ON THE DISPLACEMENTS OF EINSTEINIAN FIELDS  
ET CETERA  

ANGELO LOINGER  

Abstract. I give here: i) a very simple proof that the physical non-existence of gravitational waves (GW’s) is quite consistent with the basic principles of general relativity (GR); ii) a new argument against the physical existence of GW’s; iii) a criticism of Fock’s treatment of the GW’s; iv) some remarks on recent experimental investigations concerning the GW’s.

1. – The following is a widespread and erroneous opinion: Without gravitational waves (GW’s), one would have to explain an instantaneous propagation of a change in the metric over the whole universe simply by changing the distribution of stress or mass of a given physical system. – In reality, the physical non-existence of GW’s is quite consistent with the principles of general relativity (GR), as I have shown ad abundantiam in various papers [1], but perhaps in too concise ways insofar as the above specific belief is concerned. I shall give now in sects. 2., 3. a detailed treatment of it, with the hope of convincing even the most naive among the physicists that the adjective “instantaneous” is not the attribute of a relativistic bugaboo – if it is properly understood.

In sect. 4. I give a new argument against the physical existence of GW’s. In sect. 5. Fock’s computations concerning the GW’s are critically examined. The Appendix reports some recent (negative) results of the experimental search of GW’s due to LIGO collaboration.

2. – In previous Notes I have repeatedly emphasized that Einstein field is not analogous to Maxwell field, since it has peculiar properties of its own that are not shared by the electromagnetic field. If, however, we neglect for a moment – ad usum Delphini – the existence of the e.m. waves, we can exploit a precise property of Maxwell field for our purpose. For convenience, I utilize here the treatment of Liénard-Wiechert e.m. fields – created by a moving point charge – as is developed in the well known treatise by Becker and Sauter [2]; see in particular p.293 of this book, which gives the expressions of the electric and magnetic fields due to Liénard and Wiechert. For our aim, it is expedient to consider the first part, say $E_1$, of the electric field $E$
(e.g.), i.e. the part which does not depend on the charge acceleration. We have

\[ E_1(\tau)/e = \frac{(r - r v/c)(1 - v^2/c^2)}{(r - \mathbf{r} \cdot \mathbf{v}/c)^3} \quad \tau \equiv t - r/c, \]

with evident and standard notations. As Becker and Sauter write, \( E_1 \) has the character of a static field, it falls off as \( 1/r^2 \) for large distances. Since eq. (1) gives the first part of the expression of the global field \( E \), which is valid for all velocities \( v \), it must agree with the field, say \( E' \), created by a uniformly moving charged particle (see sect.64 of [2]):

\[ E'(t)/e = \frac{\mathbf{r}(1 - v^2/c^2)}{[r^2 - (\mathbf{r} \times \mathbf{v}/c)^2]^{3/2}}; \]

the formal difference between expressions (1) and (2) comes from the different meanings of the vector \( r \) in the two formulae. In eq. (2) \( r = r(t) \) is set equal to the vector from the instantaneous particle location, say \( B \), to the field point \( P \), while in eq. (1) by \( r = r(\tau) \equiv r(t - r/c) \) we understand the vector from the particle location, say \( A \), at retarded time \( \tau \equiv t - r/c \), to the field point \( P \). For the case of constant velocity we obviously have:

\[ r(t) = r(\tau) - \frac{r(\tau)}{c} \mathbf{v}. \]

If we write \( r(t) \equiv r_0 \), and \( r(\tau) \equiv r \) (as in eq. (1)), we find from \( r_0 = r - r \mathbf{v}/c \) for the denominator of eq. (2) that

\[ \left[ r_0^2 - (r_0 \times \mathbf{v}/c)^2 \right]^{3/2} = (r - \mathbf{r} \cdot \mathbf{v}/c)^3, \]

i.e. the denominator of eq. (1). Thus the field \( E_1 \) actually represents the field moving along with the particle; and this is clearly true also for a non-constant speed. By contrast, the second part, \( E_2 \), of the total electric field \( E = E_1 + E_2 \), which is proportional to the acceleration \( \dot{\mathbf{v}} \), has the character of a wavy \( (1/r) \) - decreasing field.

(I have reproduced almost literally some passages of Becker and Sauter [2], only the italics are mine.)

3. – We have seen that the static part \( E_1 \) of Liénard-Wiechert electric field \( E \) moves en bloc with the particle. Now, the same thing happens, in the exact formulation of GR, for the Einstein field \( g_{jk}(x^0, \mathbf{x}) \) , \( (j,k = 0,1,2,3) \), since – as it has been proved [3] – no “mechanism” exists in GR, which is capable of producing GW’s. In other terms, if we displace a mass, its gravitational field and the related curvature of the interested manifold displace themselves along with the mass. In general, qualitatively speaking, we can affirm that under this respect Einstein field and Newton field behave in an identical way. This fact is mathematically and physically evident in Friedmann’s cosmological models, as I have shown [4], owing to the perfect agreement between Friedmann’s solutions and the solutions of corresponding
Newtonian models. (Furthermore, we can remark that at any stage of the EIH-method of solution of field equations there is a suitable reference frame for which the solution has a Newtonian form.)

Conclusion: the widespread opinion reported at the beginning of sect. 1 is false: the absence of GW’s does not generate any theoretical difficulty – as Levi-Civita had pointed out many years ago.

(Generally speaking, the real existence of physical waves requires the existence of physically privileged reference frames, or of a material medium as the cosmic ether. It is not the case of GR: in it a geodesic deviation must have a Newton-like character – and therefore could be recorded only by an apparatus in a relative proximity of the gravity source.)

4. - The Einstein field equations share with Laplace-Poisson equation \( \nabla^2 U = -4\pi G \rho \) an important property. Let us consider for a moment only the case of a “cloud of dust” with mass tensor \( T^{jk} = \rho u^j u^k \), \( (j, k = 0, 1, 2, 3) \), where \( \rho(x^0, x) \) is the invariant mass density and \( u^j(x^0, x) \) is the four-velocity of a gravitating particle. It is well known [5] that we can always choose a Gaussian normal (“synchronous” in Landau’s terminology [6]) reference frame, for which:

\[
(5) \quad ds^2 = \left( dx^0 \right)^2 - h_{\alpha\beta} \left( x^0, x \right) dx^\alpha dx^\beta , (\alpha, \beta = 1, 2, 3) ;
\]

if there are only gravitational interactions – as in the present case –, this frame is also co-moving [7]: the world lines of the “dust” particles are both time lines and geodesic lines. Our mass tensor \( T^{jk} \) has only the component \( T^{00} = \rho \) different from zero. Thus – exactly as it happens for Friedmann’s models [4] – the metric tensor \( g_{jk}(x^0, x) \) depends only on \( \rho(x^0, x) \), in perfect analogy with the Newtonian potential \( U \), and it satisfies identically the geodesic equations. No GW’s are emitted – and this fact is now quite intuitive, because we see that the motion of the fluid has been formally “obliterated”.

This treatment can be immediately generalized to a continuum, whose particles are subject to gravitational and non-gravitational (e.g., electromagnetic) interactions. It is indeed sufficient to choose a co-moving reference frame – as it is always possible if the particle trajectories do not cross. Here too the metric tensor does not depend on the motion of the medium – motion that the metropolitan legend considers responsible of the emission of GW’s.

5. – Fock [8] pretended erroneously that the so-called harmonic frames possess a physical privilege with respect to the other co-ordinate systems. Thus, in particular, all his computations concerning the GW’s are performed in a harmonic frame, and with mass tensors of extended bodies. Since the motions of gravitating point masses do not generate GW’s, it is difficult to believe in a thaumaturgical virtue of largeness. Indeed, the extended bodies are composed of particles, and, further, their translational motions are correctly treated as motions of material corpuscles.
Fock’s computations regarding the GW’s are rather poor in physical significance.

**APPENDIX**

α) I report here the summary of a communication by I. Leonor at LIGO Scientific Collaboration meeting, March 23, 2005, entitled “Searching for GRB-GWB coincidence during LIGO science runs”.

**Summary:**
- developed scheme for searching for GRB-GWB coincidence in near real time
- looking forward to S5 run with \( \sim 100 \) GRB triggers in one year of coincident run
- performed search for short-duration GW bursts coincident with S4, S3, and S2 GRB’s using crosscorrelation method
- sample probability distribution consistent with null hypothesis.

The LIGO scholars are technically very clever, but evidently they cannot discover a non-existent object as a GW.

β) On arXiv:gr-qc/0505029 v1 (6 May 2005) we can read a paper of 23 pages, written by 395 LIGO-researchers all over the world, entitled “Upper limits on gravitational wave bursts in LIGO’s second science run – LIGO-P040040-07-R”.

Here are some sentences from the ABSTRACT: “We perform a search for gravitational wave bursts using data from the second science run of the LIGO detectors, using a method based on a wavelet time-frequency decomposition. This search is sensitive to bursts of duration much less than a second and with frequency content in the 100-1100 Hz range. It features significant improvements in the instrument sensitivity and in the analysis pipeline with respect to the burst search previously reported by LIGO. […] No gravitational wave signals were detected in 9.98 days of analyzed data. […]”.

At p.11 we read: “The WaveBurst analysis applied to the S2 data yielded 16 coincidence events (at zero-lag). The application of the \( r \)-statistic cut rejected 15 of them, leaving us with a single event that passed all the analysis criteria.”. And at p.13: “The investigation revealed that the event occurred during a period of strongly elevated acoustic noise at Hanford lasting tens of seconds, as measured by microphones placed near the interferometers. […] The source of the acoustic noise appears to have been an aircraft.”

In spite of the repeated failures, the LIGO scientists are still hopeful. *Spes ultima dea*.

γ) On arXiv:gr-qc/0505042 v1 (10 May 2005) the above 395 scholars have published an article (7pp.) entitled “Search for Gravitational Waves from Primordial Black Hole Binary Coalescences in the Galactic Halo”. From the ABSTRACT: “We use data from the second science run of the LIGO gravitational-wave detectors to search for the gravitational waves from primordial black hole (PBH) binary coalescence with component masses in the range 0.2–1.0\( M_{\odot} \). […] No inspiral signals were found.” – Obviously: both GW’s and BH’s are non-existent objects [9]. The so-called observed BH’s
are enormously massive bodies restricted in relatively small volumes – as it can be demonstrated by a careful scrutiny of the concerned papers [10].

δ) Again the mentioned 395 scientists on arXiv:gr-qc/0505041 v1 (12 May 2005): “Search for gravitational waves from galactic and extra–galactic binary neutron stars” (20pp.). From the ABSTRACT: “We use 373 hours (≈ 15 days) of data from the second science run of the LIGO gravitational-wave detectors to search for signals from binary neutron star coalescences within a maximum distance of about 1.5 Mpc, a volume of space which includes the Andromeda Galaxy and other galaxies of the Local Group of galaxies. [...] No inspiral gravitational wave events were identified in our search.”

The conclusion of the paper is the following (p.19): “In this paper, we have presented a data analysis strategy that could lead to a detection of gravitational waves from binary neutron star inspirals. The methods used to validate the search illustrate the subtleties of the analysis of several detectors with different sensitivities and orientations. Moreover, the experience gained by following up the largest coincident triggers will be crucial input to investigations of event candidates that are identified in future searches.”

An Italian jest says: *Chi vive sperando muore cantando.*

**References**

[1] Cf. e.g. A. Loinger, *Spacetime & Substance*, 3, No.4(14), 2002, p.145; also on arXiv:physics/0207013 v1 (July 2nd, 2002); also in *On BH’s and GW’s, II* (La Goliardica Pavese, Pavia) 2005, p.1.

[2] R. Becker and F. Sauter, *Electromagnetic Fields and Interactions*, vol.1 (Blaisdell Publ. Company, New York, etc.) 1964, sect.69.

[3] See [1] and the pertinent literature quoted there, in particular: A. Loinger, *Nuovo Cimento B*, 115 (2000) 679; Idem, *Spacetime & Substance*, 3, No.3(13), 2002, p.129; also in *On BH’s and GW’s, II* (La Goliardica Pavese, Pavia) 2005, p.52; also on arXiv:physics/0202065 v1 (February 27th, 2002).

[4] A. Loinger, arXiv:physics/0504018 v1 (April 3rd, 2005) – in course of publication in *Spacetime & Substance*.

[5] D. Hilbert, *Mathem. Annalen*, 92 (1924) 1.

[6] L. Landau et E. Lifchitz, *Théorie du Champ* (Éditions Mir, Moscou) 1966, sect.99.

[7] Cf. e.g. E. Lifchitz and I. Khalatnikov, *Advances in Physics* 12 (1963) 185.

[8] V. Fock, *The Theory of Space, Time and Gravitation* (Pergamon Press, Oxford, etc.) 1964, passim.

[9] See e.g. A. Loinger, arXiv:physics/0402088 v1 (February 18th, 2004); Idem, *On BH’s and GW’s, II* (La Goliardica Pavese, Pavia) 2005, pp.13, 17, 26, 30, 35. The first proof that the notion of BH is a nonsense was given by K. Schwarzschild, *Berl. Ber.*, (1916) 189; for an English translation of this fundamental memoir see: arXiv:physics/9905030 (May 12th, 1999), and *Gen. Rel. Grav.*, 35 (2003) 951; also in *On Black Holes and Gravitational Waves* (La Goliardica Pavese, Pavia) 2002, p.107.

[10] See in particular A. Loinger and T. Marsico, arXiv:astro-ph/0305036 v1 (March 9th, 2003), and *Spacetime & Substance*, 4, No.2(17), 2003, p.80; also in *On BH’s and GW’s, II* (La Goliardica Pavese, Pavia) 2005, p.17.