GRAVITATIONAL WAVES FROM BBH-SYSTEMS?
A (DOUBLY) VAIN QUEST

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Abstract. The theoretical reasons at the root of LIGO’s experimental failure in searching gravitational waves (GW’s) from binary black hole (BBH) inspirals.

Summary – 1. A recent LIGO’s search for GW’s. – 2. BH’s and BBH’s are fictive objects. – 3. Experimental confirmation: no BH’s and no BBH’s have ever been really observed. – 4. The GW’s according to linear approximation of GR: ghost undulations. – 5. There exists no physical “mechanism” of production of GW’s in the exact GR: they are phantom entities; and the experience confirms. – 6. Conclusion. – Appendices A, B, C, D.

1.– The abstract of a recent paper by LIGO scientific collaboration \[2\] runs as follows: “We report on a search for gravitational waves from binary black hole inspirals in the data from the second [2003] science run of the LIGO interferometers. The search focused on binary systems with component masses between 3 and 20 solar masses. Optimally oriented binaries with distances up to 1Mpc could be detected with efficiency of at least 90%. We found no events that could be identified as gravitational waves in the 365.6 hours of data that we searched.”

This is not the first LIGO’s failure in the quest of a source of gravitational waves (GW’s); however, the candid optimism of the authors remains (seemingly) intact. At p.13 of \[2\] we read: “… the characteristics of the BBH population (such as spatial, mass and spin distributions) are not known, since no BBH systems have ever been observed.” And at p.16, in Conclusions and future prospects: “This search, even though similar in some ways to the binary neutron star [BNS] inspiral search [a previous complete failure!], has some significant differences and presents unique challenges. There were no events that could be identified as gravitational waves. – The fact that the performance and sensitivity of the LIGO interferometers is improving and the frequency sensitivity band is being extended to lower frequencies makes us hopeful that the first detection of gravitational waves from the inspiral phase of binary black hole coalescences may happen in the near future. In the absence of a detection, astrophysically interesting results can be expected by LIGO very soon.” (What kind of results?) –

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2. – Unfortunately for LIGO’s scholars, their hopes are doomed to be frustrated – and for several reasons.

First of all, the general form of solution of Schwarzschild problem is given, in spherical polar co-ordinates, by the following ds² [2]:

\[
\begin{align*}
ds^2 &= \left(1 - \frac{2m}{f(r)}\right)c^2 dt^2 - \left(1 - \frac{2m}{f(r)}\right)^{-1} \left[ df(r) \right]^2 - \\
&\quad - [f(r)]^2 \left( d\theta^2 + \sin^2 \theta d\phi^2 \right),
\end{align*}
\]

(1)

where: \(m \equiv GM/c^2\); \(M\) is the mass of the concerned material point (at rest); \(f(r)\) is any regular function of the radial co-ordinate \(r\). Remark that no physical result depends on the choice of \(f(r)\). If we put

\[
f(r) \equiv \left[r^3 + (2m)^3\right]^{1/3},
\]

we obtain the original form of solution given by Schwarzschild [3], which is maximally extended since holds for \(r > 0\). Putting

\[
f(r) \equiv r ,
\]

we have the standard (by Hilbert-Droste-Weyl) form (erroneously called “by Schwarzschild”), which holds only for \(r > 2m\), as it was repeatedly emphasized by all the Fathers of Relativity; remark that the exterior part \(r > 2m\) of form [3] is diffeomorphic to form [2]. The notion of black hole (BH) is a senseless artefact based on an unphysical interpretation of the singular locus \(r = 2m\) and of the region \(r < 2m\) [4]. Moreover, an appropriate computation shows that a continued gravitational collapse of a massive celestial body ends in a mass point, not in a BH [4].

So far as the binary black hole (BBH) systems are concerned, it is sufficient to remember a sentence written by McVittie many years ago, in which he emphasized that, even if one admits the existence of BH’s (on which he was frankly sceptical), “there is no way of asserting through some analogy with Newtonian gravitational theory that a black hole could be a component of a close binary system or that two black holes could collide. An existence theorem would first be needed to show that Einstein’s field equations contained solutions which described such configurations.” [5].

3.- From the observational standpoint, the “observed” BH’s are only large, or enormously large, masses concentrated in very small volumes; indeed, no observation has ever detected any whatever characteristic property of the hypothetical BH’s, e.g. the existence of a “horizon”. On this matter we owe to Wolfgang Kundt many interesting remarks [6], for instance: “How about stellar-mass holes? […] Over 45 black hole candidates have been proposed during the past 30 years from the class of binary X-ray sources […] To me, all of them look like neutron stars surrounded by massive (≈ 5 solar masses) accretion disks, because of their often hard spectra (up to the γ-ray range), highly structured, […] and because of their indistinguishable further
properties, as a class, from all the established neutron-star binaries [...]. – And the postulated supermassive black holes at the centers of (all the active) galaxies? [...] Active galactic nuclei may owe their extreme properties to those of their central disks.” (See pp.101 and 102 of [6]).

And “no BBH systems have ever been observed.” [1].

4. – In the exact (non-linearized) formulation of GR the GW’s are only mathematical undulations fully destitute of physical reality, as it was first proved in 1917 by Tullio Levi-Civita [7] – and subsequently with different demonstrations by, in particular, Scheidegger [8], Infeld and Plebanski [9], and the present writer [10].

How about GW’s in the linear approximation of GR? Strictly speaking, a detailed investigation is superfluous, because ubi maiora minora cessant. However, since all experimentalists and many theoreticians have inadequate ideas on this matter, and are fond of the linear version of GR [11], it is suitable to re-examine the question.

In 1923 Eddington published a limpid paper in which, with utilization of previous results by Einstein and Weyl, the conceptual bases of the linear theory of the GW’s were definitely settled [12].

As it is well known, the crucial postulate of the linear approximation of GR is the following: one sets approximately:

\[ g_{jk} \approx \eta_{jk} + h_{jk}, \quad ((j, k = 0, 1, 2, 3)), \]

where \( \eta_{jk} \) is the customary Minkowskian tensor and the \( h_{jk} \)’s are small deviations, that in our case represent the passage of GW’s. Remark that, quite generally, \( h_{jk} \) is a tensor only under Lorentz transformations of co-ordinates. Eddington considers in primis – in a generic Cartesian frame – the emblematic instance of plane waves proceeding with a velocity \( V \) (not fixed a priori!) in the (negative) direction of the axis of \( x \), so that the \( h_{jk} \)’s are periodic functions of \( (x + Vt) \) only. He finds that the \( h_{jk} \)’s of the undulatory disturbance can be separated into three independent sets:

Transverse-transverse: \( h_{22}, h_{33}, h_{23}; \quad (h_{22} = -h_{33}) \);

Longitudinal-transverse: \( h_{12}, h_{13}, h_{02}, h_{03} \);

Longitudinal-longitudinal: \( h_{11}, h_{01}, h_{00} \).

One puts: \( h_+ \equiv \{ h_{22} = -h_{33} \} \), and \( h_\times \equiv \{ h_{23} = h_{32} \} \); these traceless types can be transformed into each other with a space rotation of the coordinates \( x^2, x^3 \) around the \( (x = x^1) \)-axis by an angle of \( \pi/4 \) radians.

Now, the Author proves that the transverse-trasverse waves are propagated with the velocity \( c \) of light in vacuo, whereas the other waves are propagated with an arbitrary velocity, e.g. with the speed of thought. The curvature tensor depends only on the transverse-transverse waves; the remaining waves are only analytical fictions, which disappear with a suitable (infinitesimal) change of co-ordinates. Accordingly, it seems that the transverse-transverse waves are endowed with a a physical reality. I affirm...
that this is a mere illusion. The simple proof runs as follows: i) the linear version of GR is only an **approximate** formulation; ii) in GR there is **no** class of physically privileged reference frames; moreover, for the hypothetical GW’s – solutions of Einstein equations $R_{jk} = 0$ – **all** co-ordinate systems are physically suitable and appropriate; iii) a **finite** transformation of general co-ordinates can reduce to **zero** the transverse-transverse undulations, which have a tensor character under Lorentz transformations only. An immediate corollary: the watts of the celebrated mass-quadrupole formula are only ghost watts for the **exact** GR. (According to some authors, the validity of this formula goes beyond the linear approximation. Well, even in this case its physical value would remain inexistent owing to its derivation from the gravitational energy-momentum pseudo tensor, which can be always reduced to zero by means of an appropriate change of reference system.)

5.- In 1944 Hermann Weyl published a profound memoir on the linear version of GR [13]. He emphasized that in reality the gravitational field of this version is a “powerless shadow” because it exerts **no** force on matter. Indeed, “the gravitational force arises only when one continues the approximation beyond the linear stage [...]”: a fundamental result of Einstein-Infeld-Hoffmann method (see e.g. [9]). An immediate consequence: the customary linearized computations of the action of a GW on matter (for instance, on a resonant bar or on a Michelson interferometer) are fully destitute of a physical sense.

If we continue the approximation beyond the linear stage, we find that the radiation terms of the gravitational field can be always **destroyed** by suitable co-ordinate transformations: the GW’s are, quite generally, analytical phantoms, mere products of special choices of the reference frame ([8], [9]). This result can be also demonstrated independently of any perturbative treatment; stringently, it can be proved that there exists **no** “mechanism” of production of GW’s [10]: in the last analysis, this depends on the fact that in GR the motions of the particles result in principle from Einstein field equations – as it was first demonstrated in the fundamental memoir of 1927 by Einstein and Grommer.

(There are several proofs of the real non-existence of the above “mechanism”. For instance: it is very easy to prove that the trajectories of the bodies of a physical system, which interact only gravitationally – as e.g. the bodies of the solar system –, are **geodesic** lines, and therefore any emission of GW’s is clearly impossible. This result can be extended to the cases in which there are also non-gravitational interactions.)

6.- **Conclusion.** The black holes are unreal objects and the theory of the gravitational waves based on the **linear** approximation of General Relativity is not tenable from a rigorous standpoint.
More generally and definitively, the \textit{exact} formulation of General Relativity tells us that the gravitational waves are only phantasmic entities – see particularly [7], [8], [9], [10].

It is time that unfounded ideas on General Relativity start getting abandoned.

\begin{quote}
“Betrübt euch nicht, ihr guten Seelen!
Denn wer nicht fehlt, weiß wohl wenn andre fehlen . . .”
\end{quote}

J.W. v. Goethe

\textbf{APPENDIX A}

According to an erroneous conjecture, any GW generates a given gravitational field. Now, the stress-energy-momentum tensor of a hypothetical GW is a \textit{pseudo} tensor, which can be reduced to zero with a change of reference system. Only the matter tensor $T_{jk}$ generates Einsteinian gravitational fields, just as only the mass density $\mu$ generates Newtonian gravitational fields. Under this respect, the non-linearity of Einstein field equations is not important – and it is remarkable that the supporters of the above surmise affirm its validity even for the linear approximation of GR (see e.g. at p.391 of the book by Landau \textit{et al.} [12]), neglecting further the fact that $h_{jk}$ is a true tensor under Lorentz transformations only.

\textbf{APPENDIX B}

Point \textit{ii) } of the last paragraph of sect.4. is also important for a plain proof of the physical inadequacy of any \textit{exact} theory of GW’s, for instance of the theory of the plane waves by Bondi \textit{et al.} [14]. Indeed, convenient transformations of general co-ordinates can destroy the undulatory character of the wavy disturbances, in particular of the above plane GW’s. (Another consequence of point \textit{ii) } is the following: no fundamental velocity exists in \textit{general} relativity – contrary to a current belief.) Further, also the stress-energy-momentum \textit{pseudo} tensor of Bondi’s plane waves can be obviously reduced to zero through an appropriate change of reference frame.

Finally, it is true that there is in general the possibility (see e.g. Pirani in [14]) of building exact wavy solutions of field equations for empty spacetime ($R_{jk} = 0$), which have a curvature tensor different from zero, but this is only a mathematical possibility, for the simple reason that (in the \textit{exact} GR) there is no physical “mechanism” apt to generate GW’s. (And the above wavy solutions do not possess a \textit{true} stress-energy-momentum tensor, but only a \textit{pseudo} one.)

\textbf{APPENDIX C}

The first sentence of paper [1] is: “The Laser Interferometric Gravitational Wave Observatory (LIGO) […] consists of three Fabry-Perot-Michelson interferometers, which are sensitive to the minute changes that would be induced in the relative lengths of their orthogonal arms by a passing gravitational wave.”
The above “minute changes” represent a *mechanical* effect produced by the passage of a (hypothesized) GW. Now, such a wave would be capable also of production of *electromagnetic* effects, since it would interact with the light beams in the Fabry-Perot-Michelson cavities. This interaction has been the object of an accurate study by Cooperstock and Faraooni, see their paper quoted in \[12\]. These authors solved the problem in the *linear* approximation of GR, taking properly into account the boundary conditions for the light beams. They computed the phase shift, the light deflection and the rotation of the polarization axis induced by GW’s. Their results hold also for detectors which are *large* in comparison with the wavelengths of the GW’s. The great majority of the concerned astrophysicists, in particular LIGO’s members, do not mention the electromagnetic effects of the GW’s in the interferometric detectors. Why? Are they afraid of an *embarras de richesse*?

**APPENDIX D**

The conclusion of the paper by Hough *et al.* quoted in \[11\] is astonishing. They write: “... the 1993 Nobel Prize in Physics was awarded to Hulse and Taylor for their experimental observations and subsequent interpretations [which are based essentially on the *linear* approximation of GR] of the evolution of the orbit of the binary pulsar PSR1913+16, the decay of the binary orbit being consistent with angular momentum and energy being carried away from this system by gravitational waves. Thus it is now universally accepted that gravitational waves must exist unless there is something seriously wrong with General Relativity.”

This is quite illogical: the authors believe that the interpretations of Hulse and Taylor are fully adequate; now, such interpretations rest on the linearized version of General Relativity, in which Hough *et al.* repose a complete trust ... – In reality, the above interpretations are inappropriate, as it can be proved \[15\].

The experimental failures in detecting the GW’s are a proof of the experimental adequacy of General Relativity – if *rightly* understood.

**References**

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[11] See e.g.: J. Hough, S. Rowan, B.S. Sathyaprakash, arXiv:gr-qc/0501007 (January 4th, 2005); J. Hough, É. É. Flanagan and S.A. Hughes, arXiv:gr-qc/0501041 (January 12th, 2005)

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[13] H. Weyl, Amer. J. Math., 66 (1944) 591. – In the Appendix of a paper of mine – Spacetime and Substance, vol.5, No. 2(22), 2004, pp.53-56 – I have reproduced the “Introduction and Summary” and the sects. 1, 2 of Weyl’s memoir, which are particularly relevant to present theme.

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