MCS Physics

Article 7:

The Inverse Square Root Law of Gravity

Based on the essay titled

Modified Wheelerian Perspective of Gravity

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by

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Abstract

John Wheeler's famous statement "Matter tells space how to curve space tells matter how to move" converges into a surprising underlying machinery, through a discussion of the questions "is gravity space or within space", "does force cause motion, or maybe motion causes force" and "what is the real gradient law of gravitational fields". I conclude that space is gravity, and it consists of two ingredients, the concentration gradient of one of them among the other is the gradient of gravitational fields. The Newtonian inverse square law is a phenomenologically based interpretation of a real inverse square root law.

Is gravity space, or within space?

In his third lecture of the series The Character of Physical Law[1], Richard Feynman said relating to Le Sage's theory of gravity –

> "up to today from the time of Newton no one has invented another theoretical description of the mathematical machinery behind this law, which does anything else but say the same thing over again while make the mathematics harder and at the same time does not produce some wrong phenomena.. So, there is no model of the theory of gravitation today other than the mathematical form."

In this article I would like to present a new way of thinking of the machinery of gravity, which is more closely related to John Wheeler's famous statement "Matter tells space how to curve space tells matter how to move"[2]. It is appreciated that whatever may a machinery that can underlay Wheeler's statement be, it wouldn't has been considered by Feynman "the same *Le Sage* thing over again".

Since Wheeler's statement is in an explanation of Einstein view that space **is** gravity, it is very clear that gravity in this view cannot rely on any sort of momentum carriers "shooting by, shooting by" (a quotation from Feynman's authentic description of Le Sage gravity) in every direction "through" space, until occasionally colliding with massive objects to produce gravity. Gravity in Einstein view is a continuum, as much as space is a continuum, and as such may not be originated by "shooting by" spaced apart carriers. There are no gaps in gravity.

It is accordingly suggested that gravity indeed is a continuum, the continuum of space, and the riddle actually is, how this continuum can "tell" the meaningful thing suggested by Wheeler, i.e. by what means can a continuum carry matter-interpretable information. While Einstein's approach that the information is carried as "spacetime curvatures" is well known, I would like to be more specific and present an alternative.

Modified Wheelerian perspective

Wheeler's statement hints that matter does something to space, and it is space that affects other matter's motion. Whatever may the "information" carried by space in this regard be, it should be directional, however, as well as quantitative, i.e. it should point towards the matter, the same matter that "did its magic" to space, "magic" which is both directionally and quantitatively informative to other matter and can tell them how to respond.

A point in such an informative space, a true point, or a least a quantum point, even if carrying a quantitative information, cannot carry **directional** information, however, because a point lacks directionality by principle. At least three points are required for defining a curve, and thus no spacetime curvature, can be attributed to a point. Similarly, no gravitational potential can be attributed to a point without referencing it for comparison with the potential of at least another point.

The fundamental absence of directionality in the information presented at a point of space is a great hint in my view, to the real nature of both gravity and matter, because it puts constrains on their mutual interactions: matter is particles, i.e. point like objects, so the actual entity that should respond by finding its way through the continuum of space is point like. The million dollars question is, hence, how can a directionless space point "tell" a directionless matter point how to move.

It should therefore be postulated that any particle (and photons included) that can respond to gravity, i.e. that can follow the geodesics of space, spans across a small region of space which contains at least as much true space points as required for directionality of gravitational information carried within that region to be communicated to the particle in order to "tell it how to move".

In order to allow for a substantially uniform continuum of space, and on the same time allow for continual information carrying, it is suggested that space, which according to my view of Wheeler's approach, is gravity, is a concentration gradient of one ingredient of space within another, i.e. "the fabric of space" is interwoven from **two** ingredients[I] which both together, with varying concentrations thereof, fill up the entire universe without gaps.

Particles can thus be assumed as responsive to concentration differences, by repetitively translating the concentration (hereinafter also "magnitude") at each true space point overlapping with a border region of the particle , into a respective dose[II] of motion in a direction perpendicular to a border of the particle, such that a difference in the concentration of a specific one of the ingredients from opposite ends of a particle, becomes translated into a net motion (being the differential between the respective doses) towards the direction either of greater or of lesser magnitude of the field, depending on whether the particle responds to gravity with attraction or with repulsion[III].

Referring back to Wheeler's first half of statement, "matter tells space how to curve" should, to my personal interpretation, be modified to state "mater tells space how to concentrate", meaning to say "matter affects the concentration of one ingredient of space within another". The interpretation of the closing part of the statement "space tells matter how to move" will accordingly be that a particle spanning across a tiny region of space is repetitively translating the difference in concentrations from opposite ends thereof into a net motion towards the direction informed by the concentration difference.

Bearing in mind this suggested mechanism, attention should be drawn to what often being specified as a principal dissimilarity between GR and Newtonian gravity, that according to Newton the gravitational force is a real force, while according to GR an acceleration by a gravitational field is a force-free motion along a geodesic[3], i.e. the gravitational force is a fictitious force. While often considered explanatory of the difference between them in gravitational lensing predictions, the difference between these contradicting approaches may have far reaching consequences in the understanding of gravitational fields per se, consequences to be discussed herein.

[I] One of the two space ingredients is spacents (for the meaning of spacent see MCS Physics Article4), the other ingredient is converted from a single spacent during $\boldsymbol{T_2}$ idleness period of the ***EMP*** particle cycle, and is given off during $\boldsymbol{T_3}$

[II] I mention in this article "doses" of motion, since to my viewpoint a velocity of a particle, even of a particle at rest, is actually a gross averaging up of frenetic cyclical non simultaneous micro motions in all directions summing up to its observable macro velocity. If you are not satisfied with this view, simply ignore it and read "velocity" whenever I mention "dose of motion".

[III] I predict that antimatter particles respond to gravity by repulsion. To have a better grasp of this point, for gravity repelled particles simply substitute the particle's directionality of motions figure presented in the first line of Table 1, by the figure presented in the second line.

The chicken and the egg dilemma or what comes first, force or motion?

While according to Newtonian dynamics a gravitational field is a force field obeying an inverse square law, the case may completely be different according to Wheeler's approach.

In the Newtonian approach it is clear that gravity is an accelerating force which causes accelerated motions, while in the essence of Wheeler's notion, accelerated motion is interpretable simply as a motion, i.e. an immediate response of a particle to local differences in the magnitude of the gravitational field. In a first glance, such immediate response may or may not be a response to a force, because it can seemingly be interpreted that local[IV] differences in the gravitational magnitude exert a net force on the particle, which is the cause of its motion.

I will shortly resolve against such interpretation, showing with great confidence that the particle simply translates local differences in the gravitational magnitude into a net motion, and that acceleration of ordinary matter within a gravitational field is hence simply a change in the velocity of matter uphill a gradient of field concentrations without involvement of any real force, even not a local force. Space tells matter how to move means space tells matter in what particular momentary velocity should it move.

What is the real gradient law of gravitational fields?

According to my view of Wheeler's notion, a local difference in the magnitude of a gravitational field between two spaced apart points of space is translated by a particle spanning between such points into motion. The question to be resolved is whether the differential magnitude is first translated into a force which then causes the particle's motion (hereinafter "Force Causes Motion" to be abbreviated FCM), or may be the differential magnitude is translated directly into a net motion of the particle whenever no external prevention to such motion exists, but is being translated however into a force *($F=dp/dt$)* once motion becomes prohibited due to the presence of an external obstacle (hereinafter "Motion Causes Force" to be abbreviated MCF).

Since a gravitational force is known to be inversely proportional to the square of the distance from the center of a gravitational field, if FCM is true, a differential magnitude across a particle in a gravitational field should obey the inverse square law, whether the particle acted by is at rest or freely falls.

Fortunately, a trial and error proceeding using simple algebra shows that a view of Wheeler's approach according which the difference in the magnitude of the field across a particle "tells matter how to move" by exerting a local force on the particle (i.e. FCM) cannot satisfy an inverse square law. As I show hereinafter, the thought local force of FCM can obey either an inverse third power force law or a linear force law, but not an inverse square law.

In contrast, if MCF is true, a gravitational field is a motion field demonstrable by a body freely falling from infinity within an ideal gravitational field, and as such should obey an inverse square **root** law[V]. Fortunately once more, an elegant solution

[IV] In this article the meaning of the term "local" is "across the particle".

[V] Using simple algebra I will show in a following article the buildup of a $1/\sqrt{R}$ concentration gradient from the simple cyclic operation postulated in MCS Physics Article 2, by which "matter affects the concentration of one ingredient of space within another". This showing is not essential however to the full comprehension of the principles herewith discussed.

satisfying such inverse square **root** law is achievable for my view of Wheeler's approach according which the difference in the magnitude of the field across a particle "tells matter how to move" by the particle translating the differential magnitude directly into motion.

Here is the algebra through a trial and error proceeding[VI]:

Thinking of a particle as a spherical envelope spanning across a tiny region of space and being sensitive to the magnitude of the field at each overlapping space point by translating the magnitude either into a centrally pointing force (if FCM is true) or into a centrally pointing motion (if MCF is true), let ***r*** be a radius[VII] of the envelope, and ***R*** be the distance of the center of the envelope from the center of an external gravitational field. For the sake of simplicity, vectors directed towards the center of the gravitational field will be assigned the positive sign.

Suppose MCF is true, a gravitational field obeys an inverse square **root** law, in which a magnitude $\boldsymbol{\mu}$ of a point in the field is proportional to the inverse of the square **root** of its distance ***R±r*** from the center of the field, such that $\mu \propto 1/\sqrt{R}$.

For satisfying a motion toward the center of the gravitational field, the net motion of the particle must be directed from a low magnitude of the field toward a higher magnitude. Resolving first for a mechanism in which the particle's envelope translates magnitudes of the field **inversely** proportional into motion, i.e. lower magnitudes of the field sensed by points on the envelope result with increased respective doses of motion towards the center of the particle, let the net of the doses of motion be expressed as a net velocity ***V*** toward the center of the field such that

$$V \propto \frac{1}{\mu_{R+r}} - \frac{1}{\mu_{R-r}} \propto \frac{1}{\frac{1}{\sqrt{R+r}}} - \frac{1}{\frac{1}{\sqrt{R-r}}} \cong \frac{r}{\sqrt{R}}$$

{1}

Since the change in the velocity ***V*** throughout the field is proportional to the change in the magnitude of the field (both being inversely proportional to $\sqrt{R}$), MCF can be a true machinery of gravity, in a gravitational field demonstrating a concentration gradient proportional to $1/\sqrt{R}$, for particles whose envelope respond at each point thereof with a motion dose towards the center of the particle inversely proportional to the magnitude of the field.

Trying now to resolve for a mechanism in which the particle's envelope translates magnitudes of the field **proportionally** into motion, i.e. lower magnitudes of the field sensed by points on the envelope result with decreased doses of motion away from the center of the particle, the net velocity ***V*** throughout the field is proportional to:

[VI] See table 1 on page 9 for better clarity. Note also that the proceeding is based on an assumption (the basis of which will be explained in a separate article) that the concentration of the gravitational field ingredient which is translated by particles into motion, decreases with the distance from the center of the field.

[VII] To be multiplied for each envelope's point by a cosine of the radial angle between the point and the line connecting between the center of the particle's envelope and the center of the external gravitational field.

$$V \propto \mu_{R-r} - \mu_{R+r} \propto \frac{1}{\sqrt{R-r}} - \frac{1}{\sqrt{R+r}} \cong \frac{r}{\sqrt{R^3}}$$

{2}

Since the velocity law is $V \propto 1/\sqrt{R^3}$ while a magnitude of the field is $\mu \propto 1/\sqrt{R}$, particles having envelopes which translate magnitudes of the field **proportionally** into motion **do not** present a true machinery for gravity.

Supposing now that FCM is true, a gravitational field is a force field, and as such should obey an inverse square law in which a magnitude μ of the field is proportional to the inverse of the square of a distance ***R***, such that $\mu \propto 1/R^2$.

Resolving first for a particle's envelope which translates magnitudes of the field inversely proportional into local force, i.e. lower magnitudes of the field sensed by points on the envelope result with an increased local force towards the center of the particle, let the net of the force be ***F*** toward the center of the field such that

$$F \propto \frac{1}{\mu_{R+r}} - \frac{1}{\mu_{R-r}} \propto \frac{1}{\frac{1}{(R+r)^2}} - \frac{1}{\frac{1}{(R-r)^2}} \cong 4rR$$

{3}

Since the local force law is $F \propto 4rR$ while the magnitude of the force field is $\mu \propto 1/R^2$, particles having envelopes which translate magnitudes of the field into inversely proportional local force **do not** present a true machinery for gravity.

Further resolving for a particle's envelope which translates magnitudes of the field into proportional local force, does nothing better:

$$F \propto \mu_{R-r} - \mu_{R+r} \propto \frac{1}{(R-r)^2} - \frac{1}{(R+r)^2} \cong \frac{4r}{R^3}$$

{4}

Particles having envelopes which translate magnitudes of the field into proportional local force also **do not** present a true machinery for gravity.

Consequences and predictions

- According to equation {1}, a velocity of a particle freely falling in a gravitational field is proportional to a radius ***r*** of the particle. It surprisingly follows that the universal gravitational constant G possibly differs per elementary particles of different ***r***. Bearing in mind that big ***G*** has never been tested for single elementary particles (but always for bodies consisting of atoms) the surprising prediction that there may be one ***G*** for electrons, another ***G*** for quarks, and so forth, should be tested.
- One can ask how comes that a so tiny change in the magnitude of a gravitational field from opposite ends of a particle's envelope, can result with the significant velocities presented by freely falling bodies. The answer lays in the number of points in a particle's envelope which are sensitive to the magnitude of the field. While the contribution of each single point is

negligible, the total contribution of a huge number of active points at a particle's envelope is the observed velocity[VIII]

$$V = k\frac{1}{\sqrt{R}}$$

{5}

The velocity $\boldsymbol{V}$ is a statistical product of a huge number of tiny differential velocities. The tiny difference in the magnitude of the gravitational field from opposite ends of a particle which results with a tiny net dose of motion per each pair of opposite active points on a particle's envelope, is amplified by the huge number of such pairs, to form the observable net velocity $\boldsymbol{V}$ of the particle as a whole.

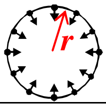
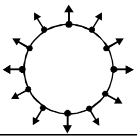
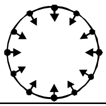
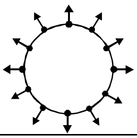
- It can also be asked that if magnitudes of a gravitational field become translated into respective velocities always the same, i.e. always depending on the local magnitude of the field and independent of the velocity of the particle, how comes that at a given distance $\boldsymbol{R}$ from the center of a gravitational field, a velocity of a body freely falling from infinity differs from the zero initial velocity of a body which has just been let to freely fall from the given distance. The answer is that in terms of inertial motion the velocity of a body at rest within a gravitational field is not zero,. The opposite is also true: the motion of a body falling from infinity within a gravitational field is **not** inertial motion. Inertial motion is a free fall of a particle in the gravitational field of itself[4], not its motion in response to a gravitational field of a remote mass. Consequently, a body at rest within a gravitational field actually has an inertial motion in a velocity equal in magnitude and opposite in direction to the velocity at that point of a body freely falling from infinity (which is equal to the escape velocity $\boldsymbol{V_e}$), which cancels out with the local velocity caused by the external gravitational field. Once the body at rest is being let to freely fall, it translates the magnitude of the external gravitational field to a local velocity exactly the same as a body freely falling from infinity, with the difference that a body at rest has an initial momentum pointing away from the center of the external gravitational field, which a body freely falling from infinity hasn't.
- The response of a particle to a gravitational field by attraction requires that the particle's spherical envelope will translate local magnitudes of the field into doses of motion towards the center of the envelope. It is predicted that particles which respond to gravitational fields by repulsion exist, and mainly differ from conventional particles only by the fact that their spherical envelopes (which are the same in nature) are closed oppositely on themselves (like clothes dressed the inner side out), thus translate local magnitudes of the field into doses of motion **away** from the center of the envelope.
- It is predicted that antimatter actually responds to gravitational fields by repulsion, which is the reason why the amounts of matter and anti matter near the center of galactic gravitational fields are enormously uneven.

[VIII] $\boldsymbol{k}$ is a combined constant which integrates the magnitude of the gravitational field with the integrated influences of the sensitive points constituting the particle's spherical envelope, accounting for their number, the radius $\boldsymbol{r}$ of the envelope and the cosine of the angular position of each point about $\boldsymbol{R}$.

- It is predicted that dark matter is antimatter, and that the reason for its darkness is the lack of interactions between antimatter particles. Antimatter particles are unable to collide because as they come close they are mutually repelled by gravity. It is consequently predicted that antimatter cannot form atoms other than anti hydrogen.
- It is predicted that flat rotation curves detected at the outskirts of galaxies result from anti hydrogen atoms trapped between the disk and the voids due to inversion in the gradient of gravitational field magnitudes at this galactic region. The cause of such inversion though beyond the scope of the present article, should not be confused with the predicted inverse response of anti matter to gravitational fields of regular gradient. Antimatter forms a gravitational field of normal gradient, but respond to the oppositely. Dark matter thus, is not absolutely dark. It is capable of emitting spectrum lines associated with the changing of energy levels by positrons in anti hydrogen atoms. The galactic halos of "dark matter" are nothing more or less than halos of anti hydrogen, i.e. there is no dark matter other then anti hydrogen.

Article sum up

Table 1

The field law (i.e. the concentration gradient throughout the field)	A field's point magnitude is translated by the particle into a dose of motion	The particle's envelope, illustrated with small arrows representing its directionality of motions translated from overlapping point concentrations of the field	The local law (after dispensing with terms of insignificant magnitude)	Is the local law in agreement with the field law?
$\mu \propto \frac{1}{\sqrt{R}}$	Inversely proportional		$V \propto \frac{r}{\sqrt{R}}$	**YES**
	Proportionally		$V \propto \frac{r}{\sqrt{R^3}}$	No
$\mu \propto \frac{1}{R^2}$	Inversely proportional		$F \propto 4rR$	No
	Proportionally		$F \propto \frac{4r}{R^3}$	No

According to my view of Wheeler's notion, a possible machinery of gravity is a one in which (i) a gravitational field is a motion field and as such demonstrates a concentration gradient obeying an inverse square **root** law, and (ii) particles of ordinary matter behave as spherical envelopes which respond to point magnitudes of the field with doses of motion towards the center of the particle that are inversely proportional to the field's magnitude. The result is a net velocity of the particle toward the center of the gravitational field.

A real gravitational field associated to a point mass is characterized by a real concentration gradient $cg \propto 1/\sqrt{R}$. The corresponding Newtonian inverse square law is a computational derivative inferred from the phenomenological consequences of the real $1/\sqrt{R}$ field law.

Table 2

	The field law	Causality		
		Cause	Result	
Newtonian perspective	$\frac{1}{R^2}$	$F_{real} = \frac{mMG}{R^2}$	$Ve = \sqrt{\frac{2MG}{R}}$	
Modified Wheelerian perspective	$\frac{1}{\sqrt{R}}$	$Ve = \sqrt{\frac{2MG}{R}}$	$g = \frac{MG}{R^2}$	$F_{fictitious} = \frac{mMG}{R^2}$

Glossary

μ the point magnitude of a gravitational field (i.e. the local concentration of one space ingredient within another)

♣ ♣ ♣

References:

[1] Richard Feynman, The Character of Physical Law (1965), MIT Press (1985) p. 39

[2] Wheeler, John Archibald (1990) A Journey Into Gravity and Spacetime, p. xi, Scientific American Library, San Francisco: W. H. Freeman, ISBN 0-7167-6034-7" textbook. San Francisco: W. H. Freeman.

[3] Hans Stephani (2004). Relativity: An Introduction to Special and General Relativity. Cambridge UK: Cambridge University Press. p. 105. ISBN 0521010691

[4] Meir Amiram MCS Physics Article 6: Inertia (2011); *viXra 1111.0099*

[5] Meir Amiram MCS Physics Article 4: Energy (2011); *viXra 1107.0046*