© Thierry PERIAT: The GTR2 proposal and the flow of time hypothesis

"Do some black holes end their life as neutrons stars?"

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Within a context envisaging the time has a fourth dimension working like a machinery creating new moments, it has been proposed in the literature that some black holes may create circumstances allowing a (quantum) tunneling and then the formation of white holes.
This document envisages the mathematical frontier between Einstein's theory of relativity and one consequence of the GTR2 proposal for a black hole with a 180 km Schwarzschild radius. The calculations are yielding a source with a radius that may reasonably be identified with a neutrons star. Therefore, the GTR2 approach defends another thesis: some black holes continue their life as neutral stars.

Flow of time, volumes, and energies.

Our universe is experimenting an accelerated expansion. This is the conclusion published in 1998 and 1999 by the High-Z supernovae search team and the Supernova Cosmology project. These results have been rewarded with the 2011 Nobel Prize in physics, [01], [02].

Instead of answering all questions, this conclusion has pushed the standard FLRW model in front of observational challenges, [03]. Two examples illustrate this affirmation: the "cosmological constant problem", [04], and the "problem of time", [05]. Furthermore, the rewarded results have received a contradiction in November 2019.

At the same time, observations, and simulations (Millennium, Illustris TNG, Bolshoi …) have revealed the existence of a titanic web containing nodes and filaments. These images motivate the construction of a cosmological models containing material strings surrounding giant empty voids.

In that document, I assume one of the three hypothesis on which the alternative proposal called "the GTR2" lies, [a]. Concretely, the fourth dimension can be related to a vector, at least locally, and the accelerated expansion of our universe takes place in *a full four-dimensional vector space*[1].

I also give the greatest importance to that experimental fact that there are quite more empty volumes than volumes occupied by a known form of energy which may be related to an observable particle. In extenso there is no particle carrying the dark matter and still less carrying the dark energy.

In that context, it becomes relevant to speak about the Universe in terms of a gigantic set of infinitesimal four-dimensional volumes. This set contains two main subsets: one is containing energy under its multiple known visages (the Shiva's arms) and another one is containing nothing known but which should intuitively coincide with the observed voids.

The repartition of energy inside a significant set of volumes inevitably opens the door of thermodynamics and points out the importance of entropy. As a matter of evidence, voids appear to be quieter than these cosmic strings surrounding them.

This *omnipresence of vacuum* justifies a revolutionary postulate: "The empty regions are a kind of perfect fluid in equilibrium at around 3°K and the particles are physical phenomenon appearing when that equilibrium is loosed. The aim of this theoretical attempt called "The theory of the (E) question" is to bring plausible arguments helping us to accept this new paradigm.

[1] This could be: V = {E(4, R), $\otimes_{\Gamma(2)}$} where the symbol $\otimes_{\Gamma(2)}$ denotes the fact that the vector space E(4, R) is equipped with a classical tensor product which is eventually deformed by the Christoffel's symbols of the second kind.

A Lamb-Rutherford way of thinking applied to two kinds of vacuum.
The ratio between empty volumes and volumes containing any known form of energy suggests that the latter are related to the formers like the top of an iceberg is related to the entire iceberg, i.e.: it is just the observable part of it.

However, as C. Rovelli remarks it at the beginning of his book [06], nature often behaves in a contra-intuitive manner. This is one of the many reasons why our five senses often do not help us sufficiently in our attempt to understand the nature, e.g.: our planet is not flat, and it turns around the Sun.

Nevertheless, the averaged volumetric density of known forms of matter in the universe is extraordinarily small, and this reinforces the intuition that that matter is an accident happening in a usually very calm and stable ocean.

Pushing this revolutionary and unconventional way of thinking up to the limits, it suggests believing that the universe is empty, but that emptiness can oscillate between a stable vacuum and a less stable vacuum.

This suggestion can motivate an extrapolation of an essential way of thinking proposed by Lamb and Rutherford [07]. This extrapolation, [b], furnishes extraordinary results; one of them exhibits the strategic role of the cyclic group C6, exactly the group which also appears when the set V = {E(4, R), $\otimes_{\Gamma(2)}$} has a C*algebra structure, [c]. This mathematical statement legitimates the dual behavior of these empty regions and the belief that they can oscillate between absolutely nothing and a little something.

With that vision, the universe is like a giant foam, a set of bubbles, the frontiers of which are equivalent to evolutive energetic surfaces (the unstable vacuum) surrounding vast stable empty regions (the voids).

The GTR2 proposal and some of its first consequences
Although it may appear to be extremely difficult to think about a time vector, the GTR2 proposal brings many advantages with it here.

- **Four dimensions and that is all -** Firstly, there is no need to add extra mathematical dimensions (like, for example, in the strings theories).

- **Strange electromagnetic fields are inducing a constraint on the metrics -** Secondly, the mathematical procedure specifying the GTR2 approach allows the introduction of a bizarre family of electromagnetic-like fields. They have a geometric origin leaving no imprint on the global electromagnetic (EM) field; in extenso: the global EM field induced by these components vanishes. Hence the energy-impulse tensor related to that field too: $T_{\lambda\mu} = 0$) but perhaps on the curvature of the universe. The latter can be, and is, measured.

  The proposal can be confronted with known experimental results. A GTR2 electromagnetic universe ($T_{\lambda\mu} = 0$) respecting Einstein's field equation with a non-vanishing cosmological constant imposes to start the calculations with:
  (01)

$$R_{\lambda\mu} - \tfrac{1}{2}.\ R.\ g_{\lambda\mu} + \Lambda.\ g_{\lambda\mu} = -\frac{8\pi G}{c^4}.\ T_{\lambda\mu} = 0 \Rightarrow \bar{R} + (\Lambda - \tfrac{1}{2}.\ R).\ \bar{g} = 0$$

Warning: The small line over a letter denotes the fact that I consider the trace of the related matrix. Recall that in general, within the context of tensor calculus, R and $\bar{R}$ do not coincide since:

(02)

$$R = \Sigma_\lambda R^\lambda{}_\lambda = \Sigma_\lambda (\Sigma_\mu g^{\lambda\mu}. R_{\mu\lambda})$$

Whilst:

(03)

$$\bar{R} = \Sigma_\lambda R_{\lambda\lambda}$$

- **There is a neutral shape around each source which is generating isotropic and static metric -** Third: within a GTR2 universe with an isotropic and static metric, I must write the following new constraint on the trace as (Newton, $\gamma = 0$; Einstein, $\gamma = 1$)[08; p. 130]:

(04)

$$\bar{g}(\text{GTR2})\ ;\ R \neq 2.\ \Lambda$$
$$=$$
$$\frac{\bar{R}}{(\frac{1}{2}.R - \Lambda)}$$
$$=$$
$$(c^2 - 1) - 2.\ (r_S/r).\ (c^2 + \gamma) - C(r).\ (1 + \sin^2\theta).\ r^2$$
$$\sim$$
$$c^2.\ \{1 - 2.\ \frac{r_S}{r} - C(r).\ (1 + \sin^2\theta).\ \frac{r^2}{c^2}\}$$
$$=$$
$$\bar{g}(\text{GTR with signature} + - - -);\ r > 0$$

This is also:

(05)

$$\bar{R} \sim (\Lambda - ½.\ R).\ c^2.\ \{1 - 2.\ \frac{r_S}{r} - C(r).\ (1 + \sin^2\theta).\ \frac{r^2}{c^2}\}$$

Let go some steps further; for such metric [08; p. 132]:

(06)

$$\bar{R}$$
$$=$$
$$\Sigma_\lambda R_{\lambda\lambda}$$
$$=$$
$$R_{00} + R_{11} + R_{22} + R_{33}$$
$$=$$
$$\{-\frac{\ddot{B}}{2A} + \frac{\dot{B}}{4A}.\ (\frac{\dot{A}}{A} + \frac{\dot{B}}{B}) - \frac{\dot{B}}{A}.\ \frac{1}{r}\} + \{-\frac{\ddot{B}}{2B} + \frac{\dot{B}}{4B}.\ (\frac{\dot{A}}{A} + \frac{\dot{B}}{B}) - \frac{\dot{A}}{A}.\ \frac{1}{r}\} - \cos^2\theta + (1 + \sin^2\theta).\ \{\frac{1}{A} - \frac{r}{2A}.\ (\frac{\dot{A}}{A} - \frac{\dot{B}}{B})\}$$

$$A(r) = 1 + \gamma.\ \frac{r_S}{r};\ \dot{A} = \frac{dA}{dr} = -\ \gamma.\ \frac{r_S}{r^2};\ \ddot{A} = \frac{d\dot{A}}{dr} = 2.\ \gamma.\ \frac{r_S}{r^3}$$

$$B(r) = 1 - \frac{r_S}{r};\ \dot{B} = \frac{dB}{dr} = \frac{r_S}{r^2};\ \ddot{B} = \frac{d\dot{B}}{dr} = -\ 2.\ \frac{r_S}{r^3}$$

For the pedagogy, let consider the case $\gamma = 1$ and $\theta = 0$.

(07)

$$\bar{R} = \{-\frac{\ddot{B}}{2A} + \frac{\dot{B}}{4A}.\ (\frac{\dot{A}}{A} + \frac{\dot{B}}{B}) - \frac{\dot{B}}{A}.\ \frac{1}{r}\} + \{-\frac{\ddot{B}}{2B} + \frac{\dot{B}}{4B}.\ (\frac{\dot{A}}{A} + \frac{\dot{B}}{B}) - \frac{\dot{A}}{A}.\ \frac{1}{r}\} - 1 + \frac{1}{A} - \frac{r}{2A}.\ (\frac{\dot{A}}{A} - \frac{\dot{B}}{B})$$

Since:
(08)

$$\{-\frac{\ddot{B}}{2A}+\frac{\dot{B}}{4A}.(\frac{\dot{A}}{A}+\frac{\dot{B}}{B})-\frac{\dot{B}}{A}.\frac{1}{r}\}=\frac{\frac{r_S}{r^3}}{1+\frac{r_S}{r}}-\frac{\frac{r_S^2}{r^4}}{4.(1+\frac{r_S}{r})^2}+\frac{\frac{r_S^2}{r^4}}{4.(1-\frac{r_S^2}{r^2})}-\frac{\frac{r_S}{r^3}}{1+\frac{r_S}{r}}=-\frac{\frac{r_S^2}{r^4}}{4.(1+\frac{r_S}{r})^2}+\frac{\frac{r_S^2}{r^4}}{4.(1-\frac{r_S^2}{r^2})}$$

$$\{-\frac{\ddot{B}}{2B}+\frac{\dot{B}}{4B}.(\frac{\dot{A}}{A}+\frac{\dot{B}}{B})-\frac{\dot{A}}{A}.\frac{1}{r}\}=2.\frac{\frac{r_S}{r^3}}{1+\frac{r_S}{r}}-\frac{\frac{r_S^2}{r^4}}{4.(1-\frac{r_S^2}{r^2})}+\frac{\frac{r_S^2}{r^4}}{4.(1-\frac{r_S}{r})^2}$$

$$\frac{1}{A}-\frac{r}{2A}.(\frac{\dot{A}}{A}-\frac{\dot{B}}{B})=\frac{1}{1+\frac{r_S}{r}}+\frac{\frac{r_S}{r}}{2.(1+\frac{r_S}{r})^2}+\frac{\frac{r_S}{r}}{2.(1-\frac{r_S^2}{r^2})}$$

This is:

$$=-\frac{\frac{r_S^2}{r^4}}{4.(1+\frac{r_S}{r})^2}+\frac{\frac{r_S^2}{r^4}}{4.(1-\frac{r_S^2}{r^2})}+2.\frac{\frac{r_S}{r^3}}{1+\frac{r_S}{r}}-\frac{\frac{r_S^2}{r^4}}{4.(1-\frac{r_S^2}{r^2})}+\frac{\frac{r_S^2}{r^4}}{4.(1-\frac{r_S}{r})^2}-1+\frac{1}{1+\frac{r_S}{r}}+\frac{\frac{r_S}{r}}{2.(1+\frac{r_S}{r})^2}+\frac{\frac{r_S}{r}}{2.(1-\frac{r_S^2}{r^2})}$$

The first and the fourth terms annihilate each other. With the hope to simplify this writing, we introduce a variable: X = r_S/r.

$$\bar{R}=-\frac{1}{r_S^2}.\frac{X^4}{4.(1+X)^2}+\frac{1}{r_S^2}.\frac{X^4}{4.(1-X^2)}+2.\frac{X}{1+X}-\frac{1}{r_S^2}.\frac{X^4}{4.(1-X^2)}+\frac{1}{r_S^2}.\frac{X^4}{4.(1-X)^2}-1+\frac{1}{1+X}+\frac{X}{2.(1+X)^2}+\frac{X}{2.(1-X^2)}$$

$$=\frac{1}{r_S^2}.\{\frac{X^4}{4.(1-X)^2}-\frac{X^4}{4.(1+X)^2}\}+\frac{X}{1+X}+\frac{X}{2.(1+X)^2}+\frac{X}{2.(1-X^2)}$$

$$=\frac{1}{r_S^2}.\{\frac{4.X^4.(1+X)^2-4.X^4.(1-X)^2+X.\{16.(1-X)^2.(1+X)+8.(1-X^2)+8.(1+X^2)\}}{16.(1-X)^2.(1+X)^2}\}$$

$$=\frac{1}{r_S^2}.\{\frac{4.X^4.(1+2X+X^2-1+2X-X^2)+X.\{16.(1-2X+X^2).(1+X)+16\}}{16.(1-X)^2.(1+X)^2}\}$$

$$=\frac{1}{r_S^2}.\frac{16.X^5+16.X.(2-X-X^2+X^3)}{16.(1-X)^2.(1+X)^2}$$

At the end:
(09)

$$\bar{R}=\frac{X}{r_S^2}.\frac{(X^4+X^3-X-X^2+2)}{(1-X)^2.(1+X)^2}$$

The Ricci scalar for this type of metric is:
(10)

$$R=\Sigma_\lambda R^\lambda{}_\lambda=\Sigma_\lambda(\Sigma_\mu g^{\lambda\mu}.R_{\mu\lambda})=g^{00}.R_{00}+g^{11}.R_{11}+g^{22}.R_{22}+g^{33}.R_{33}$$

↓

$$R=\frac{1}{B}.\{-\frac{\ddot{B}}{2A}+\frac{\dot{B}}{4A}.(\frac{\dot{A}}{A}+\frac{\dot{B}}{B})-\frac{\dot{B}}{A}.\frac{1}{r}\}-\frac{1}{A}\{-\frac{\ddot{B}}{2B}+\frac{\dot{B}}{4B}.(\frac{\dot{A}}{A}+\frac{\dot{B}}{B})-\frac{\dot{A}}{A}.\frac{1}{r}\}-\frac{2}{r^2}.\{-1-\frac{r}{2A}.(\frac{\dot{A}}{A}-\frac{\dot{B}}{B})+\frac{1}{A}\}$$

↓

$$R = \frac{1}{A}.\{(\frac{\dot{A}}{A} - \frac{\dot{B}}{B}).\frac{2}{r} + 1\} + \frac{2}{r^2}$$

$$\downarrow$$

$$r_S^2.\ R = \frac{r_S}{1+\frac{r_S}{r}}.\{(-\frac{\frac{r_S}{r}}{1+\frac{r_S}{r}} - \frac{\frac{r_S}{r}}{1-\frac{r_S}{r}}).\frac{2r_S}{r} + r_S\} + 2.(\frac{r_S}{r})^2$$

$$\downarrow$$

$$r_S^2.\ R = \frac{r_S}{1+X}.\{2.(-\frac{X}{1+X} - \frac{X}{1-X}).X + r_S\} + 2.X^2$$

Since:
(11)

$$\frac{X}{1+X} + \frac{X}{1-X} = \frac{2}{1-X^2}$$

It follows:
(12)

$$r_S^2.\ R = \frac{r_S}{1+X}.\{r_S - \frac{4X}{1-X^2}\} + 2.X^2$$

This must now be injected into (05) when $\theta = 0$:
(13)

$$\bar{R} \sim (\Lambda - ½.R).c^2.\{1 - 2.\frac{r_S}{r} - C(r).\frac{r^2}{c^2}\} = (\Lambda - ½.R).\{c^2.\{1 - 2.X) - C(r).r_S^2.\frac{1}{X^2}\}$$

Let envisage a universe with a quasi-null cosmological constant and let inject the relations (09) and (12) into (13); this is yielding:
(14)

$$\Lambda \sim 0,\ C(r) \sim 1\ [08;\ p.\ 130]$$

$$\downarrow$$

$$\bar{R} \sim -½.R.\{c^2.\{1 - 2.X) - r_S^2.\frac{1}{X^2}\}$$

This is imposing to study:
(15)

$$r_S^2.\bar{R} \sim -½.r_S^2.R.\{c^2.\{1 - 2.X) - r_S^2.\frac{1}{X^2}\}$$

$$\downarrow$$

$$X.\frac{(X^4 + X^3 - X - X^2 + 2)}{(1-X)^2.(1+X)^2} \sim -½.\{\frac{r_S}{1+X}.\{r_S - \frac{4X}{1-X^2}\} + 2.X^2\}.\{c^2.\{1 - 2.X) - r_S^2.\frac{1}{X^2}\}$$

$$\downarrow$$

$$X.\frac{(X^4 + X^3 - X - X^2 + 2)}{(1-X)^2.(1+X)^2}$$

$$\sim$$

$$-½.\frac{r_S^2.(1-X)^2.(1+X) - 4.r_S X.(1-X) + 2.X^2.(1-X)^2.(1+X)^2}{(1-X)^2.(1+X)^2}.\{c^2.\{1 - 2.X) - r_S^2.\frac{1}{X^2}\}$$

$$\downarrow$$

$$X.\{X^4 + X^3 - X^2 - X + 2\}$$

$$\sim$$

$$-½.\{r_S^2.(1 - X)^2.(1 + X) - 4.r_S.X.(1 - X) + 2.X^2.(1 - X^2)^2\}.\{c^2.\{1 - 2.X) - r_S^2.\frac{1}{X^2}\}$$

$$\downarrow$$

$$X^7 + X^6 - X^5 - X^4 + 2.X^3$$

$$+$$

$$½.\{r_S^2.(1 - X - X^2 + X^3) - 4.r_S.(X - X^2) + (2.X^6 - 4.X^4 + 2.X^2)\}.\{c^2.X^2 - 2.c^2.X^3 - r_S^2\}$$

$$\sim$$

$$0$$

$$\downarrow$$

$$X^7 + X^6 - X^5 - X^4 + 2.\ X^3$$

$$+$$

$$½.\ \{2.\ X^6 - 4.\ X^4 + r_S^2.\ X^3 - [(r_S - 2)^2 - 6].\ X^2 - [(r_S - 2)^2 - 4].\ X + r_S^2\}.\ \{c^2.\ X^2 - 2.\ c^2.\ X^3 - r_S^2\}$$

$$\sim$$

$$0$$

$$\downarrow$$

$$X^7 + X^6 - X^5 - X^4 + 2.\ X^3$$

$$+$$

$$½.\ \{2.\ c^2.\ X^8 - 4.\ c^2.\ X^9 - 2.\ r_S^2.\ X^6 - 4.\ c^2.\ X^6 + 8.\ c^2.\ X^7 + 4.\ r_S^2.\ X^4 + r_S^2.\ c^2.\ X^5 - 2.\ r_S^2.\ c^2.\ X^6 - r_S^4.\ X^3 - c^2.\ [(r_S - 2)^2 - 6].\ X^4 - c^2.\ [(r_S - 2)^2 - 6].\ X^5$$

$$+ r_S^2.\ [(r_S - 2)^2 - 6].\ X^2 - c^2.\ [(r_S - 2)^2 - 4].\ X^3 - c^2.\ [(r_S - 2)^2 - 4].\ X^4 + r_S^2.\ [(r_S - 2)^2 - 4].\ X + r_S^2.\ c^2.\ X^2 - 2.\ r_S^2.\ c^2.\ X^3 - r_S^4\} \sim 0$$

$$\downarrow$$

$$- 2.\ c^2.\ X^9$$

$$+ c^2.\ X^8$$

$$+ (1 + 4.\ c^2).\ X^7$$

$$+ (1 - 2.\ r_S^2 - 2.\ c^2 - r_S^2.\ c^2).\ X^6$$

$$+ (-1 + ½.\ r_S^2.\ c^2 - ½.\ c^2.\ [(r_S - 2)^2 - 6]).\ X^5$$

$$+ (4.\ r_S^2 - 1 - ½.\ c^2.\ [(r_S - 2)^2 - 6] - ½.\ c^2.\ [(r_S - 2)^2 - 4]).\ X^4$$

$$+ (2 - r_S^4 - ½.\ c^2.\ [(r_S - 2)^2 - 4] - r_S^2.\ c^2).\ X^3$$

$$+ ½.\ (r_S^2.\ [(r_S - 2)^2 - 6] + r_S^2.\ c^2).\ X^2$$

$$+ ½.\ r_S^2.\ [(r_S - 2)^2 - 4].\ X$$

$$- ½.\ r_S^4$$

$$\sim$$

$$0$$

Let look for solutions for this polynomial.

First formal result: Before any computing, since $X = r_S/r$, let remark that $X = 0$ ($r \to +\infty$) is a trivial solution. This seemingly meaningless statement indicates that any source generating a static and isotropic metric, when it is observed at infinity, gives the illusion to be a neutral spherical object.

Second result: For a reasonable confrontation with data which are loaned to the literature, I choose $r_S = 180$ km. The solutions I am looking for, if they exist, will give the radius of a neutral sphere surrounding the source of a static and isotropic gravitational field.

(16)

$$2.\ c^2.\ X^9$$

$$- c^2.\ X^8$$

$$- (1 + 4.\ c^2).\ X^7$$

$$- (1 - 2.\ r_S^2 - 2.\ c^2 - r_S^2.\ c^2).\ X^6$$

$$- (-1 + ½.\ r_S^2.\ c^2 - ½.\ c^2.\ [(r_S - 2)^2 - 6]).\ X^5$$

$$- (4.\ r_S^2 - 1 - ½.\ c^2.\ [(r_S - 2)^2 - 6] - ½.\ c^2.\ [(r_S - 2)^2 - 4]).\ X^4$$

$$- (2 - r_S^4 - ½.\ c^2.\ [(r_S - 2)^2 - 4] - r_S^2.\ c^2).\ X^3$$

$$- ½.\ (r_S^2.\ [(r_S - 2)^2 - 6] + r_S^2.\ c^2).\ X^2$$

$$- ½.\ r_S^2.\ [(r_S - 2)^2 - 4].\ X$$

$$- ½.\ r_S^4$$

$$\sim$$

$$0$$

$$\downarrow$$

$$2.\,X^9 - X^8 - 4.\,X^7 + 32402.\,X^6 - 361.\,X^5 + 31679.\,X^4 + 48240{,}011.\,X^3 - 16200.\,X^2 - 0{,}005.\,X - 0{,}005 \sim 0$$

With the program MATLAB, I write:
(17)

```
p=[2 -1 -4 32402 -361 31679 48240 -16200 -0,005 -0,005];
r=roots(p)
```

I find nine roots:

12.8083 +21.9238i
12.8083 -21.9238i
-25.1278 + 0.0000i
0.3655 + 1.2847i
0.3655 - 1.2847i
-1.0000 + 0.0000i
0.2803 + 0.0000i
-0.0000 + 0.0006i
-0.0000 - 0.0006i

But five from them are unphysical complex numbers. From the four remaining (quasi) real roots, one is negative and is therefore rejected; two are corresponding to the already known solution X = 0 (See first formal result). The unique acceptable solution is then:
(18)

$$X \sim 0{,}28 = \frac{r_S}{r} = \frac{180}{r} \rightarrow r \sim 643 \text{ km}$$

Discussion

I argue that the GTR2 proposal is a suitable tool for the description of neutrons stars. One of my arguments is rooted in the mathematical fact that that proposal allows the existence of electromagnetic-like fields with a geometric origin (see [a]) but of which the global tensor imprint vanishes.

There are circumstances limiting the number of GTR2 electromagnetic fields to six. They strongly suggest a one-to-one identification between each of these fields and a quark field. The global vanishing of these components inside a given volume evocates an identification with pairs like: (n, n), (p^+, p^-).

A second fact reinforces my intuition: the treatment of the constraint imposed by the GTR2 proposal on the metrics at hand, within a context respecting Einstein's fields equation (no revolution), gives a solution for the Schwarzschild radius 180 km which is compatible with (is of the same order than) previous estimations calculated for a neutron star; namely: $r_S/r \sim 0{,}28$. See for example [08; chapter

38, p. 229; X ~ 1] and [08; chapter 43, p. 254; X ~ 0,3] for a source having a mass comparable with those of the Sun.

The radius 180 km is also the one appearing in discussion initiated in [09]. That discussion concerns black holes spiraling inward and presumably having given rise to the LIGO event (see reference [6] in [09]).

The GTR2 approach, as more precisely described in personal contributions [a] and [d], incorporates second-order variations of basis vectors. The procedure allows the development of discussions entirely staying in a four-dimensional space. In that specific context, electromagnetic-like fields with a geometric origin appear.

In a first step, there is no need to modify Einstein's theory (GTR). But the constraint imposed to the GTR by the GTR2 specificities reduces the generality of the GTR and introduces the existence of an electrically neutral spherical shape around any isotropic and static source.

In applying the knowledge inherited from the GTR when the energy-impulse tensor vanishes and in injecting the GTR2 constraints into Einstein's field equation, equation (01) in fact, I get a polynomial of degree nine depending on the ratio, X, between (i) the Schwarzschild radius of the source of that isotropic and static metric and (ii) the radial distance to that source.

When the Schwarzschild radius is one of the Black holes involved in [09], then this ratio must be approximately equal to 0,28. Hence I am encouraged to suggest (predict) that that approximative value 0,28 indicates that the two spiraling black holes may have continued their life in a coalescence forming a neutron star.

Conclusion
In that document, I have envisaged one consequence of the concept called: "The arrow/flow of time" suggested by Eddington (1928). This concept is rooted in thermodynamics, especially in Carnot's and Clausius' work (as recalled in [06]).

In extenso, I have accepted to believe that, at least locally, the time is related to a fourth basis vector. In extending the mathematical machinery studying the variations of the basis vector until the second order, I have discovered the plausible existence of electromagnetic fields with a pure geometric origin (See [a] and [d] for the premises).

The GTR tells us that the black holes are regions where gravitational fields are putting the matter under extreme mechanical and dynamical pressures. My prediction: these extreme situations are forcing these fields to organize themselves inside a minimal volume in such a manner that they become equivalent to the electromagnetic-like fields of the GTR2. I have considered this prediction and verified -with calculations- that this reorganization would plausibly explain that a part of all black holes transforms into neutrons stars.

This conclusion differs from the one which has been proposed in [10], suggesting that black holes may first evaporate and then end their life as white holes after having tunneled.

Personal contributions
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[b] PERIAT, T. : Les régions vides : la vision empruntée à Lamb et Rutherford, 11 janvier 2019, ISBN 978-2-36923-138-7, EAN 9782369231387.
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