YARK Theory of Gravity, Einstein's Equivalence Principle and Modern Experiments

Alexander Kholmetskii[1], Tolga Yarman[2] , Ozan Yarman[3] and Metin Arik[4]

[1] Department of Physics, Belarus State University, Minsk, Belarus; alkholmetskii@gmail.com
[2] Okan University, Istanbul, Turkey & Savronik, Eskisehir, Turkey; tyarman@gmail.com
[3] Istanbul University, Istanbul, Turkey; ozanyarman@ozanyarman.com
[4] Bogazici University, Istanbul, Turkey; metin.arik@boun.edu.tr

Abstract
We argue in favor of the physical basis of YARK theory of gravity and show that the major part of recent criticism by Corda (Corda, C. *Symmetry* **2018**, *10*, 558-559) is based on either irrelevant or erroneous claims. We highlight a perfect agreement of YARK theory with the results of the Mössbauer experiments in a rotating system and demonstrate that the so-called "synchronization effect" proposed by Corda to account for the outcome of these experiments stems from an elementary mathematical error and must be rejected. Finally, we show that YARK theory provides a consistent alternative explanation of the origin of the LIGO signals beyond the hypothesis about gravitational waves.

Keywords: YARK theory of gravity; Mössbauer rotor experiments; Einstein's equivalence principle; general relativity theory, gravitational waves, LIGO signals

1. Introduction

In a recent paper [1], C. Corda claimed that (in his opinion) "…*the YARK theory of gravity… is largely disfavored*", and brought against it three arguments in support of his claim:

- That YARK theory violates Einstein's equivalence principle.
- That YARK theory is in disagreement with Mössbauer rotor experiments.
- That YARK theory can reproduce neither the LIGO "GW150914 signal", nor the other LIGO signals thought to be confirmations of gravitational waves (GWs).

We analyze these claims in succession below and disclose the unacceptable character of particularly the first and second claims. With respect to the third claim by Corda, we confirm in section 3 that YARK theory actually remains the only alternative theory to metric theories of gravity, which provides its own and distinct explanation of the LIGO signals beyond the hypothesis about gravitational waves (GWs).

2. Einstein's equivalence principle in YARK theory

For convenience, we first of all remind that YARK theory is based on the energy conservation law, indicating that the energy is localized inside the particle in the presence of gravity. This yields [2, 3]

$$E = \gamma m_0 c^2 \left(1 + E_B / m_0 c^2\right). \tag{1}$$

Here, m_0 is the rest mass of the particle in the absence of gravity, γ is its Lorentz factor, and E_B is its static binding energy at the given location (*i.e.*, this is the work done on the particle, being initially at rest at infinity, to carry it quasi-statically to the location in consideration near the host mass). In fact, eq. (1) states that the rest mass of the object is not a constant, but, owing to the law of energy conservation (as highlighted just above), is rather altered within the gravitational environment of concern by the value E_B/c^2.

Further, due to the intrinsic quantum mechanical relationship between the quantities "mass", "energy", "frequency", "time", and "size", the variation of the rest mass of a test particle by the static binding energy affects the time rate for the particle, and shapes a corresponding transformation of spatial intervals in the presence of gravity [2-8]. Hence, like in metric theories of gravity, it does affect the metric of space-time in YARK theory, too.

At the same time, we emphasize that the motional equation for a test particle m_0 in a gravitational field can be derived straightforwardly via the differentiation of eq. (1) – as had been originally done by Yarman in refs. [2, 3] – independently from the metric properties of space-time. This means, in particular, that YARK is not a purely metric theory like the general theory of relativity (GTR), but rather combines the properties of dynamic and metric theories [6-8].

Next, it is important to stress that the static binding energy E_B is always proportional to the rest mass of the object m_0, so that the ratio E_B/m_0c^2 entering into eq. (1), does not depend on m_0, and hence, the motional equation for the one-body problem does not depend on m_0 either.

As we had previously shown (see, e.g., [2-5]), under the framework of YARK theory, the same conclusion (*i.e.*, the independence of the motional equation of the particle from its rest mass in the presence of gravity) remains in force in the general case of many-body problem, too. This means that that the weak equivalence principle (WEP) is perfectly fulfilled in YARK theory [2-5]. In addition, it is important to emphasize that YARK theory is fully compatible with special theory of relativity, so much so that it satisfies the Lorentz local invariance and local position invariance as well. Therefore, YARK theory is wholly compatible with the Einstein equivalence principle (EEP) in contrast to what Corda contends [1].

At the same time, the physical meaning of the EEP in YARK theory, which combines the properties of dynamic and metric theories, is different as referred to purely metric theories of gravity, such as GTR. In particular, the dynamical side of YARK theory signifies that, in the case where the gravitational force experienced by a particle in a chosen frame of observation is not equal to zero, then, it does not disappear in any other frame, including the frame of free fall of the particle [9]. In the latter case, the gravitation force is "sensed" by the particle through the variation of its rest mass, even if it is exactly counterbalanced by a *fictitious force* existing in an accelerated frame of this particle [9]. This means, in essence, that the gravitational energy, contrary to what GTR delineates, can indeed be localized [9]. Therefore, EEP, in general, does not make it requisite that only purely metric theories of gravity should be adopted; compliance to it in YARK theory is, as we have seen, assured by the existence of such a reference frame wherein, at each four-point, the force of gravity can be exactly counterbalanced by a fictitious force as experienced by the particle in this frame.

This means that we have, in fact, two different interpretation of the EEP:

1) In metric theories, this principle states the possibility to eliminate gravity in any spatial point via choosing a reference frame, moving with an appropriate acceleration. This understanding of EEP reduces gravity to the alteration of geometry of space-time and, in particular, indicates that gravitational energy cannot be localized.

2) In YARK theory, the EEP states the possibility to find such a reference frame, wherein the gravitational force in a given point of space-time is exactly counterbalanced by a fictitious force emerging due to accelerating motion of this frame. Under this interpretation of the EEP, gravity not only affects a metric of space-time, but concurrently creates real forces, which determine the motional equation of the given object. Hence, the gravitation energy can always be localized; this opens a way to make YARK theory of gravity compatible with quantum mechanics [10].

It is important to stress that under both interpretations of the EEP as presented above, WEP is anyway fulfilled, which allows YARK to become similar to metric theories of gravity in many of its applications. However, further analysis of these problems falls outside the scope of the present paper. In any case, the claim by Corda [1] that YARK theory "…*macroscopically violates Einstein's equivalence principle*…" is incorrect.

Thus, only experiments can shed light on the problem regarding which interpretation of EEP - GTR or YARK theory – is closer to reality [11]. In this respect, we reiterate the full compatibility of YARK with all known astrophysical observations in the case of weak gravity [2, 3, 5-7]; we furthermore highlight a symbiosis of YARK with quantum mechanics. In addition, it is possible to recount some remarkable achievements of YARK theory – which, to the moment, still remain unsolved in GTR – such as the analytical derivation of the Hubble constant [4]; the explanation of the alternating sign in the acceleration rate regarding the expansion of the universe without involving the quest of "dark energy" [4]; and the successful explanation of the results of Mössbauer rotor experiments [5].

Now, we address the next claim by Corda that our explanation of these experiments is (in his opinion) erroneous, insofar as one should, allegedly, take into account an additional "clock synchronization effect" advocated by Corda [12]. In ref. [1], Corda again claims that his explanation of the result of these experiments on the basis of his "synchronization effect" represents "*a new proof of Einstein's general theory of relativity, and, for this reason, it has been recently awarded Honorable Mention in the 2018 Essay Competition of the Gravity Research Foundation*".

However, in the next section we show that the so-called "synchronization effect" by Corda results from an evident mathematical error.

3. Mössbauer rotor experiments and "synchronization effect" by Corda

For convenience of the readers, we remind that in these experiments, where the source of resonant radiation and the resonant absorber are both fixed on a rotor, the linear Doppler effect is absent, so that only the second order Doppler shift between the emitted and absorbed resonant radiation emerges with the relative value

$$\frac{\Delta E}{E} = -k\frac{u^2}{c^2}, \qquad (2)$$

where u is the tangential velocity of the resonant absorber, and the coefficient k should classically be equal to 1/2 due to the relativistic dilation of time in the orbiting absorber (see, e.g. [13]). However, following T. Yarman's predictions [2, 3], and via the re-analysis of old experiments on this subject performed in the past century [14], as well as the realization of our own modern experiments [15-17], we have found that k=2/3. This means that the total energy shift between the lines of a source and an absorber contains two components:

$$\left(\frac{\Delta E}{E}\right)_{dilation} = -\frac{u^2}{2c^2}, \qquad (3)$$

caused by the usual relativistic dilation of time in the orbiting absorber, and

$$\left(\frac{\Delta E}{E}\right)_{EES} = -\frac{u^2}{6c^2}, \qquad (4)$$

which we named the "extra-energy shift" (EES), so that the sum of eqs. (3) and (4) yields k=2/3 in eq. (2). Thus, the determination of the physical meaning of the EES becomes a topical problem.

In ref. [12], C. Corda has deliberated on the problem by concocting a "clock synchronization effect" between a resonant source spinning on the rotational axis and a detector of resonant γ-radiation resting in the laboratory frame. According to Corda, this synchronization effect – somehow missed throughout decades by all the previous authors – happens to supply the additional component of the energy shift between a spinning resonant source and a resting detector, which coincides with eq. (4), and thus should be added to the energy shift component between the source and the absorber (3). Thereby, the total (measured) energy shift should (in Corda's view) be defined as the sum of eqs. (3) and (4), which yields k=2/3 in eq. (2). Hence, by the logic by Corda, our experiments [15-17] represent nothing else but a "*new proof of Einstein's general theory of relativity*" [12] – even though k=1/2 had been the basis of the exact same assertion for more than half a century.

Contradistinctively, we have stressed in ref. [18] the obvious fact that the detector operates as a counter of resonant γ-quanta, not captured by the absorber, and is therefore totally insensitive to the relative energy shift component (4), which, for a sub-sound tangential velocity $u \approx 200\ldots300$ m/s, lies at the range $10^{-13}\ldots10^{-12}$. Hence, the entire struggle by Corda for the equality k=2/3 via the additional energy shift (4) between the source of resonant γ-quanta and the detector is already and obviously futile.

While we see no meaning to reproduce our detailed argumentation (presented, in particular, in refs. [9, 18]) with respect to a non-measurability of the energy shift component (4) emerging between a resonant source and non-resonant detector, we will nevertheless show below that the derivation of the entire "synchronization effect" by Corda is based on an evident mathematical error, and – when corrected – betokens no specific synchronization effect between the clock on the rotation axis and the laboratory clock.

In order to demonstrate the error by Corda explicitly, we remind that, in the derivation of his "synchronization effect", he has used eq. (10) of Ashby (ref. [19]) that he modified to the form

$$d\tau = dt'\left(1 - \frac{r'^2\omega^2}{c^2}\right), \tag{5}$$

for an observer in a rotating system. Here dt' is the time increment at r', and ω is the angular rotation frequency.

However, looking closer at the work by Ashby [19], we find out that his eq. (10) is derived from the Langevin metric for a very specific case, where one deals with the process of synchronizing two distant clocks belonging to the rotating frame, via a slow transport of a portable clock for disseminating time. For such a portable clock (whose velocity v must be as small as possible), the known expression for the proper time increment in the Langevin metric [19]

$$d\tau^2 = dt'^2\left[1 - \left(\frac{\omega r'}{c}\right)^2 - \frac{2\omega r'^2 d\varphi'}{c^2 dt'} - \left(\frac{d\sigma'}{cdt'}\right)^2\right] \tag{6}$$

(where $d\sigma'^2 = dr'^2 + (r'd\varphi')^2 + dz'^2$, and r', z' and φ' are the cylindrical coordinates), is substantially simplified. Namely, in the adopted limit $v \to 0$ for a portable clock, Ashby neglected the terms $(d\sigma'/cdt')^2$ and $(\omega r'/c)^2$ in eq. (6), and landed at the equality

$$d\tau = dt' - \frac{\omega r'^2 d\varphi'}{c^2}, \tag{7}$$

which does indeed yield eq. (5).

However, the approximation $v \to 0$, as applied by Ashby in ref. [19] under the derivation of eq. (7) for a portable clock, is obviously inapplicable to the detector of γ-radiation, which – for an observer in the origin of rotating systems – orbits with a finite tangential velocity $-\boldsymbol{\omega}\times\boldsymbol{r}'$, and its motion is described by the equations

$$r' = const, \; z' = 0, \; d\varphi' = -\omega dt'. \tag{8a-c}$$

Thus, substituting eqs. (8a-c) into the general equation (6), we obtain

$$d\tau = dt'. \tag{9}$$

This means that the rate of the clock in the origin of a rotating system and the rate of the laboratory clock are identical to each other (as obviously expected; since, the point center of the rotating appliance has a zero tangential velocity no matter what its angular velocity may be). Therefore, by getting synchronized to a laboratory clock before running the rotor system, the source clock stays synchronized to the laboratory clock at any frequency ω, so that the entire "synchronization effect" by Corda is reduced to pure fiction.

Now, we remind that the equality k=2/3 finds its perfect explanation under the framework of YARK theory, which is based on a combination of the metric properties of space-time and the quantum mechanical properties of resonant nuclei in crystal cells of an emitter and an absorber of resonant radiation [5]. However, according to Corda [1], the YARK explanation of the Mössbauer rotor experiments is "erroneous" due to the ignorance of his "synchronization effect". On the other hand, we have finally seen that such a synchronization effect exists only in Corda's mind, so that ignoring it in the YARK explanation of the origin of the EES represents an advantage, rather than a shortcoming.

4. LIGO signals in YARK theory

Focusing now to the explanation of the LIGO signals in YARK theory, we first of all point out that in ref. [1], Corda falsely portrayed the physical aspects our paper [20]. In particular, he writes: "*…while GWs are not present in their theory* (i.e., YARK)*, the same theory admits a difference $\Delta\varphi$ of the phase shift of light due to electromagnetic radiation incoming from the coalescence of super-massive bodies in a distant binary system; see Equations (11) and (14) in [10]*" (now ref. [20]). This phrase indicates that Corda seemingly did not understand the origin of the LIGO signal in YARK theory. Indeed, it is well known that any external electromagnetic radiation cannot affect the phase of the laser beams in the Michelson-Morley interferometer (MMI). The actual mechanism of the formation of the output pulse of the MMI, as imposed by the framework of YARK theory, is quite different and realistic.

According to the YARK postulate (1), the inspiral motion of two super-massive merging bodies that move, in the general case, along elliptical orbits, induces the variation of their rest masses M_1 and M_2; in turn, this leads to the corresponding variation of the α-factor (which plays the principal role in the description of the metric properties of space-time in YARK theory [2, 3]) as

$$\alpha(t) = G\big(M_1(t) + M_2(t)\big)/rc^2 \tag{10}$$

(see eq. (4) of [20]). We see that the α-factor (10), like the intensity of GWs, falls off with the distance r to Earth as $1/r$ [20]. Thus, perturbations of the α-factor (10) in YARK theory due to coalescing bodies have the same order of magnitude as the gravitational "strain" in GTR due to GWs.

Further on, the gravitational perturbation emanating from the coalescing bodies arrives at Earth, and, according to YARK theory, can induce, in general, both the variation of the wavelength of the laser beam and the length of the arms in the MMI. We would like to point out that, in YARK theory, the variation of the α-factor (10) causes a real force on the suspended mirrors in the arms of the MMI, instead of a "metric strain" by GWs in GTR. Therefore, in the case, where the frequency of the gravitational perturbation is much larger than the proper frequency of oscillation of these mirrors (which is the case for all LIGO detections), the latter remain practically immovable. Thus, the lengths of the arms remain unchanged. At the same time, the alteration of the wavelength λ of the laser beam under the gravitational perturbation does not depend on its frequency, and occurs instantaneously in YARK theory. This means that, in general, the phase of light in the output of each arm of the MMI is affected by the incoming gravitational perturbation.

Now, Corda points out in ref. [1] that, the LIGO "*…interferometric GW detectors operate in a differential mode"* [21].

The fact remains, as we will detail below, YARK is geared to well take care of this mode of operation, and we are indebted to Corda for having brought this quest up, which allows us to demonstrate, how YARK deals with it. This way we, first of all, look closer at some implications of eq. (1).

In our previous papers about YARK theory we adopted the "operational" approach, where we asserted that gravity cannot be described *a priori*, until a test mass is asserted at a given spatial location (see, e.g. [4]). This implies, in particular, that the variation of the rest mass of the test particle and corresponding alteration of its "internal dynamics" represents a primary effect of gravity, while the related variation of the metric of space-time represents a secondary effect of gravity, measured in a synchronous reference frame attached to this test particle.

Be that as it may, another approach for the description of gravity is possible in YARK theory where, due to the validity of WEP, one should point out that the geometry of space-time does not depend on the mass of any test particle. Hence, we suppose (as it was already done in the pioneer papers by Yarman [2, 3]) that the geometry of space-time in the presence of gravity represents its objective property, which thus does not depend on the presence (or absence) of any test particle in a given four-point. Under this approach, the metric of space-time is derived via the standard way, as soon as the relationship between physical space and time intervals and their corresponding coordinates in a frame of observation are established.

In the framework of either approaches, as described above, the motional equation of a massive particle in a gravitation environment is the same, although the metric expressions can, in general, be different. We plan to explore the metric side evoked by the YARK theory in a separate paper.

All the same, in order to demonstrate the emergence of the LIGO signals in YARK theory, it is sufficient to indicate the general relationship between space and time intervals in the radially-symmetric case [2, 3]:

$$t = t_0 e^{\alpha}, \tag{11}$$

$$r = r_0 e^{\alpha}, \tag{12}$$

where t_0, r_0 are the proper temporal and radial coordinates, while t, r are the corresponding coordinates for a distant observer. More specifically, t_0 is the local time (i.e., in our case, the time on Earth) and r_0, is the distance to Earth of the collapsing binary as measured by an observer on Erath; t and r are the same coordinates but as assessed by the distant observer far away from any gravitational effect – with α pertaining to the binary as determined by the local observer on Earth.

Note that the eqs. (11) and (12) arose from YARK theory, merely because rest mass decrease in gravity in conjunction with the law of energy conservation, leads through quantum mechanics the stretching of lengths and periods of time by exactly the same amount.

To simplify further analysis, we suppose now that, for the case at hand (and as assessed by the remote observer), the length L_x in the first of LIGO's two arms lying along the axis x is orthogonal to the line joining Earth to the coalescing bodies; whereas the second arm of the MMI with the length L_y is collinear with this line. In other words, the arm of length L_y lies in the radial direction as referred to the center of the collapsing binary, and is extended toward this; while the arm of length L_x lies, accordingly, at the same altitude with respect to the binary – thus in the tangential direction as referred to the binary.

One can see that, according to eq. (12), the length increment dl is different along the x- and y-axes. Indeed, along the axis x, which is tangential to the radius r, we get

$$dl_x = dl_{0x} e^{\alpha} \approx dl_{0x}(1+\alpha), \tag{13}$$

while, along the y-axis extending radially toward the binary,

$$dl_y = dl_{0y} e^{\alpha} + l_{0y} e^{\alpha} \frac{d\alpha}{dy} = dl_{0y} e^{\alpha} - l_{0y} e^{\alpha} \frac{G(M_1(t)+M_2(t))}{r^2} dl_y = dl_{0y} e^{\alpha} - \alpha dl_y,$$

or

$$dl_y = \frac{dl_{0y} e^{\alpha}}{1+\alpha} \approx dl_{0y}, \tag{14}$$

in as sufficient accuracy of calculations c^{-2}, which corresponds to the linear terms with respect to α.

Anyway, as we have mentioned above, one can adopt $L_{x0}= L_{y0}=L_0$ in YARK theory, when the frequency of quasi-harmonic oscillation of the factor α in eq. (10), is much larger than the proper oscillation frequency of mirrors in the MMI. Thence, we suppose that the lengths of the arms of the LIGO MMI remain practically altered.

At the same time, it should be recalled that the wavelength of the laser beam changes instantaneously with the variation of the factor α.

Therefore, at any frequency of gravitational perturbation, we obtain from eqs. (13) and (14) the wavelengths of the laser beam in the two LIGO arms:

$$\lambda_x = \lambda_0(1+\alpha),\ \lambda_y = \lambda_0 \tag{15a-b}$$

up to the linear terms in α.

Hence, the phase of the light in the output of the *x*-arm of the MMI is equal to

$$\varphi_x = \frac{2L_0}{\bar{\lambda}_0(1+\alpha)} \approx \frac{2L_0}{\bar{\lambda}_0}(1-\alpha) \tag{16}$$

(where $\bar{\lambda} = \lambda/2\pi$), while the phase of the light in the output of the *y*-arm of the MMI is

$$\varphi_y \approx \frac{2L_0}{\bar{\lambda}_0}. \tag{17}$$

The phase shift of light on a photodetector is defined as the difference of eqs. (16), (17), i.e.

$$\Delta\varphi = \varphi_x - \varphi_y = \frac{2L_0}{\bar{\lambda}_0}\alpha. \tag{18}$$

Comparing eq. (18) with the corresponding equation of ref. [21], describing the phase shift of light due to GWs, i.e.

$$\Delta\varphi = \frac{2L_0}{\bar{\lambda}_0} h \tag{19}$$

(where *h* is the "gravitation strain"), it becomes possible to estimate the maximal value of the α-factor, which corresponds to the amplitude of the observed LIGO signal. In particular, for the GW150914 event, the amplitude value of the α-factor corresponds to the ratio of maximal to minimal separation $\eta\approx1.5$ for the inspiralling black holes at each rotating period [20]. And this is exactly what we had operated on and plotted in our reproduction of the GW150914 signal [20].

One ought to add that the analysis of the shape of the detected signal, as implemented in ref. [20], remains unmodified, so that the shape of the GW150914 signal, obtained in YARK theory via the variation of the α-factor, is visibly indistinguishable from the shape of the output pulse due to GWs.

5. Conclusion

Thus, YARK is a vital theory of gravity, which exhibits an agreement between its predictions and experimental results in space-time physics. We believe that only experiment is a valid adjudicator between any competing theories, and this statement should be especially kept in mind when one deals with a new theory such as YARK that, in its physical meaning, substantially differs from GTR and other metric theories advanced up to the moment. Perhaps, such a difference in the physical meaning of YARK and metric theories is inevitable, as soon as we want to make compatible gravitation with quantum mechanics. In this respect, we believe that further development of YARK theory, where the problem of compatibility between quantum mechanics and gravity is already successfully solved, remains topical, and any scientifically sound criticism of our theory is of course welcome.

Unfortunately, the present criticism by Corda discloses only his misinterpretation of YARK theory and its implications (such as when he says "…*the YARK group claims that the relative phase shift has an electromagnetic origin…*"; "… *the YARK theory of gravity violates Einstein's equivalence principle…"*), notwithstanding his erroneous claims containing trivial mathematical errors to the point where he unjustifiably went on to profess "*the YARK theory of gravity … is in disagreement with the Mössbauer rotor experiments…*".

As for us, we reject this kind of criticism, while remaining open to the possibility that further developments and experimental findings are of critical importance.

Acknowledments

We extend our gratitude to George Dishman, Paul Gradenwitz, Stefano Quattrini, Jaykov Foukzon, Kåre Olaussen, Klauss Kassner, Christian Corda, Alexander Lukanenkov, Johan Fremerey and Wolfgang Engelhardt, who promoted the public discussion of the EES our team initially uncovered and later-on experimentally substantiated alongside YARK theory's remarkable reproduction of the LIGO signals.

References

1. Corda, C. The YARK theory of gravity can reproduce neither the LIGO "GW150914 signal", nor the other LIGO detections of gravitational waves. *Symmetry* **2018**, *10,* 558-559.
2. Yarman, T. The general equation of motion via the special theory of relativity and quantum mechanics. *Ann. Fond. de Broglie* **2004**, *29*, 459-493.
3. Yarman, T. The end results of general relativity theory via just energy conservation and quantum mechanics. *Found. Phys. Lett*. **2006**, *19*, 675-693.
4. Yarman, T., Kholmetskii, A.L. Sketch of a cosmological model based on the law of energy conservation. *Eur. Phys. J. Plus* **2013**, *128,* 8.
5. Yarman, T., Kholmetskii, A.L., Arik, M. Mössbauer experiments in a rotating system: Recent errors and novel interpretation. *Eur. Phys. J. Plus* **2015**, *130*, 191.
6. Yarman, T., Kholmetskii, A.L., Arik, M., Yarman, O. Super-massive objects in Yarman-Arik-Kholmetskii (YARK) gravitation theory. *Can. J. Phys*. **2016**, *94*, 271-278.
7. Arik, M., Yarman, T., Kholmetskii, A.L., Yarman, O. Yarman's approach predicts anomalous gravitational bending of high-energy gamma-quanta. *Can. J. Phys*. **2016**, *94,* 616-622.
8. Yarman, T., Kholmetskii, A.L., Arik, M., Yarman, O. Pound-Rebka result within the framework of YARK theory. *Can. J. Phys.* **2016**, *94*, 558-562.
9. Kholmetskii, A.L., Yarman, T., Yarman, O., Arik, M. Response to "The Mössbauer rotor experiment and the general theory of relativity" by C. Corda". *Ann. Phys*. **2016**, *374*, 247-254.
10. Yarman, T. The quantum mechanical framework behind the end results of the general theory of relativity: Matter is built on a matter architecture (Nova Publishers, New York, 2010).
11. https://www.researchgate.net/publication/324042677_The_Eotvos_experiment_and_the_identity_quandary_of_gravitational_and_inertial_masses_Proposition_for_a_crucial_test
12. Corda, C. Interpretation of Mössbauer experiment in a rotating system: A new proof for general relativity. *Ann. Phys*. **2015**, *355*, 360-366.
13. Landau, L.D., Lifshitz, E.M. The Classical Theory of Fields (Butterworth & Heinemann, 1999).
14. Kholmetskii, A.L., Yarman, T., Missevitch, O.V. Kündig's experiment on the transverse Doppler shift re-analyzed. *Phys. Scr*. **2008**, *77*, 035302-035306.

15. Kholmetskii, A.L., Yarman, T., Missevitch, O.V., Rogozev, B.I. A Mössbauer experiment in a rotating system on the second order Doppler shift: confirmation of the corrected result by Kündig. *Phys. Scr*. **2009**, *79*, 065007-0650012.
16. Kholmetskii, A.L., Yarman, T., Missevitch, O.V. Mössbauer experiments in a rotating system on the time dilation effect. *Int. J. Phys. Sci.* **2011**, *6*, 84-92.
17. Yarman, T., Kholmetskii, A.L., Arik, M., Akkus, B., Öktem, Y., Susam, L.A., Missevitch, O.V. Novel Mössbauer experiment in a rotating system and the extra-energy shift between emission and absorption lines. *Can. J. Phys*. **2016**, *94*, 780-789.
18. Kholmetskii, A.L., Yarman, T., Arik, M. Comment on "Interpretation of Mössbauer experiment in a rotating system: A new proof by general relativity". *Ann. Phys*. **2015**, *363*, 556-558.
19. Ashby, N. Relativity in the global positioning system. *Living Rev. Relativity* **2003**, *6*, 1-42. (2003).
20. Yarman, T., Kholmetskii, A.L., Arik, M., Yarman, O. LIGO's "GW150914 signal" reproduced under YARK theory of gravity. *Can. J. Phys*. **2017**, *95*, 963-968.
21. B. P. Abbott, et al. Observation of gravitational waves from a binary black hole merger. Phys. Rev. Lett. **2016**, 116, 061102.