Is Lorentz-invariant gravitation theory a valid alternative to general relativity?

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Abstract
Krogdahl in his critique to general relativity suggests that we should better consider Lorentz-invariant cosmology (see http://arxiv.org/pdf/0711.1145.pdf). Then this writer asks a question in researchgate.net about whether Lorentz-invariant gravitation theory is a valid alternative to general relativity. Some responses are recorded here.

Introduction
Krogdahl in his critique to general relativity suggests that we should better consider Lorentz-invariant cosmology (see http://arxiv.org/pdf/0711.1145.pdf). I tried to search on this issue and only find few articles discussing Lorentz invariant gravitation theory, one of them from wikiversity, see http://en.wikiversity.org/wiki/Lorentz-invariant_theory_of_gravitation. Then I can only locate few papers discussing Maxwell-like Lorentz-invariant gravitation theory, one of them is perhaps worth mentioning here that is by Jeffrey Kaplan, David Nichols and Kip Thorne from Caltech. They summarize DSX paper, their paper can be found at http://arxiv.org/pdf/0808.2510.pdf.
This writer asks a question in researchgate.net about whether Lorentz-invariant gravitation theory is a valid alternative to general relativity. Some responses are recorded here.

Answers
[1] **Mozafar Karamian**
Lorentz-invariant gravity, although appearing in a variety of versions, has big experimental and theoretical problems.
A major experimental problem with this theory is that it predicts perihelion advance of planets incorrectly. I worked sometime on this theory and couldn't find any version of this theory with a correct prediction on that.
Another problem is that it does not allow bending of light-path in gravitational fields genuinely.
On the theoretical side, one major problem is that energy of gravito-magnetic waves in vacuum turns out negative. Consequently, in dissipative gravitational systems, amplitude increases instead of being decreased as usual.
But, the main theoretical problem with such theories is that they do not support EQUIVALENCE PRINCIPLE. They allow universality of free-fall but gravitational field in these theories can not be transformed away by a Lorentz transformation. As a consequence, there is no a genuine gravitational time dilation in these theories.

[2] **Victor Christianto**

Is Lorentz-invariant theory of Gravitation is a valid alternative to General Relativity Theory?

Dear Mozafar, thank you for your answer. Most of what you said is correct, but allow me to point out that there are papers sometime ago which say that explaining mercury anomalous perihelion is possible using cogravity or special relativity.

See for instance Tajmar and de Matos, http://arxiv.org/abs/gr-qc/0304104v1.

And also Behera and Naik, http://arxiv.org/pdf/astro-ph/0306611v1.pdf.

But i don,t find yet derivation of bending of light from special relativity theory. Best wishes

[3] **Mozafar Karamian**
Dear Victor
I have considered those papers (and some other papers claiming that). They are erroneous. I even communicated with one of the authors last year, pointing out errors in their paper. In short, the error in such papers is that they use a gravito-magnetic effect on the planet in the REST FRAME of SUN while in that frame there is only one gravito-electric force acting on the mass of planet. That gravito-magnetic interaction would be in the rest frame of planet but even that does not work because the planet is at rest relative to itself and so the gravito-magnetic force (on the mass of planet) vanishes. They get interactions that are definable in one frame and apply them in the wrong frame. There could be a gravito-magnetic effect on the SPIN angular momentum of planet but that is empirically rejected. The perihelion advance does not display any dependence on the spin of planet.

Since those works use a similarity with (or in fact a blind imitation of) Maxwell theory, you can consider a system of electron-proton instead of a mercury-sun system. In the rest frame of proton there is only one electric field acting on the electron (forgetting the spin of proton). There is of course a magnetic spin-orbit interaction but that interaction is on the magnetic dipole of the electron not on its electric charge. The analog in the planet-sun system would be a gravito-magnetic interaction on the SPIN angular momentum of planet. But, as I said that is empirically rejected.

[4] **Thomas Buchert**
Hi Victor and Mozafar,
General Relativity yields, in the Minkowskian limit, a set of Maxwell-type equations that can also be found by completing Newton's gravitation theory with some terms that would be absent in the limit of infinite light-speed. For a short historical account of the latter see http://en.wikipedia.org/wiki/Gravitoelectromagnetism
There are indeed many articles following Heaviside's article on the subject, including the ones mentioned. I think the issue is not about the existence of a lorentz-covariant theory of gravitation (although here the literature offers a variety of interpretations and addresses problems), but the issue is about the fact that such a theory is a vector theory, and gravitational waves loose their tensorial character in the Minkowskian limit. While one may think that such a limiting theory could be a good approximation, there are qualitative differences, i.e. features that are lost during the limit, and GR principles may be violated. This does, however, not mean that any study of such a Minkowskian theory of gravitation is useless. On the contrary, we are right now working on some aspects of the vector theory

that can be translated to General Relativity by inverting the limiting procedure. In this context you can find many articles and books on teleparallel gravity (you may google this keyword), most of which deal with the Maxwellian form of relativistic gravitational equations in a suitable limit.
Cheers,
Thomas

[5] Norbert Straumann
See my paper: astro-ph /0006423 and references therein

[6] Marvin Kirsh
I think a problem here from the start entails incentives either for empirical description and prediction verse incentives to capture together what is practical for empirical purposes and a cosmology totally embedded with mathematics. We wind up with negative values in a universe itself that is a special case, absent of zero, in which determinable value is dynamic with age; attempt to unite plural operating causes into a single mathematical frame that ignores a simple accounting from prior accounting, ad-infinitum that delineates the path of emergence and cannot be accomodated to generalized, idealized mathematical description. I think at each intersection (e.g perihelion behavior), for explanation a non zero- bending, non-zero gravitation has to be attributed to all time points to establish a focus on path history; description involving simplified constancy in governing (e.g. the velocity of light in a vacuum) needs rereferal to the time dependent numerical ratio, and an of-itselfness as the existence of volume that is dynamic, heterogeneous in construction that is not highlighted by linear considerations but a prison, volume highlighted by shape/form that is constructed from linear considerations. From Einstein, Newton, Lorenz we can have empirical description that can be accurate but not containing or closed to accept alternate but non-existing possibility.
Our cosmology and math has surfaced to be like our lives in which sacrifice is made from from the set of open possibilites to participate in self established governing law and rules for increased individual certainty among social and physical survival parameters. Really existing only is the heterogeneous entity, an apriorily existing world exclusively of of-itself windup dolls and a terrain that is navigated by accounting that can be flawed in the case of living things depending on particular species and terrains.
If interested I am enclosing as attachments a recent publiction ("Determining the determined state : A sizing of size from aside/the amassing of mass by a mass...") ...the link to a current working manuscript ("Universe or World : Order for action or action for order") is:

http://ssrn.com/abstract=1376065

[7] Robert Shuler
Hello Victor, regarding Lorentz invariant gravity, I do not think it is a satisfactory theory except as others have pointed out in the weak field approximation. In addition to the difficulties matching all the empirical observations, it shares some weaknesses with GR such as predicting gravitational waves that we should have detected directly and have not. Reconciling gravitational energy loss with the inability to detect the waves is easily done

with a fairly benign but non Lorentz invariant theory. If the wavelengths become very long, the detection difficulty is explained.

If anyone is interested, I have put forward what possibly may be the simplest form of such a theory (more complex variants are possible) in a paper published last January in JMP, linked below.
http://www.scirp.org/journal/PaperInformation.aspx?PaperID=27250

[8] **Stanley Robertson**
I believe that the Yilmaz theory in harmonic coordinates is locally Lorentz invariant. That is one thing that distinguishes it from GR. It first passes to a Lorentz limit before reaching a classical Newtonian low speed limit. But it is not globally Lorentzian. I am prejudiced in favor of anything that eliminates event horizon singularities - and in my opinion, they are not just coordinate singularities. I believe that Yilmaz theory is a viable fundamental theory of particles and fields, however, it needs some attention before it can be applied to a continuum such as a stellar interior. It may be necessary to give up the harmonic coordinates there.

[9] **Ilja Schmelzer**
The closest thing to a viable Lorentz-invariant theory of gravity is the RTG of Logunov and Co, see http://arxiv.org/pdf/gr-qc/0210005v2

I personally prefer a variant http://arxiv.org/pdf/gr-qc/0205035v4 which is, as a whole, not Lorentz-invariant.

[10] **Mozafar Karamian**
@Thomas Buchert
Hi, It's true that linearized GR ends up with some Maxwell-like equations but there are still differences and issues. In linearized GR, unlike exactly-Maxwellian gravity, the metric is not Minkowski, it's a linearized form of Schwartschild. Also, energy of waves are not defined in the same way defined in electromagnetism.
And one important issue is that even linearized GR can not predict the perihelion advance correctly (it yields 4/3 of the actual value, i.e. a greater value). It is important to note that in the exactly-Maxwellian theories, there is really no source for the perihelion advance at all and those who claim that they have derived the effect, really employ some fake sources. (if that was the case and Maxwellian theory predicted the effect, then a similar effect must have occurred in the electromagnetism and in the hydrogen atom too and that would have affected the spectral lines). In linearized GR, however, there is such a source and that is still the curvature of spacetime, but the prediction is wrong because the metric is only approximate.

I agree that working on linearized gravity is not useless but we must be aware that neither linearized GR nor Maxwellian gravity provide an impeccable theory of gravity even in the weak-field limit.

[11] **Shamaila Rani**

According to theoretical perspective, it is less motivative. However, if it represents greater achievements, and having violations small, then we may go through with them.

[12] Sergey Fedosin
Dear Victor,
I think that the Lorentz-invariant gravitation theory based on the ideas of special relativity. But the modern theory of gravity must use the metric. Therefore based on the Lorentz-invariant gravitation theory was created Covariant Theory of Gravitation. Both theories, general relativity and the Covariant Theory of Gravitation, are derived from the principle of least action. Both theories contain the metric and can explain the perihelion advance, time dilation and other effects.
My answer: not Lorentz-invariant gravitation theory, but the Covariant Theory of Gravitation is a valid alternative to general relativity.

[13] Victor Christianto
Dear Thomas, Norbert, Marvin, Robert and Ilja, thanks for your answers. My interest actually is to find a Maxwell-like gravitomagnetic theory which is able to explain properly new experiments such as Podkletnov effect, where general relativity fails to do. So if you know something about that please let me know. Thank you

[14] Sergey Fedosin
Dear Victor, see http://en.wikiversity.org/wiki/Covariant_theory_of_gravitation and references there. Some explanation of Gravity Probe B data is there. The theory is developing quickly so it is possible there more accurate results.
[15] Gunter. Scharf
General relativity IS Lorentz invariant. To solve the dark matter problem one has "only" to give up the geometric interpretation of Einstein's theory.
See arXiv 1208.3749 (2012) and later papers.
Gunter Scharf, University of Zurich

[16] Miroslav Šindler
One very simple question.
If you are in the middle of a plate rotating at speed ω you will feel Coriolis force: 2 v x ω m.
You may say that you are at rest and whole universe is rotating around you and induces a constant vector field Ω = 2ω.

Does the integration over the whole universe, of a formulae given in the Lorentz-invariant gravitation theory, give this result for the gravitational torsion field Ω ?

[17] Thomas Buchert
A short clarification concerning the answer by Mozafar and the comment by Gunter:
In my comment I did not imply the usual linearization of GR, but there is another, more direct limiting procedure: formulating GR with Cartan coframes, you can send the Coframes to exact forms. This limit, or rather this restriction also results in Mawell-type equations, but on Minkowski space. The by construction locally Lorentz-covariant theory of general

relativity (the remark by Gunter) implies, through the restriction to exact forms, a globally Lorentz-covariant theory (since exactness guarantees the existence of global coordinates), and this global notion was meant in the title of the question. For a short introduction into this limit you may look at Section 7.1. in http://arxiv.org/abs/1103.2016

[18] Marshall Barnes
Does anyone know what Covariant Theory of Gravitation gives us that GR doesn't? I mean in terms of solutions to things that GR fails to address. For example, can CTG be wed with QM better?

[19] Marvin Kirsh
I wished to note that the constant velocity of a free fall fits well with the biological intuition and measurement of a linear mutation rate, x mutations/time. This might be argued to be the only tenible condition for the propogation of life/structure; at one extreme is quick radioactive decay, at the other is loss of definition in proximal frames. Entropy problem is avoided if dependence is on ratios and decreasing volume at each point of perspective....In using the term."linear" I was referring to the need to start with the conservation of momentum rather than (vectorless) energy accounted linearly. In surface plots with time as a constant system variable to witness pair events, e.g. only distances are generated, I get an egg shape when values are generated randomly and uniquely employing pi/10^17 rotations interval 10^14..output values are each unique. This means to me, with respect to causes of "open" surface points that they are maximally diverse in origin, constant (mutation rate) or angular velocity is necessary for continued propagation. I think the problem with Lorenz fixed gravitation field, as in all the inconsistencies describes here, is within the condition "maximally diverse causes" (e.g, longest path length of points forming a discontinuous surface evolved from straight line of progression), the semi-random method used to generate values for plotting function, goal is to relate to actual physical universe.I am reminded of the Rieman inequality that divides the world of quantum mechanics and the macroscopic world. I think tools as quantum mechanics are good for paper exercise, but one must start, in actual beginning with the actual world and work from there, less, starting with imagination, ending with only imagination. In the perihelion problem for instance, distinctly oriented and plural causing surfaces must be involved and would be difficult but not impossible to imagine and test, the same might be true for worst immune diseases, normally accounted elements behaving with temporally disparate motions associatable with distal causes. I think the resemblance in description to action at a distance leads to avoidance of this interpretation, but volumes of space always intercourse regardless of the laws governing them, or whether their existence and nature depends on the same, ad-infinitum. ...from any unique perspective (is no whole perspective as Einstein proposed with a single governing c) is but one unique describable (with a conceivable age), momentum bearing global body in constant change, exists and has a half life in retrospect (2x looking forwards from past) if mutation rate is constant, or (if increasing mutation rate) a predictable 1/2 life of decay(e.g. uranium), the deceasing mutation rate might be visualized to loss of competant orbit energy, lineality, collision on the macro level, failed propagation of macro structure?

[20] Ilja Schmelzer

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Günter, I disagree that the g_mn cannot be measured. We can measure distances and proper time with rulers and clocks. With a sufficient lattice of clocks we can measure all coefficients of g_mn with sufficient accuracy.

I also disagree with "In standard general relativity one puts c = 0." One is free to use nontrivial c in general relativity too.

Then, the dynamics of matter have to be taken into account in GR too.

I also disagree with "We emphasize that these solutions describe different physics because the corresponding circular velocities squared u(r) are different" If one replaces one radial coordinate r with another r1 = r1(r), all the g_mn will look very different, but the solution remains the same.

You clearly confuse here the arbitrary choice of the radial coordinate r with the physical measurement of the radius.

[21] **Victor Christianto**
@Miroslav. Thank you for your question, but I know only a few about torsion or LITG. But regarding Coriolis force, I can cite a paper by myself and Prof. F. Smarandache sometime ago (2007) discussing rotational relativity (the other name is Q-relativity). As a result of definition of quaternion metric distance, the quaternionic acceleration arises, which includes Coriolis force. Using this new geometry discovered by Alexander Yefremov, we managed to explain Pioneer spacecraft anomaly.

Perhaps you would like to see this paper, available at: http://ptep-online.com/index_files/2007/PP-08-07.PDF. Your comment is welcome.

[22] **Willem de Muynck**
More or less successful theories considering gravitation as a field on Minkowski space have been discussed in the 1980s. Two references are:
- Rastall P.
Can J Phys 57,1979,944
The Newtonian theory of gravity and its generalization
- Ya. B. Zel'dovich and L. P. Grishchuk
Usp. Fiz. Nauk 155, 517-527 (July 1988)
The general theory of relativity is correct!

Perhaps you can find an answer there.

[23] **Sergey Fedosin**
For Miroslav Šindler. The gravitational torsion field Ω is similar to magnetic induction field B. You can take the plane with electric charge in rotatation and calculate B. Then change electric charge density by mass density, and B by Ω.

[24] **Sergey Fedosin**

Is Lorentz-invariant theory of Gravitation is a valid alternative to General Relativity Theory?

I want add for Miroslav Šindler. Coriolis force is mechanical force from rotating plate on moving body. This force disappears when the body do not touch the plate. But the force of torsion field of rotating plate on the moving body take place in any case.

[25] Sergey Fedosin
For Mozafar Karamian.
Lorentz-invariant gravity possibly can explain perihelion advance of planets. For it is necessary to take into account Lorentzian factor gamma^3 and so on. See
Sankar Hajra, Classical Interpretations of Relativistic Phenomena. Journal of Modern Physics, 2012, 3, 187-199.
http://dx.doi.org/10.4236/jmp.2012.32026

[26] Mozafar Karamian
Dear Sergey
The calculations in that paper are utterly wrong. In a 1/r potential in special relativity, \gamma r^2 \dot{\theta} is conserved, not \gamma^3 r^2 \dot{\theta} as the paper claims.
As the other claims regarding derivation of the perihelion advance from SR, that derivation is also fake.
Special relativity can predict only 1/6 of the perihelion advance. This is a well-known calculation.

[27] Victor Christianto
Dear Sergey and all. Perhaps you would like to see a comprehensive report on RTG by Logunov. His 255 pages report is available at http://arxiv.org/pdf/gr-qc/0210005v2.pdf.
Best wishes

[28] Sergey Fedosin
As I see, in RTG by Logunov the gravitational metric is used, which in sum with the metric of Minkowski space gives the metric of General Relativity. So RTG is the metric theory as Covariant Theory of Gravitation and General Relativity. Although RTG is building on the Minkowski space it is not the modified Lorentz-invariant Theory of Gravitation because instead of equations of gravitational field, which must be as Maxwell equations, there is equations for the gravitational metric as a form of gravitational field.

[29] Ilja Schmelzer
Mozafar, criticizing "a variety of versions" of Lorentz-invariant theories of gravity, have you had in mind also RTG? I would be interested in criticism of RTG, because I have proposed a variant of this theory at http://arxiv.org/abs/gr-qc/0205035 .

[30] Mozafar Karamian
@Ilja Schmelzer
My explanations were about exactly-Maxwellian theories of gravity and do not necessarily apply to sophisticated manipulations of Einstein's GR which are apparently defined in Minkowski spacetime. One thing that is for sure is that exact copies of Maxwell equations do not work for gravity.
"Lorentz-invariant" theories of gravity are scalar, vector or higher-rank theories of gravity in

Minkowski spacetime. As far as I know, none of them completely works. They might explain one or two effects but none of them can explain all effects that are describable by GR. Besides, if those approaches want to compete with GR, they must do predictions that GR can not. As long as they are following GR to derive its effects by other ways, no one even listens to them. A genuine "new" theory must be independent of the old theory, explaining the known facts and making new predictions that the old theory cannot do. The new theory must convey a feeling of independence.
The non-Maxwellian theories mentioned in this page are unfortunately followers of GR. They try to modify GR in this and that way. So, I personally do not consider them genuine "new" theories of gravity, let alone considering their predictive power.

[31] Sergey Fedosin
I want add that Covariant Theory of Gravitation: 1) Is based on the Lorentz-invariant Theory Gravitation. 2) Is not follower of GR. 3) Has Maxwellian equations of gravitational field in covariant form. 4) Is deduced from the principle of least action. 5) Has the stress-energy tensor of gravitational field. 6) Can explain the Pioneer effect on the base of its equation of motion. 7. Can explain other effects of GR in its own way.

Concluding Remarks

There are perhaps some alternatives to General Relativity theory, for instance LITG (Lorentz-invariant Theory of Gravitation), CTG (Covariant Theory of Gravitation), and Yilmaz Theory. They have successfully managed to explain some phenomena. Therefore there is hope to find a valid alternative of GTR.

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