Crackpot behavior of the YARK theory of gravitation

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Abstract

Despite it is well known at the elementary level of university courses that completely non-metric gravitational theories macroscopically violate Einstein's equivalence principle, in a series of recent papers published also in Canadian Journal of Physics, T. Yarman and collaborators claimed that the so-called YARK theory of gravitation (the name has been self-created by T. Yarman and collaborators from the initials of their proper surnames), which is completely non-metric, should replace Einstein's general theory of relativity as the correct theory of gravitation. Here we ultimately show the crackpot behavior of the YARK theory of gravitation by using Einstein's equivalence principle which has today a strong, unchallengeable empiric evidence. Hence, we formally request the Editors of Canadian Journal of Physics to ultimately withdraw the papers of T. Yarman and collaborators for the sake of scientific correctness. In addition, we formally request the Editors of Canadian Journal of Physics to ultimately stop the publication of other papers on the unscientific and non-viable YARK theory of gravitation.

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A completely non-metric gravitational theory, today self-called the YARK theory of gravitation from the initials of the proper surnames of its authors, has been originally proposed by T. Yarman in Foundation of Physics [1], which published a lot of wrong and non-standard results before G. 't Hooft's management [2]. After that, some papers on the YARK theory of gravitation have been published by T. Yarman and collaborators in non-mainstream, obscure journals and in proceedings of minor conferences [3 - 6]. Recently, other papers on the YARK theory of gravitation have been published by T. Yarman and collaborators in mainstream, serious journals [7 - 10], despite such journals are not particularly focused on gravitational theory, included a series of papers in Canadian Journal of Physics [11 -14]. In all the works on the YARK theory of gravitation T. Yarman and collaborators also claimed that such a theory should replace Einstein's general theory of gravity (GTR) and that the GTR has various problems [1], [3 -14]. In addition, the YARK theory of gravitation should be in agreement with various experiments on earth and astrophysical observations [1], [3 -14]. A issue of note is that the first paper submitted by T. Yarman to Canadian Journal of Physics on the YARK theory of gravitation was rejected, as it has been stressed by the well known crank S. Crothers, who seems to be a friend and an endorser of T. Yarman, see [15]. It is very surprising and astonishing that papers on the YARK theory of gravitation, which is a completely non-metric theory of gravity as stressed various times by T. Yarman and collaborators [1], [3 -14], can be published in serious journals, because it is well known at the elementary level of university courses that completely non-metric gravitational theories macroscopically violate Einstein's equivalence principle (EEP), which has today a strong, unchallengeable empiric evidence, see C. Will [16]. We recall that the weak equivalence principle (WEP) states that the mass of the body is proportional to its weight [16], or, alternatively, that the trajectory of a freely falling test mass (i.e. a mass which is not acted upon by such forces as electromagnetism and too small to be affected by tidal gravitational forces) is independent of the mass internal structure and composition [16]. The WEP also states the *Universality of Free Fall*, which means that all the bodies fall with the same acceleration [16]. The EEP is a more powerful concept stating that [16]:

a) WEP is valid;

b) the outcome of any local non-gravitational experiment is independent of the velocity of the freely-falling reference frame in which such an experiment is performed (local Lorentz invariance, LLI);

c) the outcome of any local non-gravitational experiment is independent of where and when in the universe such an experiment is performed (local position invariance, LPI).

C. Will [16] also stresses that if EEP is valid, then gravitation must be a "curved space-time" phenomenon. This means that the effects of gravitation are completely equivalent to the effects of living in a curved space-time [16]. In other words, gravity is not a force. Instead, it is inertia in a curved space-time manifold [17]. Thus, one sees that, if EEP is valid, then in local freely falling frames, one needs the laws governing experiments to be independent of the velocity of the frame (LLI), with constant values for the various atomic constants (in order to guarantee LPI) [16]. The only laws of Nature that fulfill this are the ones being compatible with the special theory of relativity, such as Maxwell's equations of electromagnetism, and the standard model of particles [16]. In addition, in a local freely falling frame, test masses appear to be not accelerated, and then moving on straight lines [16]. Such *locally straight* lines obviously correspond to *geodesics* in a curved space-time [16]. The strong, unchallengeable consequence of this argument is that the only viable theories of gravity are the metric theories of gravity, or possibly theories that are metric apart from very weak or short-range non-metric couplings [16, 17]. We stress that there is a rigorous mathematical demonstration of our last statement. Let us assume:

1. The existence of a space-time manifold.

2. The validity of EEP.

Then, following [18 - 20], one supposes that no particles are accelerating in the neighborhood of a point-event with respect to a freely falling coordinate system (X^{μ}). Setting $T = X^0$ we can write [18 - 20]

$$\frac{d^2 X^{\mu}}{dT^2} = 0, \tag{1}$$

which is locally applicable in free fall. Now, the chain rule gives [18 - 20]

$$\frac{dX^{\mu}}{dT} = \frac{dx^{\nu}}{dT}\frac{\partial X^{\mu}}{\partial x^{\nu}}. \tag{2}$$

If we differentiate eq. (2) with respect to T we get [18 - 20]

$$\frac{d^2 X^{\mu}}{dT^2} = \frac{d^2 x^{\nu}}{dT^2}\frac{\partial X^{\mu}}{\partial x^{\nu}} + \frac{dx^{\nu}}{dT}\frac{dx^{\alpha}}{dT}\frac{\partial^2 X^{\mu}}{\partial x^{\nu}\partial x^{\alpha}}. \tag{3}$$

Let us combine eqs. (1) and (3). Then we obtain [18 - 20]

$$\frac{d^2 x^{\nu}}{dT^2}\frac{\partial X^{\mu}}{\partial x^{\nu}} = -\frac{dx^{\nu}}{dT}\frac{dx^{\alpha}}{dT}\frac{\partial^2 X^{\mu}}{\partial x^{\nu}\partial x^{\alpha}}. \tag{4}$$

If one multiplies both sides of eq. (4) by $\frac{\partial x^{\lambda}}{\partial X^{\mu}}$ one obtains [18 - 20]

$$\frac{d^2 x^{\lambda}}{dT^2} = -\frac{dx^{\nu}}{dT}\frac{dx^{\alpha}}{dT}\left[\frac{\partial^2 X^{\mu}}{\partial x^{\nu}\partial x^{\alpha}}\frac{\partial x^{\lambda}}{\partial X^{\mu}}\right]. \tag{5}$$

By putting $t = x^0$ and by using again the chain rule, one can eliminate T in favor of the coordinate time t obtaining [18 - 20]

$$\frac{d^2 x^{\lambda}}{dt^2} = -\frac{dx^{\nu}}{dt}\frac{dx^{\alpha}}{dt}\left[\frac{\partial^2 X^{\mu}}{\partial x^{\nu}\partial x^{\alpha}}\frac{\partial x^{\lambda}}{\partial X^{\mu}}\right] + \frac{dx^{\nu}}{dt}\frac{dx^{\alpha}}{dt}\frac{dx^{\lambda}}{dt}\left[\frac{\partial^2 X^{\mu}}{\partial x^{\nu}\partial x^{\alpha}}\frac{\partial x^{0}}{\partial X^{\mu}}\right]. \tag{6}$$

We recall that the bracketed terms involving the relationship between local coordinates X and general coordinates x are functions of the general coordinates [18 - 20]. In that way, eq. (6) gives immediately the geodesic equation of motion using the coordinate time t as parameter [18 - 20]

$$\frac{d^2 x^{\lambda}}{dt^2} = -\Gamma^{\lambda}_{\nu\alpha}\frac{dx^{\nu}}{dt}\frac{dx^{\alpha}}{dt} + \Gamma^{0}_{\nu\alpha}\frac{dx^{\nu}}{dt}\frac{dx^{\alpha}}{dt}\frac{dx^{\lambda}}{dt}, \tag{7}$$

which can be re-written in terms of the scalar parameter s as the standard geodesic equation [18 - 20]

$$\frac{d^2 x^{\lambda}}{ds^2} = -\Gamma^{\lambda}_{\nu\alpha}\frac{dx^{\nu}}{ds}\frac{dx^{\alpha}}{ds}. \tag{8}$$

Thus, we have shown that the two assumptions of the existence of a space-time manifold and of the validity of EEP **rigorously imply that the gravitational motion must be geodesics**. In other words, the correct gravitational theory **must be a metric theory** (or a possibly theory that is metric apart from very weak or short-range non-metric couplings, but this is NOT the case of YARK theory). We stress that T. Yarman and collaborators did not understand this key point in [10]. In fact, in [10] they verbatim claim that "said derivation (i.e. the above one) is exclusively restricted to the domain of a purely metric theory". This is, of course, completely wrong. We indeed did NOT assume that the gravitational theory must be metric. We assumed ONLY the existence of a space-time manifold and the validity of EEP. Through our rigorous mathematical computation we have shown that these two assumptions imply that the gravitational theory must be purely metric. In other words, this was a conclusion and a result. It was NOT an assumption, contrary to the claims of T. Yarman and collaborators in [10]. In addition, in [10] T. Yarman and collaborators generated further confusion by verbatim adding that "in YARK theory the derivatives $\frac{\partial X^{\mu}}{\partial x^{\nu}}$ already do not depend explicitly on spatial coordinates, but only on the static gravitational binding energy". This is another very elementary mistake which is connected with the issue that T. Yarman and collaborators claim that YARK theory permits to localize the gravitational energy [1], [3 -14]. In the opinion of T. Yarman and collaborators the gravitational energy should remain a non-vanishing quantity in all plausible frames of reference [1], [3 -14]. This should permit to write down, explicitly, a stress-energy tensor for the gravitational field [1], [3 - 14]. Clearly, T. Yarman and collaborators do not understand the real meaning of EEP. In fact, another consequence of EEP is that one can always find in any given locality a reference's frame (the local Lorentz reference's frame) in which ALL local gravitational fields are null. No local gravitational fields means no local gravitational energy-momentum and, in turn, no stress-energy tensor for the gravitational field [10]. In fact, the hypothetical presence of a gravitational energy will immediately generate a breakdown of both LLI and LPI, and this is in contrast with tons of experimental data [16]. Also in this case, T. Yarman and collaborators claim that this statement is again strictly applicable only to metric theories, as is the case with the GTR [10]. This is again completely wrong. In fact, it is well known that this is a mere consequence of Einstein's 'happiest thought' that a freely falling body has not weight [21]. Einstein's 'happiest thought' is indeed at the foundation of both of WEP and EEP. In other words, EEP has two rigorous consequences:

* Gravitational motion must be geodesic.
** The gravitational energy cannot be localized.

Both of points * and ** are consequences of EEP and, in turn, one does NOT need the assumption that a gravitational theory must be metric to verify points * and **. The metric behavior of a gravitational theory is **a consequence** of point * instead of an a priori assumption.

Clearly, based on the extreme precision on which the EEP is today tested and verified [16], the demonstration that we have reviewed above - i.e. that geodesic motions arise from the EEP - **ultimately rules out YARK theory**. In fact, that theory is founded on the absence of curvature[1], [3 - 14] and so has a crackpot behavior. Despite the claims of T. Yarman and collaborators that the YARK theory of gravitation should be in agreement with various experiments on earth and astrophysical observations [1], [3 -14] (but we have shown in [20] that T. Yarman and collaborators are basically wrong in their YARK interpretation of the Mössbauer rotor experiment), the YARK theory of gravitation is indeed in macroscopic contrast with the strongest observational constrain that a gravitational theory must satisfy, that is the EEP, which is founded on tons of experimental data [16].

Thus, we formally request the Editors of Canadian Journal of Physics to ultimately withdraw the papers [11 - 14] for the sake of scientific correctness. In addition, we formally request the Editors of Canadian Journal of Physics to ultimately stop the publication of other papers on the unscientific and non-viable YARK theory of gravitation.

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