of measure and keeps them in synch with its expansion of space and mass, there is no absolute standard of measure and no *apparent* increase in mass or energy. So maybe the law of conservation should be restated that *within a given measurement frame of reference* total massergy can neither be created or destroyed. In this regime, though one can’t perceive any change in the relative sizes of things, their masses and the energy extant, one instead perceives this ongoing increase in dynama pumped into the universe as the *passage of time* and the *effects of gravitation*.

Q: *In this theory, what replaces the gravitational influence that dark matter was to provide?*

A: Some years ago, there was an illustration in Smithsonian Magazine (Jan. '89 "Galaxies" by James Trefil, p. 46) showing a large halo of dark matter surrounding a galaxy beyond the galaxy's visible spiral arms. Looking at it, the area of the dark matter halo could be interpreted as not representing matter at all. Instead, it could represent the direction and intensity from which a massive gravitational influence comes from that acts on the galaxy -- the direction of the rest of the universe. An analysis of gravitational interactions at the quantum level shows that there are really three players in every gravitational interaction: object A, object B and the rest of the universe. So the interaction of dynama and opacity between any two objects and the rest of the universe may account for the gravitational effects that have been attributed to dark matter, as is demonstrated in the Galactic Gravitation Calculator program. In that case, the effects previously attributed to dark matter may be mostly due to bright matter that is everywhere else.

Q. *What differentiates the Dynama-Opacity Theory from the MOND (Modified Newtonian Dynamics) theory?*

A. The MOND (Modified Newtonian Dynamics) theory,[34] suggests a modification of Newtonian gravitation that yields about the same results in large scale space as does the Dynama-Opacity Theory. In the terminology of computer languages, the MOND is like a high level programming language solution, whereas Dynama-Opacity is like a low level machine language solution. At the high level where MOND operates, it is not necessary to know how gravitation works at the nitty gritty quantum level. It deals with the question about *what* is happening gravitationally in large scale space by focusing on the way gravitation changes in relation to the rate of gravitational acceleration. In large scale space, rates of acceleration are a tiny fraction of what they are in small scale solar system space, and so using this rate of acceleration as a key, a correction factor is applied to the Newtonian mathematics so that the indications of system mass are essentially the same as visible mass, thus eliminating dark matter as a factor. But correct as MOND may be, it still doesn't explain just what is happening and how. That is where the Dynama-Opacity Theory, with essentially the same mathematical results, seems to have something more to offer.

Q: *If all objects and the space between them are expanding, then why don't the stars of millions of years ago that are seen today look infinitesimal in terms of our present day size scale?*

A: If this theory is correct, then space-time can be conceived as having a fabric, as many have suggested. Maybe in the form of twistors, as some (most notably, Roger Penrose) have proposed. Thus, as two initially parallel rays of light travel along the lines of this fabric, as the fabric expands in all spatial dimensions, it moves the rays farther apart in absolute spatial terms. But in terms of our expanding frame of reference, they appear to remain parallel. Also, as time passes, the photon particles of light are expanded two dimensionally and pushed apart three dimensionally due to the action of dynama, in a manner similar to material particles. Thus, as the light carrying the image of a star traverses millions of light years, that image expands until it reaches us, so that the image seen today remains relative to the current frame of size reference. It's somewhat like a movie image being projected through a lens that enlarges it from a small 35mm source to fill a 100 foot wide movie screen. In free space, twistors might perform a function similar to the projector lens.

Q: *How does this theory account for gravitons - the theoretical force carriers of gravity?*

A: A great deal of effort has been devoted to attempting to observe gravitons, the presumed force carriers of gravitation. Under the theory of dynama, the function expected to be performed by gravitons may be performed by the elementary particles of matter. With the strong force, the weak force and the electromagnetic force, matter is the source of the force. For each of those forces, a force carrier - like photons of light - carry energy from one mass of matter to another. But according to the theory of dynama, matter is not the source of gravitational energy, space is, and the force of gravity is the result of the interaction between this energy and the opacity of matter. In this paradigm, it appears that there are no gravitational force carriers being sent from one piece of matter to another. Instead, it may be that the elementary particles of matter themselves perform the particle function in the quantum wave-particle duality, while dynama performs the wave function. Yet another possibility is that there may be a dynamaton force carrier associated with antigravitation that is continuously infused into the universe along with dynama.

---

[34] "Does Dark Matter Really Exist?"; Mordehai Milgrom; Scientific American; August 2002; p 42.

Q: *How does this theory's gravitation deal with objects of differing mass, or size?*

A: It is a known fact that regardless of differences in mass, size or shape, any two bodies (in a vacuum) will accelerate toward the earth at the same rate, and if they are dropped at the same moment from the same height (with no air friction), they will strike the earth at the same moment. This phenomenon, which is the basis of the principle of equivalence between gravitational and accelerational effects, is due to two factors: the properties of the ultimate particles of matter, and the effect on them of the separating force of dynama acting through space between all of the larger objects composed of those ultimate particles.

Per the earlier discussion of ultimate particles (and strings/superstrings - included here as "ultimate particles"), one can examine the separating force of dynama acting between the ultimate particles of the earth and those of a small object above its surface, as well as between the small object and the rest of the universe. This separating force between any two objects acts only between the ultimate particles of the two objects. Since all ultimate particles are apparently similar in mass, size and shape (except those traveling at high speed), they all expose the same amount of surface area opacity to the separating force. Thus, all particles that are the same distance from the earth, though they may be particles of several different objects, will be affected to the same degree by the flow of dynama from outer space toward the earth's gravitational "shadow," as well as the much lesser flow of dynama between the earth and the objects. In this way, differences in the mass, size and shape of objects composed of these ultimate particles would have no effect on those objects' rates of acceleration towards the earth (aside from the effect of air friction).

Q: *In this theory, how is gravitation affected by the different shapes of various objects?*

A: A spherical object of a uniform density would cast a dynama shadow that would be evenly distributed in all directions, so that a nearby object at a given distance would experience the same gravitational influence anywhere at the same distance around the parent object. But what if a parent object is not spherical? The shape of an object generally has no effect, because the interaction of opacities between two objects is between *each elementary particle* of the two objects. Objects in the universe are mostly full of empty space between their elementary particles, so that no matter how one object turns in relation to the other object, all of the elementary particles of one object are usually visible to every elementary particle of the other object. Because of this, the opacity shadow of an oblong object would have an oblong shape in its projection, but at any given distance from its center of mass would have the same overall strength with respect to dynama from the part of the universe on the opposite side of it, so that gravitational calculations based on the center of mass would be the same regardless of shape. Thus gravitation between two objects is focused on their centers of mass regardless of shape. However, this rule could begin to break down where matter gets much more densely packed - as in a very heavy star or black hole - where matter becomes so dense that every elementary particle in one object may not be visible to every elementary particle in a second object.

Q: *Can more be said about how, theoretically, dynama expands the universe?*

A: According to this theory, dynama is the energy that floods all space with antigravitation which causes the force of gravity where antigravitation is blocked. In this theory, because the force of gravity is present everywhere to some degree, it is inferred that the energy of dynama is infused throughout all space, the space within things as well as the space between things. In the space between objects, the expansive energy of dynama causes a force to be exerted between all objects in the universe (which would likely have become gravitationally bound when their matter was together in the Big Bang[35]), tending to *push them apart* with a force that is proportional to the distance between the objects. At first, this is counter-intuitive - pushing things

[35] Joseph Silk, The Big Bang - Revised and Updated Edition; W.H. Freeman & Co.; New York; 1989

apart instead of pulling them together. But in this theory the radiant shadow of "mass opacity" causes things to pull together, in accord with Newton's "square of the distance" principle of gravitational force.

For the energy of dynama to continue to have a constant effect as time passes and the universe expands, as said above, more dynama would have to be constantly flowing into the universe everywhere at once, *within* elementary particles as well as *between* them. The continuing infusion of the energy of dynama, would mean that in terms of time and space, the universe continues to be created - though not in the sense contemplated by the "steady state" theory of cosmology. Of course, such an ongoing infusion of energy seems to contradict the principle of the Conservation of Massergy (mass + energy). Actually it doesn't, due to a correlative expansion of standards of measure in the Dirac expansion model, as shown in the appendix.

Within all objects, the expansive energy of dynama makes the objects expand. So dynama is making all space expand, and because the space within objects is expanding at the same rate as the space between objects, all standards of measure are also expanding as are any observers of the process, so that it is impossible to measure the expansion. The size relationships of things and the dimensions of the space between them appear to remain the same. The one thing that is measurably different from one moment to the next, even if objects in one's field of view don't move relative to each other, is time - it constantly moves as inexorably as dynama continues to push and gravitation (where mass casts a dynama shadow) continues to pull. This spreading of the fabric of space enlarges photons as well, so that distant objects, millions of light years away, appear in the same size scale experienced on Earth today. Also, this expansion of space and the standards of measure may cause space to appear flat when it is actually curved.

Q: *Where is experimental observational support for this theory?*

A: The GGC program's database of scientifically gathered astronomical observations have been thoroughly used with the GGC to make calculations based on the D-O theory. The results of these calculations coincide with this theory's underlying concepts and predictions. The GGC is able to account for the observations of orbital motion in the outer reaches of galaxies almost entirely with the gravitational influence of the mass of luminous matter which has actually been observed, versus the practice in dark matter theory of attempting to account for this orbital motion with the gravitational influence of dark matter that has not been directly observed in outer space.

Definitions

dynama - "di-NAM-uh" - (noun) basic animating energy; a type of antigravitational energy that infuses spacetime, both within and between elementary particles. It provides a continual impetus for spacetime's multidimensional expansion, and is being continuously added to all spacetime. Its source is as yet undetermined.

"Dynama" is an energy that infuses spacetime (both within and between elementary particles). It provides a continual impetus for spacetime's multidimensional expansion, and drives the binary phasing of matter between its complementary particle and wave states at the rapid rate of 7.40076 X 10^{42}cycles/sec., or T_f. The continuous discontinuity of this binary phasing enables change, facilitating the dimensional expansion of spacetime.

The name, dynama, was first given to dark energy by the author in 1984 in his paper "Beyond Equivalence…"[36] replacing the cumbersome name he previously gave it in the title of his 1962 paper, "Theory On *Constant Irrepressible Universal Energy*."[37] Like the word *dynamic,* it is rooted in the Greek *dunamis,* power. It seems a more appropriately descriptive name than "dark energy" for a type of energy that is neither dark nor bright but transparent and that appears to play such a basic animating role with all mass and time.

binary time - a hypothetical concept of time driven by dynama, whereby all of existence is cycling between complementary particle and wave states, at an extremely rapid frequency that is the reciprocal of Planck time: 7.40076 X 10^{42} cycles/sec. In one instant particles appear like frozen motion picture frames. As they fill with the tension of time dynama, they collapse into their wave states and expand until the tension is below the threshold at which they precipitate again into their particle states, but with the particle larger than before (in absolute spatial measures, if such were possible), and separated from other particles the same apparent distance as before due to the expansion of spacetime between the particles during the wave phase. Then the cycle begins anew. Throughout the universe this process is synchronized by virtue of the same frame of reference being carried forward from the initial unity of the Big Bang. Certain events occur so quickly -- such as the emission of a photon by an electron, and the electron's dropping to a lower atomic orbit -- that the event is completed within a single wave phase. In such a case, because position is a particle phase attribute only, it appears that the electron has instantaneously disappeared from one place and appeared somewhere else without seeming to have passed between the two places. Any event that can occur within a single wave phase would seem to drop through the cracks of time and defy the constrictions of Special Relativity against simultaneous interactions between separated places.

At best, this hypothesis about binary time and the dynama that drives it is probably a very rough analogy of what is actually happening. Superstring theory may eventually describe dynama and its binary time process with greater veracity and subtlety. The theory of this phenomenon was first described by the author in his 1984 paper, "Beyond Equivalence..."

object oriented paradigm (OOP) - similar to the Object Oriented Programming concept of computer software technology, but applied to understanding the structure of nature and physics because OOP seems

---

[36] R. W. Seiler, "BEYOND EQUIVALENCE: The Connection Between General Relativity and Quantum Mechanics"; Vantage Communications Inc.; Nyack, NY; May 7, 1984

[37] Roger W. Seiler, "Theory On Constant Irrepressible Universal Energy - a theory on gravitation"; Deep Springs College; February, 1962

to underlie the design of nature. It utilizes the objected oriented concepts of encapsulation, inheritance and polymorphism to view a natural object as an instantiation of a class (design blueprint) containing inherent data and methods that determine its functionality in the world. Part of this analytical approach to nature is the continuity of inheritance, which places great demands on any theory about the origin of something, because whatever properties were present in the primary object, must also be present in its subclassed offspring. Any discontinuity of inheritance calls into question the validity of the concept of the primary object. This philosophy has particular application to further development of superstring theory and the Big Bang theory, especially the concept of the inflationary epoch. Also, under the rules of OOP, the question "What existed before the Big Bang?" is not an absurdity.

opacity – "oh-PA-ci-tea" – the ratio between the density of a mass and the hypothetical density limit of matter, expressed in this theory as 8.208394 X 10^{92} gr/cm^3. The more dense an object is, the more opaque it is to the energy of dynama passing through it. To find the opacity of an object, divide its mass density by this density limit of matter.

ultimate particle - an ultimately indivisible piece of matter, be it a vibrating superstring or particle. The hypothetical binary time phasing contemplated in D-O theory may account for the "vibration" envisioned in superstring theory. Because superstring theory is still very much a developing theory, the author has chosen to continue to use the term "ultimate particle," even though a superstring would not be the sort of dimensionless point often associated with "ultimate particle."

In a sense, the ultimate particle is analogous to the data "bit" in computer data. Eight bits make a "byte" of data, and through the permutations of those "on" or "off" bits, each byte can represent any of 256 characters. Likewise, if there is an ultimate "bit" particle, such bits may be arranged in byte-like fashion to create differentiated particles such as quarks, electrons, neutrinos, etc. Perhaps the ultimate particles are binary, like time and like computer data, with an ultimate particle ("on") and an ultimate anti-particle ("off"). These otherwise identical particles might combine to create the various particle sets that contain both matter and anti-matter attributes. Further, the ultimate particle or superstring may conform to the requirements of the object oriented paradigm (see above) that appears to closely mirror the design of nature.

APPENDIX

Physical Constants

According to "1986 Adjustments of the Fundamental Physical Constants," published by Pergamon Press, the most currently accepted values for G, h and c are:

$G = 6.67259 \times 10^{-8}$ dyne·cm²/gr²
$h = 6.6260755 \times 10^{-27}$ erg·sec/cycle
$c = 2.99792458 \times 10^{10}$ cm/sec

Planck Dimensional Units

"Regular h" quantum of action versions:

Planck length (L_p) $= (Gh/c^3)^{1/2} = 4.0508331 \times 10^{-33}$ cm/cycle
Planck time (T_p) $= (Gh/c^5)^{1/2} = 1.3512124 \times 10^{-43}$ sec/cycle
Planck mass (M_p) $= (ch/G)^{1/2} = 5.456213 \times 10^{-5}$ gr/cycle
Planck energy (E_p) $= (c^5h/G)^{1/2} = 4.9037997 \times 10^{16}$ ergs/cycle

"Bar-h" versions based on quantum of angular momentum "ħ" (derived from "h" thus: $\hbar = h/2\pi = 1.0545726 \times 10^{-27}$ erg·sec/cycle):

L* = ħ Planck length = $1.6160485 \times 10^{-33}$ cm/cycle
T* = ħ Planck time = $.5390556 \times 10^{-43}$ sec/cycle
M* = ħ Planck mass = 2.1767138×10^{-5} gr/cycle
E* = ħ Planck energy = 1.9563329×10^{16} ergs/cycle

Calculation with the above values confirms these functional relationships:

$$c = L_p/T_p = L^*/T^*$$
$$G = L_p^3/M_pT_p^2 = L^{*3}/M^*T^{*2}$$
$$h = L_p^2M_p/T_p$$
$$\hbar = L^{*2}M^*/T^*$$
$$E_p = M_pL_p^2/T_p^2$$
$$E^* = M^*L^{*2}/T^{*2}$$

There appears to be a tautology here in the way constants are defined. From the human observer's point of view, because one can more readily directly measure c and G and h, one could think of them as the primary constants and the Planck units as derived. But the basic commodities of the universe are space, time and mass, and it is really at the quantum level where they interact. So from a truly quantum functional standpoint (that is, from the point of view of the elementary particles or strings where the action really is), it is the Planck units that are fundamental and it is c, G and h (constants of convenience at the human scale) that are dependent on them.

Q & A

See the Q & A section for additional discussion about how the dynama theory relates to a wide range of issues concerning gravitation.

Constant Size Relationships

(This section is reproduced from the author's 1984 paper, "Beyond Equivalence...")

As time passes while we observe the world around us, different sized objects -- like a mouse and a cat -- remain the same relative sizes. But if everything is expanding, presumably at the same rate, then why doesn't the mouse get bigger in relation to the cat? If they both expanded outward an inch per time period, then the mouse would get much larger compared to its original size than would the cat, and would thus seem to ""grow"" compared to the cat. So, in a world of dynamastic expansion, how do objects of different sizes maintain the same relative proportions? (And thereby preserve the cat's peace of mind!) Good question.

In a dynamastically expanding universe, matter is expanding because space is expanding, and the expansive acceleration of any object depends on the total amount of dynama contained within it (both the dynama within the object's ultimate particles and the dynama between the particles but within the object). The larger the object, the more dynama it contains, and thus more expansive force, causing a faster rate of surface expansive acceleration than for a smaller object. (The acceleration is relative to the standards of measure of any prior instant.) Hence, the object's total intrinsic expansionary force equals its volume times its intrinsic acceleration times a constant of proportionality. Secondly, as the larger of two objects expands, it progressively contains more dynama and thus more expansive force than the smaller object, and the more expansive force contained, the greater the outward acceleration of the object's expanding surface. Thirdly, because dynama exists everywhere in a constant quantity per unit of space, an object's location in space makes no difference to the amount of dynama it contains. Thus, for same-shaped objects of different sizes, their comparative surface rates of expansionary acceleration are proportional to a comparison of any one dimension (height, or length, or width), thus keeping them at the same relative sizes.

How this works is shown below. For ease of comparison and calculation, any two objects compared can be mathematically converted to spherical shapes. Also, we will assume that it would be possible to take dimensional measurements during a later time period using the standards of measure of an earlier time frame (though this is probably a practical impossibility). Thus, based on the factors mentioned in the previous paragraph, the relative surface expansionary accelerations of two objects is proportional to their radii.

In the examples below, four formulas come into play:

1) $a_1 = a_2 n$ — The surface acceleration of object 2 equals object 1's surface acceleration multiplied by the number of times object 2's radius is larger than the 1st object's radius.

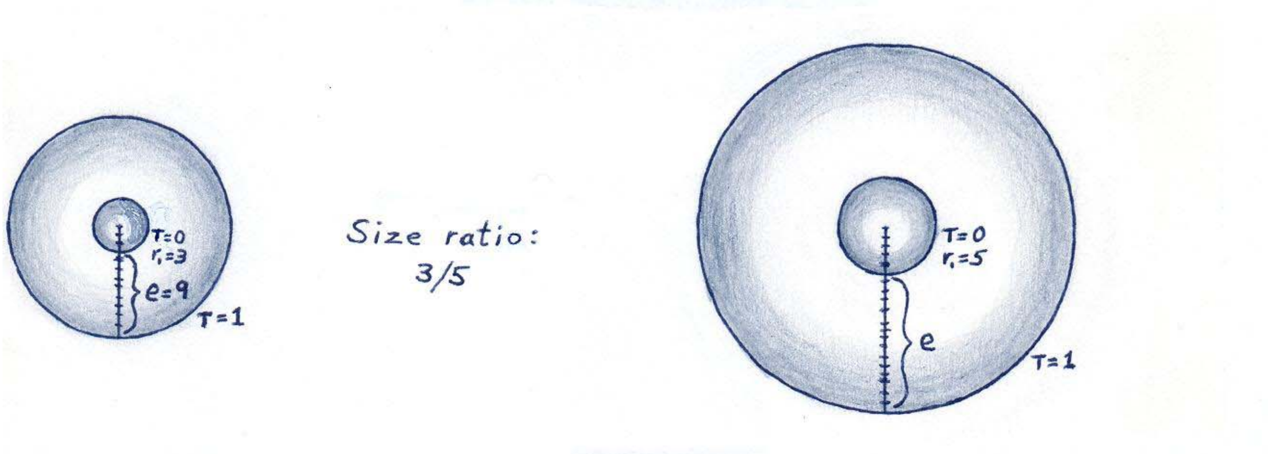
2) $e = V_o t + at^2/2$ — This is the standard physics formula for the distance covered by an accelerating point. "e" represents this distance, "V_o" is the outward reaching velocity of the expanding object's surface at time T=0, "t" is the duration of our period of measurement, and "a" is the expansionary rate of acceleration.

3) $a_1 = 2e/t^2 - 2V_o/t$ — This is a transformation of formula #2 that enables us to determine the expansionary surface acceleration of object 1.

4) $r_2 = r_1 + e$ — This says that the radius of a sphere at the end of our period of measurement equals its beginning radius plus the distance covered by the surface of the expanding sphere while we measured its expansion.

Example:

In this idealized illustration, an other-than-reality expansionary acceleration is used to make the results more obvious. Also, the type of measurement units is immaterial, so it is omitted. Note the beginning size (not volume) ratio between objects A & B, based on their radii, of 3/5.



Object A:

Given: $r_1 = 3$, $e = 9$, $t = 1$, and $V = 0$

Then: $a_1 = 2e/t^2 - 2V_o/t$
$= 18/1 - 0/1$
$= 18$

Then at T=1 (also t = 1):
$r_2 = r_1 + e$
$= 3 + 9 = 12$

Object B:

Given: $r_1 = 5$, $t = 1$, $V_o = 0$

Then: $a_2 = a_1 n$
$= (5/3)(18) = 90/3$
$= 30$

Then at T=1:
$e = V_o t + at^2/2$
$= 0 + 30\cdot1\cdot1/2 = 15$
$r_2 = r_1 + e$
$= 5 + 15 = 20$

Thus size ratio at T=1: 12/20 = 3/5

Or at T=2 (also t = 2):
$e = V_o t + at^2/2$
$= 0 + 18\cdot2\cdot2/2$
$= 36$
$r_2 = r_1 + e = 39$

At T=2:
$e = V_o t + at^2/2$
$= 0 + 30\cdot2\cdot2/2$
$= 60$
$r_2 = r_1 + e = 65$

Thus size ratio at T=2: 39/65 = 3/5

Or at T=3 (also t = 3):
$e = V_o t + at^2/2$
$= 0 + 18\cdot3\cdot3/2$
$= 162/2 = 81$
$r_2 = r_1 + e$
$= 3 + 81 = 84$

At T=3:
$e = V_o t + at^2/2$
$= 0 + 30\cdot3\cdot3/2$
$= 270/2 = 135$
$r_2 = r_1 + e$
$= 5 + 135 = 140$

Thus size ratio at T=3: 84/140 = 3/5

(This page intentionally blank. Please proceed to next page.)

How To Use The Galactic Gravitation Calculator

For your convenience in working with the Galactic Gravitation Calculator program (may be downloaded from www.leadersoft.com), the program's Help file for taking the Demo Tour is printed below.

TAKING THE DEMO TOUR

The Galactic Gravitation Calculator demonstrates various aspects of gravitational interactions at three distance scales: solar system, galaxy, and extra-galactic.

The gravitational theory incorporated in the calculations of this computer program builds on the field theory of General Relativity and its intimate relation to quantum mechanics through which gravity is actually implemented. The program thereby demonstrates how the fabric of space at much larger distance scales than the solar system is determined by the total mass of the universe and *appears* to function differently at large spatial distances than in the tiny world (in relation to galactic and extra-galactic space) of our solar system. Actually, gravitation functions the same at all distances, but some effects only become large enough for us to perceive at large scales of distance.

On the main screen of this program, the third icon from the left pictures a calculator. Click on this icon to see a list of options for doing gravitational calculations at different scales of space - solar system, galactic, and extra-galactic. However, in taking the tour, we'll explore these scales of space out of their hierarchical order, so that we can get right to the heart of the difference between this program's theory of gravity and other theories. The program demonstrates how the fabric of space at much larger distance scales than the solar system is determined by the total mass of the universe and *appears* to function differently at large spatial distances than in the tiny world (in relation to galactic and extra-galactic space) of our solar system. Actually, gravitation functions the same at all distances, but some effects only become large enough for us to perceive at large scales of distance.

GALAXY MASS CALCULATOR

The first stop on our tour is the **Galaxy's Mass** option. It shows how the orbits of gas clouds and stars at the outer reaches of spiral galaxies - velocities which are often greater than can be accounted for by Kepler's laws of planetary motion - can be accounted for without requiring the presence of an enormous halo of dark matter. Upon taking this option, click on the calculator's Help button for information about how to operate it and comments about its function. Upon leaving that calculator, please return to this Help topic for guidance on the rest of the tour.

Mass Of The Universe

The results of the underlying formula depend on the mass of the universe, which can be entered here. Most estimates range between .5 (five tenths) X 10^{56} and 5 X 10^{56} grams. The default value of 1.4476 X 10^{56} grams appears to fit the dynamics implied by many observations of galactic motion, and yields resulting masses for galaxies that are close to mass estimates for the visible content of the galaxies. You can change this value for the mass of the universe and see what effect it has on the formula's calculation of the galaxy's mass within the orbit observed. In general, you will see that the larger your estimate for the mass of the universe (which actually is a constant), the less mass is required of the galaxy in order to account for the velocity of an orbiting object. In the gravitational field theory of General Relativity, space throughout the universe is treated as curved according to the total mass of the universe, and this curvature - though slight, could play a role in all gravitational interactions. However, recent experimental observations of the universal background radiation from Antarctica strongly suggest that the universe is flat. However, the Dynama-Opacity theory works regardless of whether space is flat or curved.

In explaining the field theory of gravity in General Relativity, an analogy is often used of space being like a sheet of stretched rubber. If a heavy object is placed on it, the object depresses the sheet of rubber in its vicinity, causing other smaller objects traveling nearby to roll down (gravitate) into the depression toward the large massive object. This computer program's underlying theory also supports that analogy, but with emphasis on this factor: the thickness and strength of the sheet of rubber are inversely determined by the total mass of the universe. That is, the more massive the universe, then the thinner is the analogous sheet of rubber so that lesser mass is required of an object to create the same depth of depression in the rubber sheet as would be caused by a more massive object in a less massive universe (with a thicker and stiffer sheet of rubber). It is conceptually useful to imagine the "sheet of rubber" as if it were the surface of a very large spherical balloon, with gravity acting inward. With this image, one can visualize the overall curvature of space throughout the universe - if it exists. And the more the balloon is inflated, the thinner is its rubber sheet as it stretches out. But one should not be too dependent on the "sheet of rubber" analogy, as it has many limitations in representing the entire complex nature of gravitational dynamics. The Dynama-Opacity theory functions independently of whether space is curved or flat, so it can work with either general circumstance.

Calculator Fields

The <Get Data> option fills-in the fields labeled *SubGal Object* (identifies the orbiting matter), *Orbit Radius, Orbital Velocity, Galaxy,* and *Galaxy's Standard Inside-Orbit Mass Calculation*. This last item is a mass calculation based on a combination of Newton's gravitational formula and the formula for centrifugal reaction, which is at the root of the theory of dark matter: $M = rV^2/G$ where M is the mass of part of the galaxy contained within the observed orbit, r is the radius to the orbit from the galactic center, V is the orbital velocity of the observed object at the radius indicated, and G is the Newtonian gravitational constant. The result of this standard calculation is presented here for comparison with the result of the Galactic Mass Calculator's gravitational formula, which is quite different. Its result appears under the heading, *Mass Inside Of Orbit, New Calculation Method.* To execute the calculation, press either the <Calculate> or <Step Calculate> button. The latter button reveals the formula used, and shows the calculation one step at a time.

The *Orbital Spiral Angle Of Climb* field is used to experiment with the spin-off theory of galaxy formation, which is an alternative to the generally accepted condensation theory of galaxy formation. This field provides a way to test the implications of the spin-off theory when calculating the mass of the galaxy.

You can experiment with the results of this program by manually entering your own data and then by pressing the <Calculate> button.

SUN MASS CALCULATOR

The second place to visit is the Sun's Mass calculator, the second option from the top on the Gravitational Calculator Selector screen. This calculator uses the same gravitational formula to deduce the mass of the Sun based on the mass of an orbiting planet as was used to deduce the mass of a galaxy in the first calculator. So it serves as somewhat of a check of the validity of the formula, because we are quite sure of the mass of the Sun. It does show a tiny difference in mass calculation between this and the standard methods that becomes almost perceptible by current instruments at the distance of Pluto.

This tool automatically calculates the mass of the Sun, based on the orbital radius and velocity of a planet, using both the standard Newtonian gravitation formula and the quantum gravity formula that underlies this program. Just select a planet from the database table, and then press <Calculate> to see the results.

You may notice that the mass of the Sun calculated with respect to the orbits of different planets seems to vary slightly. This is due to a slight lack of precision in the general purpose orbital data we gathered from various sources. If one inserts more precise planetary orbital data, then the calculated mass of the Sun is more precise and the differences based on different planets' orbits disappear.

It appears that the two methods of mass calculation demonstrated are identical, but actually they differ by an almost imperceptible amount, more so the greater the distance from the Sun. This slight difference is due to the quantum gravity formula's inclusion of the influence of the rest of the universe, which at the tiny distances involved in the solar system (in relation to the entire galaxy and the universe beyond), has a minuscule effect. At the distance of the Earth, the difference is only about 5 kilograms, or in more everyday terms, about 10 pounds. The involvement of the rest of the universe increases in the equation the farther out we go, so that at the outermost planet, Pluto, the difference is about 290,000 kilograms - equivalent to the mass of about 200 Ford Taurus automobiles.

At greater distances, the new formula infers less Sun mass for a given orbital velocity and radius. Or put another way, at great distances, planets will orbit ever so slightly faster for a given Sun mass than indicated by the standard Newtonian formula. But the difference is so slight that it may be nearly impossible to measure with even the most sensitive of instruments now available.

In comparing the Sun mass result based on the data of different planets, the calculated mass of the Sun (whether calculated by the Newtonian or Seiler's formulas) varies about $.01 \times 10^{33}$ gm due to a slight lack of precision in the planetary data used here for orbital distance and velocity. When more precise planetary data is found, it will be inserted in the Planets database in order to minimize the variance in results.

There are two more calculation options dealing with gravitational transactions within the scope of the solar system - Planet Orbit Velocity and Satellite Orbit Velocity. Both of these use transformations of the same gravitational formula used for finding the galaxy's and Sun's masses, in order to find the velocity needed to maintain an orbit. The calculations of planetary velocities match actual observations, and the calculation of satellite velocities matches results found by standard calculation methods. If you'd like to try your hand at being an astronaut planning to blast off and go into orbit around any planet, then use the Satellite Orbit Velocity calculator to figure out what velocity you must attain for an orbit at any particular distance above the planet. It's interesting to see the differences in orbital velocities required for different planets.

PLANET ORBITAL VELOCITY

As Johannes Kepler discovered, planetary orbits are elliptical instead of circular, though they are nearly circular. Comets, however, have quite eccentric elliptical orbits.

Because of the elliptical nature of its orbit, a planet does not travel at the same velocity everywhere along its orbit. Instead, where it is closer to the sun, it travels faster than when it is farther from the sun, in accordance with Kepler's laws of planetary motion.

This calculator will give you the *average* orbital velocity of a planet at its average distance from the sun along its orbit. In other words, for the sake of simplicity, it gives you the orbital velocity as if the orbit was circular instead of elliptical.

Kepler's Laws Of Planetary Motion

Based on the astronomical observations of the Danish astronomer, Tycho Brahe (1546-1601), Johannes Kepler (1571-1630), a German who had been an assistant to Tycho, finished formulating his three laws of planetary motion in 1619. The three laws are rephrased here in their most generally applicable form:

1. Each planet or satellite moves about its more massive gravitational captor (in our solar system: the sun) in an elliptical orbit, with the captor at one focus of the ellipse.

2. A straight line between the satellite and its captor sweeps out equal areas in space in equal intervals of time.

3. The square of the sidereal period (time taken to complete one orbit) of a planet or satellite is in direct proportion to the cube of the semimajor axis of its orbit.

In general, Kepler's laws state that the farther an orbiting planet or satellite is from its gravitational captor, the slower its orbital velocity. In other words, the farther one is from the captor, the weaker the captor's gravitational pull, and so the less speedily one must race onward in one's orbit to avoid being sucked in toward the captor.

These three laws of planetary motion apply to all gravitationally directed orbital motion within the scale of the solar system. Observations of orbital motion in the outlying reaches of spiral galaxies has indicated that orbital motion at that large scale may not be Keplerian, because orbital velocities there often do not decrease with distance from the galactic core, but instead remain the same for different distances. (See "The Rotation Of Spiral Galaxies" by Vera C. Rubin, *Science* June 24, 1983 p. 1339-44.)

SATELLITE VELOCITY

Use this calculator to determine the velocity of a moon or other satellite in its orbit around a planet. You can select the planet from the database, from which the planet's data for mass and radius will be automatically retrieved and entered into the calculator for you.

You must manually enter the data of whatever moon or satellite for which you wish to determine the orbital velocity in the fields titled *Satellite, Sat's Height Above Planet* OR *Distance From Planet Center.* These last two fields give you the option of entering either the satellite's altitude above the planet's surface - to which the calculator will automatically add the planet's radius - OR you can enter a distance to the satellite that already includes the planet's radius. Many tables of satellite data show the distance as from a point in the center of the planet to the center of the moon or satellite, and so this latter field accommodates that type of distance figure. However, if you want to calculate the orbital velocity of the Space Shuttle, and all you know is that it is 350 kilometers above the Earth's surface, then use the first field for height. Press the <Calculate> button to get the orbital velocity in both kilometers per second and miles per hour.

For your information, listed below is some data regarding a few moons in our solar system (all distances shown are average distances in kilometers from center of planet to center of moon). You can select the planet's data from the database, and then manually enter the moon's distance in the second "height" field to have its orbital velocity calculated.

Our moon: distance 384,404 km period 27.322 days
Jupiter's Io: distance 421,600 km period 1.769 days
Jupiter's Europa: distance 670,900 km period 3.551 days
Jupiter's Ganymede: distance 1,070,000 km period 7.155 days
Saturn's Janus: distance 157,500 km period .749 of a day
Saturn's Titan: distance 1,221,000 km period 15.945 days

Using the sidereal period (earth days to complete one orbit), you can do your own off-line calculation of the velocity to check the accuracy of this method of calculation. A manual calculation would be done as follows:

1. Multiply the distance listed (radius from center of planet to center of moon) by two to get the orbit diameter.

2. Multiply the orbit diameter by pi, 3.14159265 to get the circumference, or length of the orbit.

3. Divide the circumference by the sidereal period to get the distance traveled per earth day; then divide that number by 86400 (the number of seconds in a day) to get kilometers traveled per second.

The final demonstration is the calculating of the mass of a galactic cluster based on the orbital velocity of one of the cluster's galaxy's. It's Help topic explains some important differences between this extra-galactic scale of space and the lesser scales we have worked with in the other calculator options.

GALACTIC CLUSTER MASS

From the galaxies database, you can select a galaxy and the program will automatically enter its distance from the center of the galactic cluster and its orbital velocity into the appropriate calculator fields. Then upon pressing the <Calculate> button, R. Seiler's gravitational formula will give you the mass of the galactic cluster within the galaxy's orbit. Also shown is the mass estimate calculated by the Newtonian formula, which typically expects about a hundred times more mass in the cluster to explain the orbital velocity, than is indicated by Seiler's formula.

Unlike a planet orbiting a star, the motion of a single galaxy orbiting within a galactic cluster indicates only a small portion of the total mass within its orbit because of three factors: 1) the gravitational vectors acting on the galaxy are not as focused on the center of mass throughout its travel as is the case in a solar system; 2) the orbits of galaxies in clusters often appear to be like flat looping ellipses - somewhat like the orbits of comets, these orbits don't seem well ordered in relation to each other, and being far from circular orbits, it is much more difficult to determine the average velocity and average distance from center which facilitate calculating the cluster's mass; and 3) some of the velocity of the galaxy is probably due to momentum acquired from non-gravitational causes. For example, the Big Bang itself presumably imparted momentum to all outflying matter, the relative differences of which would only become apparent in large scale space.

As with the Galaxy Mass Calculator, one can change the estimate for the mass of the universe and see how it has an inverse effect on the mass of the cluster required to account for the velocity of the orbiting galaxy. Also, one can see that the greater the distance from the cluster's center, the less additional cluster mass is needed to account for the orbital velocity, as the gravitational influence of the rest of the universe comes more into play. The same gravitational functionality is responsible for much of the "gravitational lensing" effect whereby light rays appear bent that are coming toward us from sources beyond the cluster.

GRAVITATIONAL FORCE - OPACITY METHOD

To see how the basic Dynama-Opacity gravitational force formula works, use this option. For this example, "Object A" is the Sun, and "Object B" is any of the planets. Press <Get Data> to select the required planaetary data from the database, and then press either <Calculate> or <Step Calculate> to have the program execute the calculations. As before, <Step Calculate> shows the formulas in operation, a step at a time. This demonstration compares the opacity method results with the results from the standard Newtonian formula.

MORE INFORMATION AND FEEDBACK

If you'd like more information about this program and its underlying concepts, please contact the author, Roger Seiler, via email at: roger@leadersoft.com or via phone at 1-845-358-0406 or fax at 1-845-358-0359. Postal address is c/o Leadership Software Corp., P.O. Box 725, Nyack, NY, 10960 USA.

The author is interested in getting comments and feedback from others regarding the Dynama-Opacity Theory and the Galactic Gravitation Calculator presented in this paper.

BIBLIOGRAPHY

Edwin A. Abbott, Flatland; Barnes & Noble; NY; 1972

George O. Abell, Realm of the Universe, Second Edition; Saunders College; Philadelphia; 1980

Niels Bohr, ""Can Quantum-Mechanical Description of Physical Reality Be Considered Complete?"; Physical Review 48; 1935 p. 696

Hermann Bondi, The Universe At Large; Doubleday; NY; 1960

Max Born, The Restless Universe; Dover; NY; 1951

Jacob Bronowski, The Ascent of Man; Little Brown & Co.; Boston; 1973

Nigel Calder, Einstein's Universe; Viking Press; NY; 1979

Nigel Calder, The Key to the Universe; Viking Press/Penguin Books; NY; 1978

J. J. Callahan, "The Curvature of Space in a Finite Universe"; Scientific American, Aug. 1976; also p. 20 of Cosmology +1; W. H. Freeman & Co.; San Francisco; 1977

Richard A. Carrigan, Jr. and W. Peter Trower, Particle Physics in the Cosmos - Readings From Scientific American; W. H. Freeman and Co.; New York; 1989

Ronald W. Clark, Einstein the Life and Times; World Publ. Co.; NY; 1971

Heather Couper and Nigel Henbest, Big Bang; DK Publishing; New York; 1997

P. C. W. Davies, Space & Time in the Modern Universe; Cambridge University Press; Cambridge, England; 1977

P. de Bernardis, et al, "A flat Universe from high-resolution maps of the cosmic microwave background radiation"; Nature, April 27, 2000; p. 955

A. Einstein, B. Podolsky and N. Rosen, "Can Quantum-Mechanical Description of Physical Reality Be Considered Complete?"; Physical Review 47; 1935; p. 777

Albert Einstein, Relativity; Crown Publishers Inc.; NY; 1961

Kitty Ferguson, Stephen Hawking - Quest For A Theory Of Everything; Bantam Books; New York; 1992

Robert L. Forward, "Spinning New Realities" (twistors & Roger Penrose); Science80, Dec. 1980; p. 40

George Gamow, "The Evolutionary Universe"; Scientific American, Sep. 1956; also p. 12 of Cosmology +1 (see above).

George Gamow, Gravity; Doubleday & Co.; NY; 1962

George Gamow, Mr. Tompkins In Wonderland; Cambridge University Press; Cambridge, England; 1939

George Gamow, Thirty Years that Shook Physics; Doubleday & Co.; NY; 1966

Robert Geroch, General Relativity from A to B; University of Chicago Press; Chicago; 1978

John Gliedman, "Einstein Against the Odds: the Great Quantum Debate""; Science Digest, June 1983; p. 74

Rick Gore, "The Once and Future Universe"; National Geographic, June 1983; p. 704"

J. R. Gott III, J. E. Gunn, D. N. Schramm, and B. M. Tinsley "Will the Universe Expand Forever?"; Scientific American, March 1976; also in Cosmology +1 (see above), p. 82

S. W. Hawking, "The Quantum Mechanics of Black Holes"; Scientific American, Jan. 1977; also in Cosmology +1 (see above) p. 75

Stephen Hawking and Werner Israel, 300 Years Of Gravitation; Cambridge University Press; Cambridge; 1989

William J. Kaufman III, The Cosmic Frontiers of General Relativity; Little Brown & Co.; Boston; 1977

H. Arthur Klein, The World of Measurements; Simon & Schuster; NY; 1974

Eric J. Lerner, The Big Bang Never Happened; Times Books - Random House; New York; 1991

John C. Mather and John Boslough, The Very First Light; BasicBooks - HarperCollins Publishers; New York; 1996

Mordehai Milgrom, "Does Dark Matter Exist?"; Scientific American, August 2002, p. 42

C. W. Misner, K. S. Thorne, and J. A. Wheeler, Gravitation; W. H. Freeman & Co.; San Francisco; 1973

Sir Issac Newton, Principia; Motte's translation revised by Cajori; University of Cal. Press; Berkeley; 1962

Heinz R. Pagels, The Cosmic Code; Simon & Schuster; NY; 1982

John R. Pierce, Quantum Electronics; Doubleday; NY; 1966

Martin J. Rees and Joseph Silk, "The origin of Galaxies"; Scientific American, June 1970; also in Cosmolgy +1 (see above) p. 53

Eric M. Rogers, Physics for the Inquiring Mind; Princeton University Press; Princeton, NJ; 1960

Vera C. Rubin, "Dark Matter in Spiral Galaxies"; Scientific American; June 1983 p.96

Vera C. Rubin, "The Rotation of Spiral Galaxies"; Science; 24 June 1983 p.1339

Carl Sagan, Cosmos; Random House; NY; 1980

Allan R. Sandage, "The Red Shift"; Scientific American, Sep. 1956; also in Cosmology +1 (see above) p.5

E. L. Schatzman, The Structure of the Universe; McGraw-Hill; NY; 1968

Dennis Sciama, "Cosmology Before and After Quasars"; Scientific American, Sep. 1967; also in Cosmology +1 (see above) p. 31

Maarten Schmidt and Francis Bello, "The Evolution of Quasars"; Scientific American, May 1971; also in Cosmology +1 (see above) p. 42

Roger W. Seiler, "Theory On Constant Irrepressible Universal Energy - a theory on gravitation"; Deep Springs College; February, 1962

R. W. Seiler, "BEYOND EQUIVALENCE: The Connection Between General Relativity and Quantum Mechanics"; Vantage Communications Inc.; Nyack, NY; May 7, 1984

Roger W. Seiler, "Quantum Gravity, Mass Opacity And The Orbits Of Outer Stars"; paper submitted to the Gravity Research Foundation; March 27, 1987

Joseph Silk, The Big Bang - Revised and Updated Edition; W. H. Freeman & Co.; New York; 1989

E. F. Taylor and J. A. Wheeler, Spacetime Physics; W. H. Freeman & Co.; San Francisco; 1966

Kip S. Thorne, "The Search for Black Holes"; Scientific American, Dec. 1974; also in Cosmology +1 (above) p. 63

Robert M. Wald, Space, Time, and Gravity; University of Chicago Press; Chicago; 1977

M. Mitchell Waldrop, "Inflation and the Arrow of Time"; Science, vol 219, March 1983; p. 1416

Adrian Webster, "The Cosmic Background Radiation"; Scientific American, Aug. 1974; also in Cosmology +1 (above) p. 34

Steven Weinberg, The First Three Minutes; Basic Books; New York; 1988

Frank Wilczek, "The Cosmic Asymmetry Between Matter and Antimatter"; Scientific American, Dec. 1980; p. 82

Fred Alan Wolf, Taking the Quantum Leap, Harper & Row; NY; 1981