Is General Relativity really General Relativity?

Taha Sochi (Contact: ResearchGate)
London, United Kingdom
Date of Publication: January 5, 2025

Abstract: In this short paper we briefly discuss the issue of the theory of general relativity as a supposed generalization of the theory of special relativity to see if general relativity did really generalize special relativity as a relativity theory. The simple conclusion that we reach in this discussion is that the theory of general relativity is not actually a generalization of the theory of special relativity and hence general relativity is neither a general theory nor a relativity theory. In short, the so-called "general theory of relativity" should more appropriately be called the "special theory of general covariance" since it is special in content (as it is essentially a gravitation theory) and it lacks the physical substance of relativity (as it is actually about mathematical artwork of general covariance rather than about physical relativity).[1]

Keywords: Special relativity, general relativity, general covariance, principle of relativity, gravitation, epistemology of science, philosophy of science, contemporary physics, fundamental physics, modern physics.

[1] Large part of the theoretical background and fine details of this paper can be found in my books about special and general relativity (see [1, 2]). So, any gap in this short paper should be filled by referring to these books which I advise the interested readers to consult when necessary.

The Essence of General Relativity

Anyone familiar with the literature of the special and general theories of relativity should know that after the publication of the special theory of relativity (which is essentially a combination of the formalism of Lorentz and the interpretation of Poincare) Einstein started to look for a more general theory that lifts the restrictions and limitations on the special theory of relativity. In short, the project of general relativity was supposedly a project for generalizing special relativity as a relativity theory.

Now, the special theory of relativity has two main limitations (which the general theory of relativity, at the start, was supposed to address so that it becomes general):

1. The special theory of relativity is not general in its **physical content** and substance since it essentially relativizes mechanics and electrodynamics but not other main physical disciplines such as gravitation (see [1, 2]).[2]
2. The special theory of relativity is not general in its **domain of validity** and application since it is restricted to the inertial frames of reference.

So, at the outset of the project of generalizing the special theory of relativity it was supposed that the awaited general theory of relativity should address these two limitations (or at least one of them to become general in some sense).

The development of general relativity over about ten years witnessed many twists and turns (which we assume the reader to be familiar with its historical details and hence we do not need to go through these details). The simple conclusion that we want to reach in this paper is that the quest for generalizing the special theory of relativity was distracted and diverted several times (due to confusions and sources of misunderstanding as well as insurmountable difficulties that forced the diversion of route and change of direction), and the result of all this is that the final product of this project (i.e. the so-called "general theory of relativity") was not really a generalization of special relativity as a relativity theory. In simple terms, the actual final destination of the project did not match its initial objective and target.

In fact, the first limitation (with regard to the restriction of special relativity by excluding gravitation) was obviously the main concern in the first days of the project of general relativity where the equivalence of inertial and gravitational mass (and the subsequent interest in the equivalence principle in its classical sense and beyond) dominated

[2] We may include quantum mechanics as another discipline but it was not created yet at the time of appearance of special relativity noting that it was relativized later on (noting as well that gravitation defied relativization specially and generally apart from the general covariance of general relativity which we are dealing with in this paper).

this project. This is understandable since gravitation was the main branch of physics at that time that evaded relativization by the special theory. However, the relativization of gravitation was just one part of the generalization project (or rather one part of one part of the generalization project). So, being aware of the demand of the other part of generalization (i.e. the extension of the theory to non-inertial frames of reference), the project adopted an "economic" strategy by combining the two issues (i.e. the issue of relativizing gravitation and the issue of extending the theory to non-inertial frames of reference) where the principle of equivalence was exploited (and even distorted, abused and misused) maximally to bridge the gap between gravitation and non-inertiality of frames by claiming the equivalence in some sense (and actually in so many different senses in the later development of the theory as can be seen in the literature) between gravitation and acceleration.

As a consequence, it appeared that a clever trick to overcome some of the insurmountable difficulties of this project and "get two for the price of one" is to "relativize" gravitation (which, thanks to the magical principle of equivalence, embeds acceleration and hence non-inertiality). This means that the project took its first major turn by "condensing" or "reducing" the entire project through this "cunning" combination which reduced the required effort for addressing the above two limitations to become an effort for addressing a single issue which combines these two limitations (i.e. the limitation of gravitation and the limitation of non-inertiality of frames).

Now, this is not sufficient to achieve what is supposed to be achieved by this theory because we still need to "relativize" gravitation (or rather the combined gravitation-acceleration). So in short, we supposedly achieved so far half of this project through the combination of the issue of physical content with the issue of domain of validity into a single issue and hence all we need to do now to "achieve" the final goal of this project is to achieve the second half by relativizing this single entity, i.e. the clever combination of "gravitation-acceleration".

Now, the theory of special relativity started as a result of experimental evidence (or rather indicative empirical findings) of the validity of the principle of relativity (whether in its classical form or in its Lorentzian form) and hence what special relativity was supposed to do is to formulate this experimentally founded relativization (whether of mechanics or electrodynamics or whatever other discipline that this theory is supposed to relativize). But in general relativity we do not have such experimental evidence or empirical findings of a relativity principle that extends beyond inertial frames of reference to include non-inertial frames of reference. In other words, we do not have any physical

substance (through experimental evidence and empirical findings) to formalize in a theory (such as the supposed general theory of relativity). In brief, the physical substance of relativity that we have in the theory of special relativity is missing in the awaited theory of general relativity (which is still to be formulated and created).

So, it appeared that we need another magical trick (in addition to the magical trick of combing gravitation and acceleration through the equivalence principle) to overcome this insurmountable difficulty. The essence of this second trick is to reduce the missing physical substance of the general principle of relativity (which is beyond our reach) to a mathematical issue or demand that (in principle) is easier to achieve if we get sufficient mathematical ingenuity and technical sophistication (e.g. by employing the machinery of differential geometry and tensor calculus). This is the second major turn in the development of the general theory of relativity where the physical relativity is reduced (through the adoption of general covariance) to a "mathematical relativity" which is not really a relativity since it lacks the physical substance of relativity. In fact, this is like an act of magician who wants to show us (through his power of mental suggestion and psychological influence) in physical reality (corresponding to physical relativity) what is actually an imaginary illusion (corresponding to the mathematical artwork of general covariance which is no more than an aesthetic mathematical artifact).

Accordingly, when the long-awaited "theory of general relativity" was born it was a very different theory from what is expected and what it is supposed to be at the outset of the project of generalizing special relativity and hence it failed all the legitimate expectations of a "general theory of relativity" since it was *neither general in its physical content* (since it is essentially a gravitation theory that does not include other physical disciplines) *nor general in its domain of validity* (since it did not really address the issue of non-inertial frames of reference noting that the equivalence between gravitation and acceleration is questionable if not entirely wrong; see for instance [2, 3]). Moreover, it was *not really a relativity theory* since the mathematical nicety of general covariance is not equivalent to the general principle of physical relativity. In short, the long-awaited newborn was neither general nor relativity but was actually special (in its supposed generality) and covariant (in its supposed relativity).

To conclude, the final version of the "general theory" which appeared in 1915-1916 and was called "the general theory of relativity" (or "the theory of general relativity") failed to address any one of the aforementioned limitations (related to physical content and domain of validity); in fact it failed even to be a continuation to "special relativity" as a relativity theory (since by representing "relativity" by "general covariance" it ceased to be a theory

of "real physical relativity" to become a theory of "fake mathematical relativity"). More clearly and meticulously:

• This alleged *general theory* (which is essentially a gravitation theory) failed to generalize the content of the (special) theory to include all (or at least the main) disciplines of physics at that time (to be at least like special relativity which generalized the content of relativity beyond mechanics to include electrodynamics).

• This alleged *general theory* (which is essentially a gravitation, but not acceleration, theory that does not deal with non-inertial frames of reference despite the questionable principle of equivalence) failed to generalize the domain of validity by extending the relativity principle beyond inertial frames of reference to include non-inertial frames of reference.

• This alleged *relativity theory* (which is essentially a general covariance theory rather than a relativity theory) failed to produce a physically-genuine relativity theory that extends the physical relativity principle of special relativity beyond inertial frames by including non-inertial frames of reference. Instead of this, a general covariance principle was produced and implanted in the theory (based on mathematical artworks without any real physical substance of relativity) with a misleading suggestion (either explicitly or implicitly) that this general covariance is the same or the equivalent of the generalization of the relativity principle to include non-inertial frames of reference.

We should finally note that considerable part of the difficulties of understanding general relativity and appreciating its real physical substance and content originates from the mis-labeling and mis-marketing of this theory as a general theory of relativity where the investigators and inspectors of this theory (whether students or scholars or even specialized experts in this subject) spend considerable time and effort to convince themselves that it is really a general theory of relativity as they need to distort and manipulate many things (ideas, concepts, etc.) to digest this theory as a general theory of relativity and convince themselves forcibly that it is actually what it is supposed to be (according to its labeling) by making twists and fabricating excuses to justify the mismatch between the reality of the theory and what is expected from it as a general theory of relativity.

Conclusions

We outline in the following points two major conclusions that we can obtain from the discussion that we presented in this paper:

1. There are empirical evidence and experimental support for the "special principle of rel-

ativity" (whether in its classical form or in its Lorentzian form) as embedded in the formalism of classical mechanics as well as in the formalism of special relativity where this evidence is based on the privileged status of inertial frames of reference. However, there is no such evidence or support for the "general principle of relativity" which general relativity is supposed to embed and represent in its formalism. In fact, even the nature and meaning of this alleged "general principle of relativity" is not obvious in the general theory of relativity apart from the mathematical artwork of "general covariance" which the proponents of this theory try to suggest (wrongly and misleadingly) to be the equivalent of the "general principle of physical relativity".

2. The label of "the theory of general relativity" (or "the general theory of relativity") is misleading since it does not reflect the reality of this theory and its actual physical content. In fact, the theory is neither general nor relativity. It may be more appropriate to call it "the special theory of covariance" (or "the special covariance theory") where "special" refers to its limited physical content (as it is essentially a gravitation theory and does not include other branches of physics, such as quantum physics[3] , or extend to non-inertial frames of reference) while "covariance" refers to its tensorial nature which is a mathematical nicety and artwork that does not represent the essence and content of relativity as a physical principle. In fact, if this (mathematical) covariance is equivalent to (physical) relativity then the Newtonian theory (which is formulated in a general covariant form by a number of physicists and mathematicians such as Cartan) should also be a general relativity (or at least a relativity theory); moreover special relativity in its original non-tensorial form should not be a relativity theory (although it is actually a relativity theory considering its physical content and essence). The fact that the tensorial formulation is a choice for special relativity but a necessity for general relativity (see [2]) should indicate that special relativity is a genuine relativity theory (since it does not care about tensorial formulation noting that its relativistic nature is embedded in and represented by its physical substance rather than in/by its mathematical form) while general relativity is a covariance theory (but not a relativity theory) because it desperately needs tensorial formulation (since its "fake mathematical relativity" will

[3] Actually, even electrodynamics which was included in the special theory of relativity does not appear in the theory of general relativity at least in its initial formulation. The absence of a genuine physical treatment of the issue of non-inertial frames of reference in the theory of general relativity should also cast a shadow on the inclusion of mechanics (kinematically and dynamically) in this theory at least in its initial formulation. The subsequent mathematical treatments to address these issues and shortcomings of the theory and fill the gaps in it are generally artificial and questionable and they lack intuitivity and originality since they are based on twisted approaches and dodgy mathematical and non-mathematical techniques and methodologies.

be lost by disposing of its tensorial formulation noting that it does not have genuine physical relativistic nature and substance beyond this "fake mathematical relativity").

References

[1] T. Sochi. *The Mechanics of Lorentz Transformations*. CreateSpace, first edition, 2018.

[2] T. Sochi. *General Relativity Simplified & Assessed*. Amazon Kindle Direct Publishing, first edition, 2020.

[3] J.L. Synge. *Relativity: The General Theory*. North-Holland Publishing Company, Amsterdam, first edition, 1960.