
Radial Falling in (4+1)-Dimensional Spacetime

Preface. This is part of a work in progress, most of whose features will later appear in a more comprehensive document. The original motivation and context of this particular extract are explained in the Introduction. This Preface is to point out that the original (February 2008) version has now been revised and updated (May 2008). The main changes are: 1) certain important differences between the “Epsteinian space-propertime tube” diagram and the Space Generation tube diagram (p. 2) are now more clearly described. And 2) more emphasis is given to the crucial distinction between motion *through* space vs. motion *of* space, especially as it relates to the relationship between (3+1)-dimensional spacetime and (4+1)-dimensional spacetime.

Introduction. Several key questions about the Space Generation Model of gravitation (SGM) are addressed here, most of which relate to the graphic on p.2. Thanks to a recent dialog with one of my correspondents, the need to more clearly integrate this graphic into the model has come to the fore. Rather than revise the presentation as it was written expressly for this correspondent, I will simply explain the context in this Introduction.

The dialog was initiated soon after I chimed into a physics blog in which the proponent was advocating use of a variation of the usual Minkowski diagram. [<http://www.scienceblog.com/cms/minkowski-diagram-and-misrepresentation-spacetime-14696.html>] I recognized the variation as being very much like a similar approach taken by Lewis Carroll Epstein, in his book, *Relativity Visualized*. So I mentioned this and offered to send to any interested readers a jpg of a figure from Epstein’s book showing that the variation is, essentially, a 90 degree *projection* of the usual Minkowski diagram. I got one taker, the correspondent referred to above, whom I’ll refer to as Dr. H. In the initial email, Dr. H mentioned having visited this website (GravitationLab.com) and offered some encouragement, tempered with his guess that he thought

he knew what would be the result of the interior solution experiment. Dr. H mentioned having previously applied the Schwarzschild interior solution to the Relativistic twin problem. In my response I mentioned references that dealt with the same subject, most notably the work of Frank R. Tangherlini. [‘Postulational Approach to Schwarzschild’s Exterior Solution with Application to a Class of Interior solutions,’ *Il Nuovo cimento*, vol 25 (1962) p. 1081.]

In one of Tangherlini’s papers he presented an interior solution which, though based on reasonable postulates, resulted in predictions that dramatically contradicted predictions based on the standard approach to General Relativity (GR) and even Newtonian Gravity (NG). This was exemplified by application of the solution to motion with respect to hollow shells of matter. Tangherlini’s novel solution predicted that, if a test object were dropped into a hole in the shell, after accelerating part way in, it would eventually experience a repulsion and never enter the inner cavity. Tangherlini did not regard this as being physically realistic – but as *interesting*, given the seemingly reasonable postulates he started with.

A discussion of Tangherlini’s work prompted my assertion that his interior solution prediction resembled what my prediction would be for the same circumstance. After explaining the physical basis for my prediction (literal interpretation of accelerometers and clocks) and how it involved the need for a fourth dimension of space, Dr. H replied with a handful of pertinent observations and questions, of which I will list three:

1) It occurred to Dr. H that my model might entail a contradiction in that, though it may be reasonable to invoke an extra dimension to account for the stationary *acceleration* due to gravity (accelerometer readings) how would this same extra dimension also account for the stationary *velocity* due to gravity (clock rates)? Especially by appealing to the graphic on the next page it can be shown that this apparent contraction may be resolved.

2) Up to the time when he wrote, it had not yet been made clear to Dr. H exactly how my model justifies rejection of the standard wisdom that higher dimensional “embedding spaces” are irrelevant for gravity. The standard wisdom makes sense if GR proves valid even for the interior solution. But since there is not yet any empirical support for GR’s interior solution, this “wisdom” may turn out to be the irrelevant thing. A higher dimensional space that *moves* may be exactly what’s needed to account for the pattern of motion that is actually found inside matter.

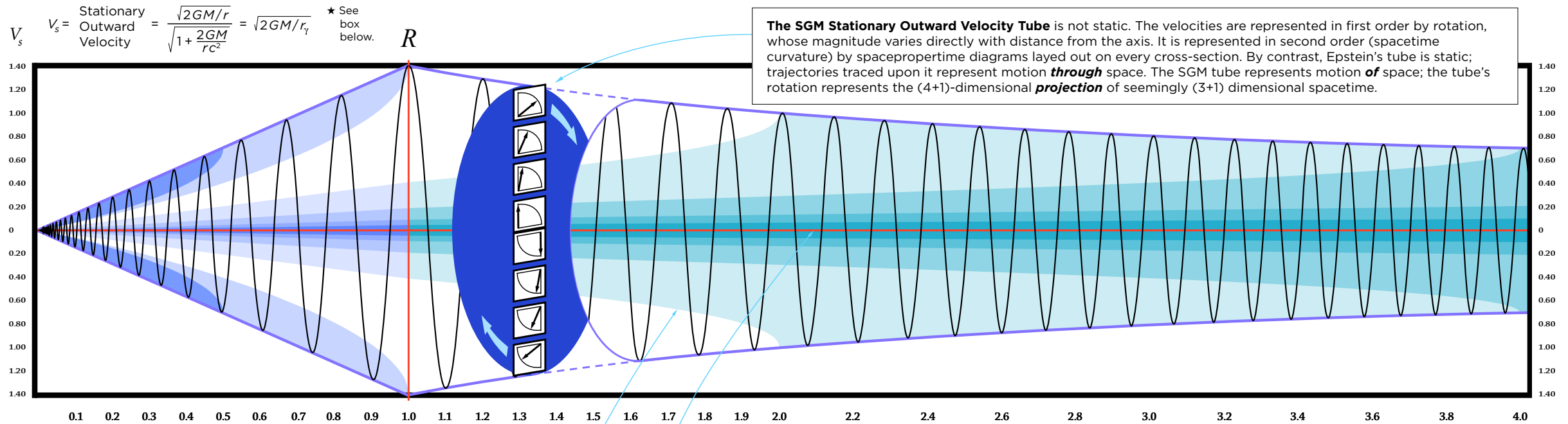
3) Evidently in response to my assertion that my model is based on a literal interpretation of accelerometer readings and clock rates, Dr. H expressed concern over the difficulty of defining a *global time*. Is there a “base” clock rate, a global reference time, relative to which it makes sense to make absolute statements about the rates of clocks? A key element of the SGM (which is also discussed in my third paper, *Light and Clock Behavior in the Space Generation Model of Gravitation*) is the idea that not only clocks at infinity, but also clocks *falling from* infinity (as well as a clock at the center) may serve as a time standard – at least for a locally dominant gravitating body. Defining a global time thus depends on how global one needs to get. As pointed out by Dr. H, the problem appears insoluble in the context of GR. Various ether theories have their respective approaches to this problem. The approach offered by the SGM is not only novel and, I believe, reasonable, it is *testable*.

With the context thus laid out, the following pages should add substantially to the content of Papers 1-3 in bolstering the plausibility of the SGM, and thereby providing additional motivation to perform the experiment that would seal its fate.

Main problem defined. The present objective is to show that both the acceleration and the velocity due to gravity derive from motion “into or outfrom” the fourth dimension of space, where this motion is conceived as being generated by the perpetual creation of new space by matter.

Space Generation Model (SGM) Radial Falling from $r_\gamma = (0.5, 1.0, 2.0, 4.0, 8.0 \text{ and } 16.0)R$

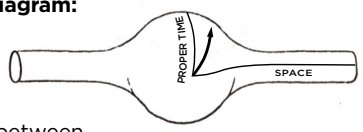
May 8, 2008



The SGM Stationary Outward Velocity Tube is not static. The velocities are represented in first order by rotation, whose magnitude varies directly with distance from the axis. It is represented in second order (spacetime curvature) by spaceproptertime diagrams layed out on every cross-section. By contrast, Epstein's tube is static; trajectories traced upon it represent motion **through** space. The SGM tube represents motion **of** space; the tube's rotation represents the (4+1)-dimensional **projection** of seemingly (3+1) dimensional spacetime.

Epstein's Tubular Spaceproptertime Diagram:

The pointer can be thought of as a speedometer needle showing speed only through time (time axis, at rest); only through space (space axis, light ray); or anywhere in between.



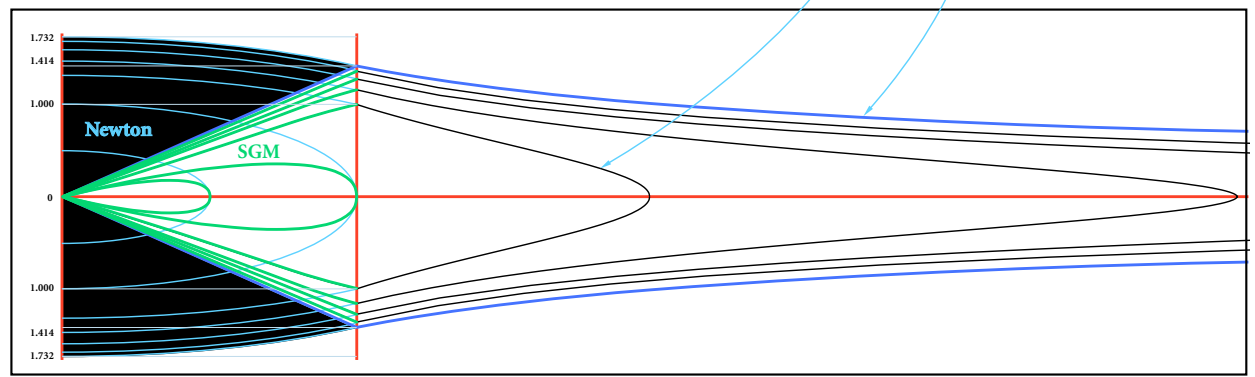
SAME TRAJECTORIES: ABOVE, BASED ON 4D SPACE GENERATION BELOW, BASED ON ATTRACTION

★ Uniform proper acceleration results in a speed that asymptotically approaches c :

$$v = \frac{gt}{\sqrt{1 + \frac{g^2 t^2}{c^2}}}$$

Accumulation of matter results in a stationary outward velocity that similarly approaches c . Black holes never form. (See upper left equation.)

$$r_\gamma = r + \frac{2GM}{c^2}$$



The speed represented by the outer envelope (above) corresponds to the motion of the gravitating body and anything firmly attached to it; motion of space. Therefore, the extreme (*maximal geodesic*) trajectory of an object falling from infinity corresponds to $V_s = 0$. A maximal geodesic is the optimal "tracer" of gravity-induced motion; it reveals the movement of space past it, which is not the same as it moving through space. The contours of the other shapes represent falling from smaller distances where the initial velocity is, in the sense of this model, positive. The graphs of these trajectories branch off not from $V_s = 0$, but from the outer envelope. The meaning of the waveform is discussed in the following text.

The curves for the exterior ($r_\gamma > R$) are gotten from the standard Newtonian equation and are then subtracted from the magnitude of the outer envelope for every corresponding distance (r_γ). The curves for the interior are approximations based on equations from a preliminary model. If the curves were plotted in the usual manner, the graph would instead look something like the one on left.

This objective might be reached along three possible routes: 1) Accepting as given the slowing effect on clocks (velocity) and showing how this “leads to,” without further assumption, the observed effect on accelerometers; 2) accepting as given the positive accelerometer readings (acceleration) and showing how this “leads to,” without further assumption, the observed effect on clocks; or 3) showing that these effects necessarily go with each other, which would imply that these approaches are ultimately equivalent.

The graphic model is obviously very abstract. Due to the addition of one more space dimension it is more abstract than Epstein’s tubular spacetime graph, which serves well as a basis for comparison, since his model is clearly related to the consequences of GR’s Schwarzschild solution. [Lewis Carroll Epstein, *Relativity Visualized* (Insight Press, San Francisco, 1988) chapters 9-11.]

Let’s see how far we get by adopting option (1). By virtue of the ticking of one’s clock, in the context of relativity, we have movement up the time line. If the spacetime graph is rolled into a tube and a massive body is nearby, the body’s gravity causes the tube to flare (or the body’s gravity can be *represented* by the flaring of the tube). This “induces” motion in a particular direction *through space* (toward the body). What makes the tube flare? How does *nature* go about causing the trajectory that we draw on the tube? What must matter be *doing* to make this happen? Nobody knows. The approach explored below may begin to provide some answers.

General remarks on hyperdimensionality. By definition, increasing the number of space dimensions means introducing a new perpendicular direction along which motion can occur. An important distinction should be made here between the present conception and more “typical” speculations on the existence of hyper-dimensional worlds (having greater than three space dimensions). The possible reality of a fourth space dimension has often been suggested as a condition in which 4D beings could supposedly pluck things out of locked boxes and do various other magical things. In a more “serious” physical context, one also

finds (as is well known) Kaluza-Klein-like speculations that were invented so as to weave electromagnetic phenomena more intimately into the geometrical structure of General Relativity. Most modern incarnations of Kaluza-Kleinian modelling invoke way more than one extra dimension, which (as with the original) are usually conceived as being tiny, wrapped up, “compactified” and basically, inaccessible dimensions of space. In this context, the extra dimensions are often imagined to have a characteristic “size.” The present idea, by contrast, is to simply extend the dimensional hierarchy: point, line, plane, volume . . . to “hypervolume” so that each step along the way *includes* each preceding step. By this way of thinking, dimensions do not have characteristic “sizes.” Some researchers have speculated that one or more of the extra dimensions may be “large” and so be subject to observational testing. But the key thing is that in all of these “standard” conceptions, the extra dimensions serve essentially just to widen the stage upon which physical forces operate. A macroscopic material chunk of this stage is still conceived as being an essentially static “conserved” thing. Things are still regarded as moving *through* the (n+1)-dimensional spacetime. A given dimension is not associated with a global pattern of motion. In other words, in none of these standard schemes, does an extra dimension represent a *motion of space itself* – as a process that is grossly manifest both locally (common effects of gravity) and cosmologically (redshift and other consequences). The latter characteristics are the essence of the present conception, which I call the Space Generation Model of gravitation (SGM).

Although the fourth space dimension may be “disguised” due to our theoretical inventions that treat its effects in other terms, it is not really “hidden.” It is in plain view and, if the SGM is essentially correct, the disguise would be most dramatically revealed as such by a test of the interior solution. (4+1)-dimensional motion means each of the “first three” dimensions are *included*; it means the first three dimensions all move in every direction so as to generate the fourth. Matter is the source of this motion; matter is the source of space. Although globally omnidirectional (symmetrical), the motion thus manifests plainly evident asymmetries due to the inhomogeneity of matter. Bodies of matter are as focal points of the motion.

Clearly such a radical departure from our usual conceptions of gravity (i.e., Newtonian gravity and General Relativity) involves effects that do not exist in the intrinsic (3 + 1)-dimensional static geometry. Therefore, in the SGM an understanding of the extrinsic (4+1)-dimensional embedding space is *crucial*. If a spherical body of matter and its surrounding Schwarzschild field are static things, then the embedding space is needless. But if the 4D embedding space is an expression of the ultimate *source* of the “dynamics” of the seemingly 3D space, then the exterior Schwarzschild field would be seen as a kind of average, a staticized geometrical description of a circumstance that is actually quite non-static, and therefore having only limited, approximate validity. And the Schwarzschild *interior* solution would be entirely wrong.

Visualizing the fourth space dimension. Coming back then, to our graphic, to represent this new direction of motion – the motion *of* space – we imagine that the tube (outer envelope) rotates, the rotation axis being a radial line from the source mass. Let’s think of the whole length of the tube, from $0 < r < \infty$ as having a uniform angular speed. The velocity at a given radial distance from the massive source then corresponds to the height of the outer envelope in the above figure. A key difference between Epstein’s approach and ours is as follows. Although he does not explicitly say so, Epstein’s tube and the path traced upon it represent two things: the rate of a clock attached to the source mass (with respect to a clock at infinity) and the rate of a falling clock with respect to the source mass. With respect to a resting clock at infinity the rate of the falling clock thus supposedly suffers two reduction factors, one due to the “potential” (metric coefficient) where it is momentarily located and one due to its motion, the source mass here being regarded as the standard of rest. The “rest” status of objects attached to the mass is represented on Epstein’s tube by movement straight up the time axis (zero movement along the space axis).

Now consider the SGM tube, whose outer envelope, having a constant rotational velocity, represents only the rates of clocks *attached* to the gravitating body. Imagine an array of clocks at various locations

attached to a very tall (“rigid,” yet negligibly massed) pole that projects radially from the source body. Beyond the surface of such a body GR and the SGM agree on what the rates of these clocks would be. But these models strongly disagree about the rates of clocks that are “falling” in the field. In terms of our graphic, dropping a clock alongside the pole would correspond to “disconnecting” it from the outer envelope. The frequency of such a clock and its proper time would then be represented by the spaceproptime diagram residing on the interior cross-section of our tube. Clocks whose trajectories lie within the outer envelope all tick faster than stationary clocks. The clock with the fastest rate is the one that falls from infinity (maximal geodesic).

Rotation and gravitation: motion *through* and motion *of* space. Before going into more detail about “falling-dropping” problems in terms of our tubular model, let’s first consider the rates of moving clocks in the absence of gravity. If the problem involved two *inertial* reference frames, using Epstein’s approach, we’d have two “flat” parallel tubes. We would have no physical reason to “prefer” one over the other. A perhaps seemingly “preferred” frame, in this context, would be represented as the tube containing a circular world line that keeps looping back on itself. Whereas the “moving” frame would trace out a helix. The equivalence of inertial frames, however, means we might just as well imagine it being the other way around; we can adopt either as our “resting” frame of reference. Or we can adopt a third reference frame from which the world lines of the first two are differently pitched and directed helixes in their respective tubes.

As long as the motions can be represented by such parallel tubes – which would also be appropriate in the case of *rotation* – it is well to describe it as motion through space, motion through an essentially passive backdrop. Although rotation possesses absolute characteristics that cannot be made to vanish by a coordinate transformation, its representability by parallel “spaceproptime” tubes indicates a certain *flatness* or three-dimensionality which characterizes motion *through* space.

This is all thus to suggest how much more fundamental it is when

we find the motion diagram tube to *flare*. By the present view this flaring indicates that the spaceproptime tube model is no longer adequate, because it is static; it represents a static backdrop of three-dimensional space and one dimension of time. Instead, we now regard the flaring as indicating the movement of space, and so we “embed” the spaceproptime diagram within the more fundamental absolute motion of the “tube” (space) itself.

Rotation has often been referred to as stationary motion. Its absolute effects on measuring rods and clock rates suggest the well known analogy with gravitation. To sum up the present argument then, we acknowledge the analogy, but emphasize the crucial difference: Rotational stationary motion is still motion through space(time); (3+1)-dimensional. Gravitational stationary motion is motion of space(time); (4+1)-dimensional. GR does not answer the question, what causes spacetime to curve. The SGM suggests that the curvature of spacetime is caused by stationary motion. Let’s now return to our question as to how *acceleration* ties into all of this.

Inhomogeneous time and stationary acceleration.

Yet the nagging question remains: Why is it that in frames in which fixed clocks do not keep time at the same rate, free bodies spontaneously accelerate? We have no answers. –

[R. W. Brehme, Am. J. Phys **53** (10) 1985, 952.]

Geometrically minded physicists may object to Brehme’s final conclusion (as one of them did in a Letter to the Editor) and cite the relativistic equations showing how these things do indeed always come with each other. Being a reputable relativist himself, Brehme was most likely not looking for that kind of answer. His question, to my mind, reveals a sensitivity to the ironic and pervasive feature of General Relativity, that devices that may “innocently” be thought of as indicating the existence of motion are instead regarded as *resting*. From this perspective, when “free objects” begin to move with respect to the seemingly resting

devices, it appears mysterious. The more common perspective, unfortunately, is either to ignore this mystery or to pretend that it has been “explained” by mathematics.

Presently, we regard the motion sensing devices as *telling the truth* about their state of motion. This obviously doesn’t make sense if the motion so indicated is regarded as being motion through space. For then acceleration indicated by an accelerometer attached to one of our tall poles, for example, would seemingly have to be undiminished at any height along the pole. In other words, it would be impossible to account for the fact that accelerations so measured actually vary substantially along the height of the pole. Regarding matter as a source of space and space as having four instead of only three dimensions clearly *necessitates* inhomogeneities whereby the varying magnitudes of acceleration, velocity and clock rate should be inextricably related to one another.

One way to illustrate this is to begin with two clocks separated by a distance h (which is small compared to the distance from the source body) along our pole, whose extremities thus have slightly different gravitational “potentials,” $\Delta(GM/r)$, or “metric coefficients,” $\Delta(1 - 2GM/rc^2)$. The difference in clock rate between the extremities of h can be expressed as the difference in *velocity* that would accrue due to their (nearly identical) accelerations, $g(r)$:

$$\Delta f \simeq f_h \left[1 - \sqrt{1 - \frac{2g(r)h}{c^2}} \right] \simeq f_h \left[1 - \sqrt{1 - \frac{\{g(r)t\}^2}{c^2}} \right], \quad (1)$$

where f_h is the rate of a clock at the upper extremity of h and t is the time required to fall the distance h . It is interesting that any clock rate difference corresponding to a height difference will involve (or is expressible as involving) the square root of an acceleration, g times 2 times a length. According to the SGM the slowest clock in the system is the one at the surface. The stationary outward velocity that causes the slowing of this clock can be expressed as $\sqrt{2gR} = \sqrt{2GM/R}$. The clock rate differences and their corresponding velocity differences can be expressed without reference to the acceleration. But the “geometry of the situation” inescapably involves the acceleration. The geometry of the situation might be as per Epstein, in which spacetime is (3+1)-

dimensional and represented as a static tube. Or it might be as per the SGM, in which spacetime is (4+1)-dimensional and is represented by a spacetime tube undergoing perpetual stationary motion and the state of rest is represented not only by clocks *at* infinity, but by clocks *falling from* infinity.

Inverse-square acceleration. Now let's now try coming at it from the other direction, option (2), at first assuming only an "acceleration field." The inverse-square law is a beautiful thing. In what I believe to be an exaggerated accolade of General Relativity, Steven Weinberg wrote:

In fact, it is fair to say that, not only does Einstein's theory not supplant Newton's theory, it explains Newton's theory. . . There was no explanation in Newton's theory of why it had to be an inverse square law. This explanation was finally provided in 1915 and 1916, by Einstein's general theory of relativity. . . according to which the force of gravity is due to a curvature in spacetime.

Curiously, a few pages later Weinberg admits that,

Einstein's general theory of relativity still left open the question: Well why is there any gravity at all? Why does space curve? Why isn't space just perfectly flat and there is no such thing as gravity? Who asked for that?

Especially given these unanswered questions, it seems obvious to me that Einstein's theory doesn't really explain Newton's. I think it would be more accurate to say that Einstein's theory *would not work* – or it would be a lot more complicated – if gravity didn't operate according to an inverse-square law. [Steven Weinberg, 'Newtonianism in Today's Physics,' in *Three Hundred Years of Gravitation*, eds., S. W. Hawking and W. Israel (Cambridge University, Cambridge, 1987) pp. 5-16.]

In the SGM the generation of space provides an intuitive picture of why this is gravity's law. At any two given distances, in a given small

increment of time, shells of *equal volume* are accelerated outwardly. The radial thickness of both shells is given by the inverse square law.

Misner, Thorne and Wheeler had occasion to expound, in the context of standard cosmology, on how there is no such thing as a "flow meter" for space – with which to measure the alleged perpetual widening of space between the galaxies. [C. W. Misner, K. S. Thorne, and J. A. Wheeler, *Gravitation* (Freeman, San Francisco, 1973) p. 740.] In the SGM, an *accelerometer* may be thought of as a "flow meter," which would be measuring the flow of new space only if the pattern of the flow were omnidirectionally outward (gravity), not if it were inward (rotation) or linear (rockets, muscles). This latter qualification, of course, refers again to the difference between movement through space ("pseudo-flow") and the movement of space ("bona fide flow").

Considering the far extremity of our pole, where spacetime is only ever so slightly inhomogeneous, the deviation from flatness arises because space is coming from, flowing out from, one particular direction. If an accelerometer is dropped from the "top" of the pole, its reading remains zero the whole way "down." The speed that accrues is everywhere attributable *to the pole*, because that is where accelerometers give positive readings and clock rates are slowed corresponding exactly to the speed with respect to this extreme case falling accelerometer. Now suppose the accelerometer has an in-built clock. The perpetual zero acceleration reading also corresponds to a maximum clock rate. Nothing ever forces this particular falling system out of its straight-up-the-timeline state. This thus represents the optimal "tracer" of motion; the state of rest reference; the "maximal geodesic."

Referring again to the graphic, the magnitude of the acceleration is represented by the changing speed with which a projection of the spinning helix moves along the axis. In this way, the stationary outward velocity is actually represented twice: once by the height of the envelope (stationary rotation) and once by the projected movement along the axis (maximal geodesic).

Now consider an accelerometer-clock dropped from a closer distance to the source. At the moment of release, the acceleration suddenly goes from a positive magnitude to zero. The rate of the clock, on the other hand, changes more gradually, as it can only change by

its changing speed with respect to a nearby maximal geodesic. Since this speed gets slower and slower with respect to the maximal geodesic, the rates of clocks falling "downward" actually increase, even as their speeds with respect to the body's surface increase. (This is a testable prediction, as noted before.)

As long as the bodies are falling *beyond the surface* of the source mass, their apparent speeds with respect to the pole will increase in accordance with the acceleration given by the pole-based accelerometers. At least as a first approximation, the apparent speed increase (or decrease) due to this acceleration will be independent of velocity, as observed.

It is relevant to note that this description of falling in an exterior field is not unlike that of Tom Martin's flow model of gravitation, which he has shown to be consistent with most of the observable consequences of the exterior Schwarzschild solution. [<http://www.gravityresearch.org/>] Curiously, in his model it did not matter whether the flow was outward or inward. Thus, his conception is *not* that matter is the source of new space, nor that the motion requires an extra space dimension. His model therefore does not agree with the SGM with regard to the interior solution. Since this is also where we find a dramatic disagreement with Newton and Einstein, let's now consider the interior.

Rather than begin by following our falling clock-accelerometer from the surface into a hole through the source mass, let's start at the center. Then the predicted motion from the surface inward will make more sense.

Assuming that the inverse-square flow of new space suffices to "explain" gravity outside the source mass, let's imagine that the source mass is very very small. We take note of the ever-so-slightly altered rate of a clock at its surface, accelerometer readings and the corresponding maximum speed with respect to its characteristic maximal geodesic. All of these magnitudes will deviate very little from what you'd find in perfectly flat spacetime. Then we begin to add, one after another, thin shells of matter whose density is the same as the "core." By Gauss' Law, which is a direct consequence of the inverse-square law, the effect of such additional shells of matter cannot contribute to the acceleration within a given shell. Of course, from the gravity-as-attraction

point of view the speed supposedly “produced” by each layer does not in any way get reduced, so the speed should increase all the way to the center. By contrast, according to the SGM, by adding more shells we are not adding “potential” for more downward speed of a *falling* object. Rather, we are creating the physical condition of more *outward* speed of the *source mass*. The speed is only attributable to bodies that have or have had (in effect) “contact” with the source body. Nothing ever pushes or pulls falling objects toward the center; all non-zero accelerometer readings are of those attached to the body. Therefore, the maximum speed that can be accrued by or attributed to a given layer of the sphere is that due to the matter within its surface. Near the center the velocity should therefore be no faster than it was with our initial kernel, before we started adding shells. The stationary outward velocity of such layers of matter varies directly with radius, just as does the stationary outward *acceleration*. Therefore, as indicated by the outer envelope on the graph, the velocity follows the linear drop to zero from the surface.

Another unique feature of the SGM comes into play here. It’s not that coordinate distances differ from proper distances; this is also true of GR. What’s unique is that, in the SGM proper distance is what determines the stationary outward velocity. The “gravitational radius,” $2GM/c^2$ is thus added to the coordinate value of r , the sum being what I call r_γ . This latter distance is what determines the velocity and the consequent “metric effects.” One of the results is elimination of the ticklish General Relativistic problems of singularities and horizons. This feature arises here because it means the increasing velocity due to our process of adding shells of matter follows a linear relation only as a “weak field” first approximation. As $2GM/c^2$ approaches and exceeds r , the relationship becomes non-linear. In the limit, density approaches a $1/r_\gamma^2$ law as V_s approaches c .

Now let’s consider dropping a clock-accelerometer from the sur-

face. This object has, in effect, an initial outward velocity $V_s = \sqrt{2GM/r_\gamma}$. Upon release its acceleration suddenly drops to zero. But, as before, the rate of the clock changes gradually as its speed changes with respect to a nearby maximal geodesic. Since neither of these trajectories, nor those due to falling from any stationary location, would pass the center, the “field” would *appear* to be producing a velocity-dependent “repulsive” effect. According to the SGM, the correct description of this occurrence – should it be empirically found to happen – is not that the falling object approaches the center ever more slowly. It’s that the space that separates it from the center diminishes, and as the amount of intervening space diminishes, it moves outwardly past the object ever more slowly.

Conclusions. As I mentioned earlier, I am not certain that the above conceptual, visual discussion resolves the apparent mathematical contradiction you have pointed out. If it does not, I would certainly like to know exactly where the problem lies, because it seems to me that the picture holds together fairly well. Stationary outward velocity and stationary outward acceleration seem to inevitably *coexist*. And they are both modelled by the above graphic, in which the fourth space dimension is represented by perpendicular motion (rotation) of a spacetime manifold that is otherwise regarded as (3+1)-dimensional and static. Be that as it may, I should briefly comment on a few loose ends.

How does this model relate to the various “gravity as expansion of matter” ideas one can find scattered here and there beyond the pale? In other words, if matter is perpetually generating space, does that mean that matter is also expanding and increasing? The answer is yes, but it’s an obvious mistake (impossibility) to envision the expansion as occurring in only three space dimensions. Furthermore, the rate of 3D

expansion is actually very small, being on the order of that hypothesized in the Steady State cosmologies of old. Matter is increasing only at such a rate as to maintain a constant cosmic density. The spatial flow can appear quite rapid near its sources, but the smoothed out “cosmic fluid” is of such a low density that linear dimensions of seemingly 3D objects change only slowly from one moment to the next (but exponentially, and so very rapidly on cosmic time scales).

As was also noted earlier, what *governs* the expansion is the relationship between the three key density regimes and how they combine to give the magnitude of Newton’s constant:

$$G = 4 \left[\frac{\rho_{SGM}}{\rho_N} \cdot \frac{c^2 a_0}{m_p} \right] = 8 \left[\frac{\mu_{CBR}}{\rho_N} \cdot \frac{a_0}{m_e} \right], \quad (2)$$

where ρ_{SGM} is the average cosmic density, ρ_N is the density of nuclear matter, a_0 is the Bohr radius, μ_{CBR} is the cosmic radiation density and m_p and m_e are the proton and electron masses.

As you may have already deduced, this model also provides an explanation for the “origin of inertia.” The magnitude of a body’s resistance to *linear* acceleration is directly proportional to the magnitude of that body’s *omnidirectional* acceleration of itself and its surrounding space. Every instance of material bodies being linearly pulled or pushed is met with an outward push back and tendency to remain “centered in the self-generated flow” in proportion to how much space the pushed body is generating.

The direction of time is also hereby de-mystified. Time only increases because space and matter also only increase. If the test object in the interior solution experiment oscillates, then a video of the motion would look the same forwards or backwards. But if it doesn’t oscillate, then time’s arrow would be seen to point in the same direction as the arrows of the fourth dimension of space, matter and gravity, i.e., outward.