THE BLACK HOLES DO NOT EXIST "ALSO SPRACH KARL SCHWARZSCHILD"

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Abstract. According to the *original* theoretical analysis of 1916 by Karl Schwarzschild the black holes do not have a physical reality.

A paper "für Alle und Keinen".

Introduction

I recall here the *main* stages of an important theoretical acquisition, which was originated by a fundamental memoir of 1916 by Karl Schwarzschild, i.e.: the general theory of relativity (GR) does *not* allow the physical existence of black holes (BH's) – if rightly understood.

From the *observational* standpoint the alleged discoveries of BH's are mere *flatus vocis*: in reality, the astronomical observations prove only the presence of very large – or enormously large – masses concentrated in very small ("punctual") volumes.

1916

In this year Schwarzschild published two epochal memoirs, respectively entitled "Über das Gravitationsfeld eines Massenpunktes nach der EINSTEINschen Theorie" [1], and "Über das Gravitationsfeld einer Kugel aus inkompressibler Flüssigkeit nach der EINSTEINschen Theorie" [2]. In the first paper the Author gives the *exact* solution of the problem of the Einsteinian gravitational field which is generated by a point mass M at rest. If r, ϑ, φ are spherical polar co-ordinates, we have the following expression for the spacetime interval $\mathrm{d}s$:

$$(1)\quad \mathrm{d}s^2 = \left[1 - \frac{2m}{\mathrm{R}}\right] c^2 \mathrm{d}t^2 - \left[1 - \frac{2m}{\mathrm{R}}\right]^{-1} (\mathrm{dR})^2 - \mathrm{R}^2 \left(\mathrm{d}\vartheta^2 + \sin^2\vartheta \mathrm{d}\varphi^2\right),$$

where $m \equiv GM/c^2$; G is the gravitational constant and c is the speed of light *in vacuo*; $\mathrm{R} \equiv [r^3 + (2m)^3]^{1/3}$.

This $\mathrm{d}s^2$ holds, physically and mathematically, in the *entire* spacetime, with the only exception of the origin $r = 0$, seat of the mass M. (Remark that this singular point has an associate superficial area equal to $4\pi(2m)^2$: this means simply that the Einsteinian material point is *not* identical with the Newtonian material point, as it was emphasized in 1923 by Marcel Brillouin [3].)

In the second paper [2] Schwarzschild determined the Einsteinian gravitational field generated by an incompressible fluid sphere. Now, if one computes the limit of this solution when the sphere contracts into a material point of a finite mass M, one finds anew the Schwarzschildian form of solution for a mass point of the first memoir (see A. Loinger, *arXiv:gr-qc/9908009*, August 3rd, 1999). It is very interesting that a fluid sphere of uniform density and *given* mass cannot have a radius smaller than $(9/8)(2m)$.

1916-1917

If in lieu of the R of eq.(1) we put simply the radial co-ordinate r, we obtain the so-called *standard form* of the solution of the problem solved in [1] (Schwarzschild problem). This form was discovered independently by Hilbert [4], Droste [4], and Weyl [6]. It is usually, but ***erroneously***, named "by Schwarzschild". The HDW-form is *physically* valid only for $r > 2m$, because within the spatial surface $r = 2m$ (a singular locus) the time co-ordinate takes the role of the radial co-ordinate, and *vice versa* (and therefore $\mathrm{d}s^2$ loses its essential property of physical appropriateness) and the solution becomes *non*-static. Quite properly, Nathan Rosen emphasized repeatedly that the radial co-ordinate of the HDW-form has been initially chosen in such a way that the area of the space surface $r = k$ is equal to $4\pi k^2$: consequently, it is very difficult to admit that the co-ordinate r can transform itself into the time co-ordinate within the space region $r < 2m$.

Finally, it is very easy to prove that in the manifold defined by HDW-form for $0 < r < \infty$ it is impossible to assign the *time arrow* to every time geodesic, according to physically reasonable criteria; on the contrary, this difficulty does *not* exist for the Schwarzschild form (1), [7].

The fictive notion of BH was generated by *erroneous* reflections on the "globe" $r = 2m$ of the standard HDW-form. *It would not have come forth if the treatises of GR had expounded the Schwarzschild form of solution in lieu of the standard form.*

Remark that the validity restriction $r > 2m$ of the standard form does *not* imply a *physical* limitation. Indeed, as all the classic Authors knew, the exterior part $r > 2m$ of the HDW-form is diffeomorphic to the Schwarzschild form, which holds for $r > 0$.

1922-1923-1924

As far back as 1922 all the competent scientists knew the right interpretation of the standard HDW-form. Indeed, in 1922 a meeting was held at the Collège de France, which was attended by Einstein. The physical meaning of the "globe" $r = 2m$ was discussed and definitively clarified – see the lucid paper by M. Brillouin quoted in [3]. This Author investigated also another interesting form of solution to Schwarzschild problem, which can be formally obtained by putting in eq.(1) the simple expression $r + 2m$ in lieu of R. The validity domain of Brillouin's form is identical with that of Schwarzschild's form. Moreover, Brillouin shows that it is *not* permitted to extend the radial co-ordinate r of Schwarzschild's and Brillouin's forms to

the negative values of the interval $-2m < r < 0$, and proves simultaneously that the attribution of a physical meaning to the interval $0 < r < 2m$ of the standard HDW-form (*as the inventors of the BH's do*) is pure nonsense.

In 1924 Eddington published the second edition of his splendid treatise on Relativity (reprinted in 1930, 1937, 1952, 1954, 1957, 1960), in which we find a very general form of solution to Schwarzschild problem [8]:

(2)
$$\mathrm{d}s^2 = \left[1 - \frac{2m}{f(r)}\right] c^2 \mathrm{d}t^2 - \left[1 - \frac{2m}{f(r)}\right]^{-1} [\mathrm{d}f(r)]^2 - [f(r)]^2 \left(\mathrm{d}\vartheta^2 + \sin^2\vartheta \mathrm{d}\varphi^2\right),$$

where $f(r)$ in *any* regular function of r; we see immediately that: if $f(r) \equiv \mathrm{R}$, we have the Schwarzschild form (1); if $f(r) \equiv r$, we have the standard HDW-form; if $f(r) \equiv r + 2m$, we have the Brillouin form; *etc.*

All the physical results are independent of the particular choice of the function $f(r)$.

Quite similar considerations can be made for the gravitational fields generated by *electrically charged* particles.

The years *post* 1924

The previous conception can be easily generalized to the gravitational field generated by the spinning particle of the well-known Kerr's solution.

In regard to the "maximally extended" form of solution to Schwarzschild problem due to Kruskal [9] and Szekeres [10] – a rather baroque form –, we can declare its *physical superfluity*, because already the (static) forms of Schwarzschild and Brillouin, in particular, are "maximally extended".

Continued gravitational collapse: it is almost evident that if we bear in mind, e.g., Schwarzschild's and Broillouin's forms, *no continued collapse can generate a BH* – and this was just Einstein's opinion [11].

Since 1998 I have published several articles on *arXiv* in which the non-existence of the BH's has been demonstrated anew. The papers of the years 1998 ÷ 2001 have been collected in a book [12]; papers of the successive years on the same subject have been published (on *arXiv* and) on *Spacetime and Substance*.

I was motivated by a simple consideration: *all* the Great Spirits who founded and developed GR thought that the notion of BH belongs to science fiction [13].

APPENDIX

Observations made by a team of astrophysicists of the *Max-Planck-Institut* for Extraterrestrial Physics have allowed to determine the positions of the star denote with the symbol S2 in its motion around the Milky-Way's centre [14]. It has come out that the S2-orbit is a *Keplerian* ellipse with a period of 15.2 years.

The accuracy of the above research seems indisputable, but the conclusion of the authors – according to which the centre around which S2 revolves is a *black hole* – seems fully unjustified. Indeed, the existence of the observed

Keplerian orbit can only explain the presence of a "punctual" supermassive body at the centre of the Milky-Way – and not of a supermassive BH [15].

It can be also demonstrated that the two supermassive celestial bodies at the centre of the distant galaxy NGC 6240 (see *NASA Press Release*, November 20th, 2002) cannot be black holes [15].

References

[1] K. Schwarzschild, *Berl. Ber.*, (1916) 189; for an English translation see *arXiv:physics/9905030*, May 12th, 1999. This translation has been published also on *Gen. Rel. Grav.*, **35** (2003) 951.

[2] K. Schwarzschild, *Berl. Ber.*, (1916) 424; for an English translation see *arXiv:physics/9912033*, December 16th, 1999.

[3] M. Brillouin, *Journ. Phys. Rad.*, **23** (1923) 43; for an English translation see *arXiv:physics/0002009*, February 3rd, 2000.

[4] D. Hilbert, *Gött Nachr.*, zweite Mitteilung, vorgelegt am 23.Dez. 1916; Idem, *Math. Annalen*, **92** (1924) 1.

[5] J. Droste, *Ned. Acad. Wet.*, S.A., **19** (1917) 197.

[6] H. Weyl, *Ann. Phys. (Leipzig)*, **54** (1917) 117. See also L. Flamm, *Phys. Z.*, **27**(1916) 448.

[7] Private communication by S. Antoci.

[8] A.S. Eddington, *The Mathematical Theory of Relativity*, Second Edition (Cambridge University Press, Cambridge) 1960, p.64.

[9] M. Kruskal, *Phys. Rev.*, **119** (1960) 1743.

[10] G. Szekeres, *Publ. Mat. Debrecen*, **7** (1960) 285.

[11] A. Einstein, *Ann. Math.*, **40** (1939) 922.

[12] A. Loinger, *On Black Holes and Gravitational Waves* (La Goliardica Pavese, Pavia) 2002, Part I.

[13] For a bibliography on the BH's see, e.g., the review article by A. Celotti, J.C. Miller and D.W. Sciama, *Class. Quantum Grav.*, **16** (1999) A3. This paper is a *summa* of all the current (and erroneous) opinions about the BH's.

[14] R. Schödel *et alii*, *Nature*, **419** (2002) 694.

[15] For a detailed discussion cf. A. Loinger and T. Marsico, *Spacetime & Substance*, No.2 (17) 2003.

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