the general science journal

The Kerr-metric, mass- and light-horizons, and black holes' radii.

(using gravitomagnetism)

T. De Mees - thierrydm@pandora.be

Abstract

Black holes can generally be defined as stellar objects which do not release any light. The Schwarzschild radius, derived from GRT, defines the horizon radius for non-rotating black holes. The Kerr metric is supposed to define the horizon of rotating black holes, and this metric is derived from generally "acceptable" principles. The limit for the Kerr metric's horizon for non-rotating black holes is the Schwarzschild radius.
By analysing the outcome for rotating and non-rotating black holes' horizon, using the Maxwell Analogy for Gravitation (MAG)[5,6,7,8] (or historically more correct: the Heaviside[2] Analogy for Gravitation), I find that the Kerr metric must be incorrect in relation to the definition of horizons of rotating black holes. If the Maxwell Analogy for Gravitation is supposed to be "a good approach" of GRT, we may assume that the Maxwell Analogy is a valid analysis tool for the star's horizon metrics.
I rather find that the Kerr metric does purely not defines typical horizons at all, but only a kind of orbit vanishing condition of spinning stars (I call the Kerr-type of horizon further the "mass-horizon"). Moreover, the metric is not complying with MAG but by a factor of two. I find a second metric for the definition of horizons, based on the bending of light (I call this further the "light-horizon"). Moreover, I deduct the equatorial radii of rotating black holes. The probable origin of the minutes-lasting gamma bursts near black holes is unveiled as well. Finally, I deduct the conditions for explosion-free black holes.
The deductions are based on the findings of my papers *"Did Einstein cheat?"*[7], *"On the geometry of rotary stars and black holes"*[8] and *"On the orbital velocities nearby rotary stars and black holes"*[9].

Keywords. Maxwell Analogy – gravitation – rotary star – black hole – Kerr Metric – torus – gyrotation – horizon
Methods. analytical
Graphs. WZ-Grapher

<u>Index</u>

1. The orbital velocities nearby Rotary Stars and Black Holes.

Introduction: mass-horizons and the Kerr Metric.

Schwarzschild found one horizon for non-rotation black holes by applying GRT. With the Kerr metric, which gives the conditions nearby black holes, two horizons are found. Here, I look for horizons via the Maxwell Analogy.

The horizon can -unhappily- be defined as the ultimate possible orbit of masses about the spinning star. In order to find the horizon's radius in this chapter, I look after the orbit which has an orbital velocity of the speed of light. This horizon I call the "mass-orbit horizon" or simply the "mass-horizon". If the horizon's radius is greater than the star's radius, we can speak of a black hole of the mass-horizon-type. Indeed, the region of the poles of spinning stars do not respond to the same requirements than the equator, and thus is not emission-free.
In my former paper concerning orbital velocities[9], I have derived the orbital velocity nearby rotary stars and black holes, using the Maxwell Analogy for gravitation (usually named 'gravitomagnetism' or 'gravitation and co-gravitation', or what I prefer to call *gravitomagnetism*). The orbital velocity is always higher than the classical Keplerian orbital velocity.
The result is:

$$v = v_{orbit} = v_k \sqrt{1 + \left(v_k \, s_\Omega\right)^2} + v_k^2 \, s_\Omega \qquad (1.1)$$

wherein I have named the Kepler velocity v_k :

$$v_k = \sqrt{\frac{G\,m}{r}} \qquad (1.2)$$

and wherein I have defined the *"angular spread"* s_Ω (dimension of inverse velocity [s/m]) as :

$$s_\Omega = \frac{\theta}{r} \qquad (1.3)$$

Here, θ is defined as the *"specific angular density"* of the spherical star (dimension of time [s]):

$$\theta_{sphere} = \frac{R^2\,\omega}{10\,c^2} \qquad (1.4)$$

At what conditions will matter orbit at the speed of light?

By putting $v_{orbit} = c$, we can find where the orbit velocity should reach the speed of light. This deduction is purely theoretical, because very probably this case will lead to a disintegration of the orbiting matter into gamma rays. For any orbit closer to the black hole, no matter orbits will still subsist.

By filling (1.2), (1.3), (1.4) and $v_{orbit} = c$ in (1.1), we get:

$$\frac{G\,m}{r} + \frac{G\,m\,R^2\omega}{5c\,r^2} - c^2 = 0 \qquad (1.5)$$

This equation is quadratic in r if we multiply it by r^2. And of the two solutions, I keep only the positive one for now:

$$r_{MH+} = \frac{G\,m}{2c^2} + \sqrt{\left(\frac{G\,m}{2\,c^2}\right)^2 + \frac{G\,I\,\omega}{2c^3}} \qquad (1.6)$$

wherein we have replaced the inertial moment of the sphere by I (see 1.7).

$$I = \frac{2}{5} m R^2 \tag{1.7}$$

Thus, the faster the star spins, the farther away from it, the orbital velocity of light can yet be reached. And for non-rotating black holes, the orbit radius becomes:

$$r_{MH,\,\omega=0} = \frac{G\,m}{c^2} \tag{1.8}$$

which is half the Schwarzschild radius. It is probable that (1.6) gives the condition of disintegration of matter near a spinning star, due to the high energies involved for masses reaching the speed of light, and it seems reasonable to take in account this possibility.

In the following lines, I simplify (1.6) for fast spinning stars with masses of at least that of the sun. Equation (1.6) becomes after some manipulation:

$$r_{MH+} = \frac{G\,m}{2c^2} + \sqrt{\left(\frac{G\,m}{2\,c^2}\right)^2 + \frac{G\,I\,\omega}{2\,c^3}} \tag{1.9}$$

The second term under the root sign is much smaller than 1 for all the known stars and black holes. Thus, knowing that:

$$x << 1 \quad \Rightarrow \quad \sqrt{1+x} \approx 1 + \frac{1}{2} x \tag{1.10}$$

it follows that:

$$r_{MH+} \approx \frac{G\,m}{2c^2}\left(2 + \frac{I\,c\,\omega}{G\,m^2}\right) \tag{1.11}$$

Since the definition of the Schwarzschild radius is :

$$R_s = \frac{2\,G\,m}{c^2} \tag{1.12}$$

the equation (1.11) can be re-written as:

$$r_{MH+} \approx \frac{R_s}{2} + \frac{I\,\omega}{2\,m\,c} \tag{1.13}$$

The equation (1.13) shows that the evolution of the mass-horizon radius is linear in ω. The faster the star spins, the wider away from its centre the mass-horizon orbit becomes. This equation means that no mass can 'survive' for that radius, nor smaller radii.

Remark that the negative solution of the quadratic equation (1.5) does not have yet a clear physical meaning here. It would be quite speculative to associate this equation with the empty inner space of a toric black hole, but this option merits a closer study.

$$r_{MH-} = \frac{G\,m}{2c^2} - \sqrt{\left(\frac{G\,m}{2\,c^2}\right)^2 + \frac{G\,I\,\omega}{2\,c^3}} \tag{1.14}$$

In my former paper *"On the shape of black holes"*[(9)] I demonstrated, using MAG, the high probability of toric black holes when they spin fast. The two mass-horizons that I found here could signify the confirmation of my earlier finding. Both (1.6) and (1.14) resemble the Kerr metric horizon solutions. But they differ with a factor of two from the MAG metric. Here, the equations describe the limit conditions of an orbital velocity of matter at the speed of light. In the discussion chapter, these matters will be further explained.

In the following lines, I simplify (1.14) for fast spinning stars and black holes. Equation (1.14) becomes after some manipulation:

$$r_{MH-} = \frac{G\,m}{2c^2}\left(1 - \sqrt{1 + \frac{2\,I\,c\,\omega}{G\,m^2}}\right) \tag{1.15}$$

The second term under the root sign is expected to be far smaller than 1. Hence, knowing that:

$$x << 1 \quad \Rightarrow \quad \sqrt{1+x} \approx 1 + \frac{1}{2}x \tag{1.16}$$

it follows that for fast spinning stars, the second mass-horizon becomes:

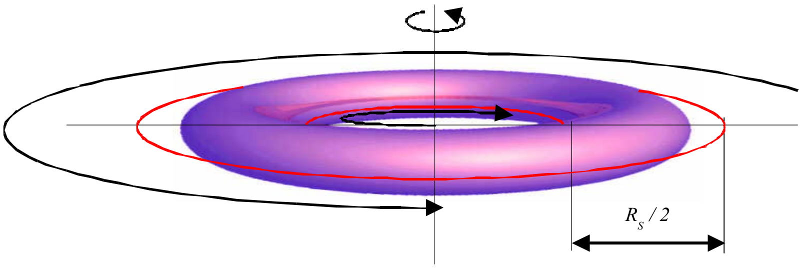
$$r_{MH-} \approx -\frac{I\,\omega}{2\,m\,c} \tag{1.17}$$

Remark that (1.17) is independent of the mass, but dependent of its geometry.

The torus shape of fast spinning stars

In the paper *"On the shape of rotary stars and black holes"* I deduct that fast spinning stars are torus-shaped. Can this also be deducted from the MAG mass-horizon?

Indeed, in the same paper, I come to the conclusion that when particles arrive in the torus hole, the only steady motion is a circular equatorial orbit which is retrograde to the torus' spin. When looking at (1.17) , there is a surprising minus sign. And this is perfectly complying with the predicted retrograde orbit. When (1.13) and (1.17) are graphically represented (fig.1.1) , it becomes clear that the two mass-horizons (red boundaries) differ only with the width of half the Schwarzschild radius.



The spinning star's mass-horizons

Fig.1.1

Thus, according (1.13) and (1.17) , the shape of the mass-horizon at the fast spinning stars' equator is disk-like with an empty central zone, and it can be expected that such spinning stars are torus-like with a thickness below $R_S/2$.

This chapter gave the solution for the zone nearby the black hole where matter tends to orbit at the speed of light and the confirmation of the torus-like shape of spinning stars. Before discussing the findings of this chapter more in depth, I first study the general problem of the bending of light nearby black holes.

2. The bending of light into a circular orbit.

Introduction: what is a light-horizon ?

Another approach could be the study of the bending of light by the spinning star. Although this chapter seems to be quite identical to the former one, there is an important difference. Here, I speak of the bending of *light* in the gravitomagnetism field, and not about *matter* in an orbit. And the result of circular light-bending is called the *light-horizon*.

For this purpose, we take the solution which we have found in "*Did Einstein cheat?"*[(4)] , equation (6.14), written in its general form.

$$-F_{\varphi,\alpha} = G\frac{2\,m\,m'}{r^2} + G\frac{m\,m'}{2\,r^2c^2}v_1^2\cos^2\alpha + G\frac{m\,m'\,R^2\,\omega_\varphi^2}{5\,c^2\,r^2}\cos^2\varphi \qquad (2.1)$$

This equation describes the bending of light, taking in account three forces and thus three terms, based on : 1° the pseudo-gravitational effect, which is two times the value of the Newton gravitation, 2° the dragging velocity (in the present case: of the Milky Way) and 3° the star's rotation (in the present case: the sun). And I found this equation to be far more accurate than the GRT derivation.
The very important finding in this derivation was that light is not bent by gravitational effects (because the rest mass of light is zero), but only by the mass stream of the light wave itself, travelling in the gravitation field of the star.

What specifies the light-horizon of black holes?

In this case, of course, I do not consider the Milky Way's dragging velocity v_1 , which I assume to be insignificant nearby the black holes we want to study. The last term in (6.14) (in "*Did Einstein cheat?"*) comes from the basic equation (4.3) for spheres, in *"A coherent double vector field theory for Gravitation"*.

$$\Omega_{ext} \Leftarrow \frac{-G\,m\,R^2}{5r^3c^2}\left(\omega - \frac{3\,r\,(\omega \bullet r)}{r^2}\right) \qquad (2.2)$$

Combined with (1.1) of the same paper, $F_\Omega = m\,(g + v \times \Omega)$, wherein $g = 0$, this becomes for the equator plane:

$$F_\Omega = \frac{G\,m\,R^2\omega^2}{5c^2r^2} \qquad (2.3)$$

Besides staying at the equator level of the star only, I consider accelerations instead of forces. So, the acceleration becomes:

$$a = G\frac{2m}{r^2} + G\frac{m\,R^2\omega^2}{5c^2\,r^2} \qquad (2.4)$$

Since this acceleration is a bending, thus, radial acceleration, and since we look at the light performing a circular orbit, the acceleration a is supposed to also comply with the centripetal acceleration v^2/r, which is a purely geometrical formula. For light, we replace the speed v by c. Hence:

$$\frac{c^2}{r} = G\frac{2m}{r^2} + G\frac{m\,R^2\omega^2}{5c^2r^2} \qquad (2.5)$$

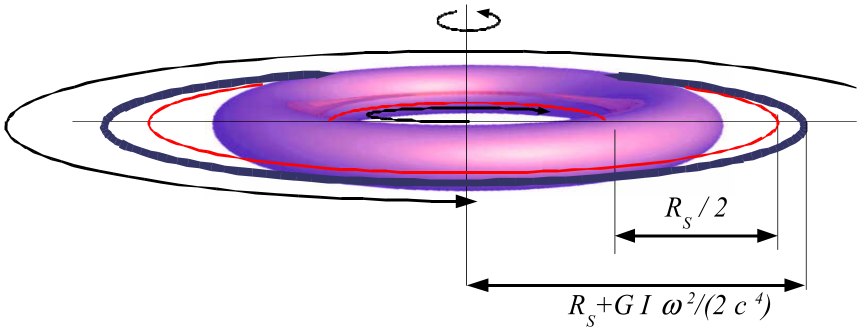
The solutions for the light horizon's radius r are given by:

$$r_{LH} = R_s + \frac{G\,I\,\omega^2}{2\,c^4} \qquad (2.6)$$

wherein R_s is the Schwarzschild radius, and I the inertial moment of the star (in (2.2) this was a sphere) :

$$R_s = \frac{2 G m}{c^2} \qquad (2.7) \qquad\qquad I_{sphere} = \frac{2}{5} m R^2 \qquad (2.8)$$

Equation (2.4) is thus describing the bending of light beams in circular orbit about black holes. Horizons cannot better be defined than with this equation. In the discussion chapter, it will become clear why this is so.



The spinning star's mass-horizons and its light-horizon

Fig.2.1

In figure 2.1, the light-horizon's diameter is larger than the external mass-horizon diameter. This is not always the case, as will explained in the discussion chapter.

Remark that (2.6) can be expressed in terms of the star's equator velocity $v = \omega R$. Assuming that the inertial moment can be expressed as a factor λ , multiplied with $m R^2$, the expression becomes independent from R. Setting $I = \lambda m R^2$, equation (2.6) becomes:

$$r_{LH} = R_s \left(1 + \frac{\lambda v^2}{4 c^2} \right) \qquad (2.9)$$

For ring-shaped black holes, $\lambda = 1$.

3. Deriving the radius of Pure Black Holes.

The radius of a ring-shaped Pure Black Hole.

If, as I found, (2.6) describes the horizon of black holes, there is a special case which even goes beyond that result: when the light-horizon coincides with the star's equator, a part of the star is invisible, even when looking from the poles to the star, whereas this obscuration was not the case in the former horizons. I speak of "*pure black holes*" at the limit where the equator of the star is obscured.
In (2.3) , the sphere's moment of inertia can be replaced by I (there, it was for a sphere). Equation (2.5) can then be replaced by:

$$\frac{c^2}{r} = G \frac{2 m}{r^2} + G \frac{I \omega^2}{2 c^2 r^2} \qquad (3.1)$$

As explained in former chapters, black holes are preferably torus-shaped, even probably thin ring-shaped for fast spinning stars. I assume the latter in order to simplify the calculations, and I will check the validity of the simplification afterwards.
For thin rings, $I = m R^2$, where R is the radius at the equatorial level of the star.

In (3.1) the value for ω equals v/R. The solution to the light-horizon r for ring-shaped black holes is then:

$$r_{LH} = R_s \left(1 + \frac{v^2}{4\,c^2}\right) \tag{3.2}$$

which is indeed identical to (2.9) with $\lambda = 1$. Symbol R_s is again the Schwarzschild radius: $R_s = \dfrac{2\,G\,m}{c^2}$ *(1.12)*

If the radius of the black hole coincides with the radius of the light-horizon, one finds the *pure black hole*'s radius. This happens for any velocity v in (3.2) smaller than c , and (3.2) gives than the corresponding radius $r = R$. The velocity at which the star's equatorial radius coincides with the light-horizon is than expressed in terms of R :

$$v_{eq} = \frac{2\,c}{\lambda}\sqrt{\frac{R_{eq}}{R_s} - 1} \tag{3.3}$$

With (3.3) , I obtain a circular bending of light upon the equator of the star itself. Light cannot escape, and the horizon is the star's equator. Hence, I can describe partial black holes, whereof a part is invisible, even when observed from the poles. As said before, I call them "*pure black holes*".

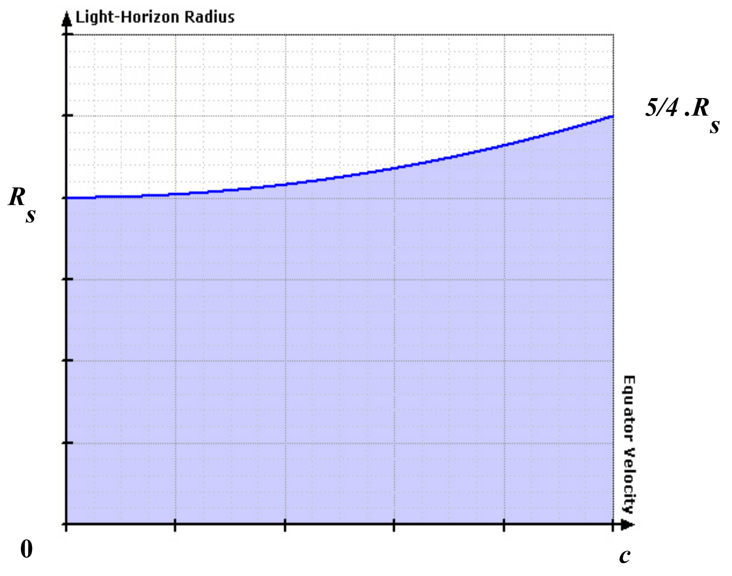
It follows immediately that for non-spinning stars ($v = 0$) , the radius R becomes the Schwarzschild radius R_s . If one puts $v = 0$ in (3.2) , indeed the Schwarzschild radius is found :

$$v_{eq} = 0 \quad \Rightarrow \quad r_{LH} = R_{eq} = R_s \tag{3.4.a}$$

The maximum velocity is c. The results are then:

$$v_{eq} = c \quad \Rightarrow \quad r_{LH} = R_{eq} = R_s \left(1 + \frac{\lambda^2}{4}\right) \tag{3.4.b}$$

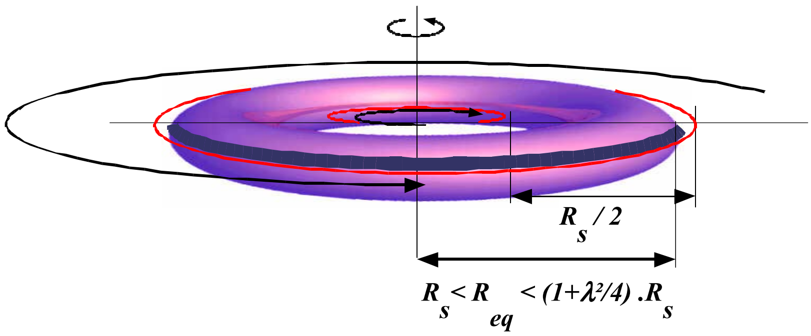
The result of (3.3) needs more clarification. The graphical presentation of fig. 3.1 will help us a lot.



Ring-shaped black hole ($\lambda = 1$) : Pure Black Hole's light-horizon radii.

Fig. 3.1

The graphic evolutes (for $\lambda = 1$) from R_s to $4/5.R_s$ with increasing velocity of the ring-shaped black hole's equator, until the equator's velocity reaches the (theoretical) maximum velocity of light. Equation (3.2) is beautifully describing the required radius at the equator level of *pure black holes* (with spin or not).



The Pure Black Hole's light-horizon and the mass-horizons

Fig.3.1

It is then clear that if I depict this graphically, I get fig.3.1. , wherein I show the light-horizon (large dark boundary) and the mass-horizons (red boundaries) as well. Immediately, it becomes clear that the Kerr metric will not comply with the shape of a torus-like black hole, because the Kerr metric has a distance of R_s between both mass-horizons as well, instead what I found with MAG: $R_s/2$, which then comply without any problem.

Are Pure Black Holes explosion-free ?

In a former paper[8], I have deducted the radius of continuous compression of spherical spinning stars at the equator level (with negligible only-gravitation influence). This deduction was based on the gyrotation field equations for a sphere, and we use (2.8) in order to obtain a more general equation. The minus sign is added for the convention of attraction.

$$\Omega_{ext} \Leftarrow -\frac{G\,I}{2\,r^3c^2}\left(\omega - \frac{3\,r(\omega \bullet r)}{r^2}\right) \qquad (3.5)$$

Herein r is the distance to the centre of the sphere, R is the radius of the sphere and ω is the spin velocity.

The equatorial gyrotation force is given by the analogue Lorenz force $a_x = \omega\, R\, \Omega_y$ (3.6)

and the last term of (3.5) is zero for Ω_y .

Hence, the acceleration due to gyrotation at the equator plane is:

$$a_x = -\omega^2\, R\,\frac{G\,I}{2\,r^3c^2} \qquad (3.7)$$

At the other hand, we have the following forces: the centrifugal force and the gravitation force. For fast spinning stars, the gravitation force can be neglected, and we find that, in general:

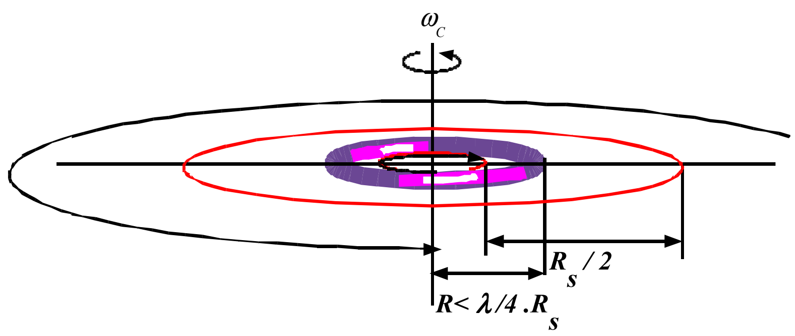
$$a_{tot} = \omega^2\, R\left(1 - \frac{G\,I}{2\,r^3c^2}\right) \qquad (3.8)$$

which becomes zero at an equilibrium when the acceleration a_{tot} is zero. The Compression Radius $r = R_C$ can then be found for black holes with an inertial moment in the form $I = \lambda\, m\, R^2$:

$$r = R_C = \sqrt[3]{\frac{\lambda\, R_s R^2}{4}} \qquad (3.9)$$

which becomes explosion-free at the equator if one puts $R = r = R_C$.

$$R_C = \frac{\lambda\, R_s}{4} \tag{3.10}$$



The MAG explosion-free Black Hole with spin velocity ω_C

Fig.3.2

and any spin velocity ω_C , large enough, is valid. The non-explosion condition (3.9), valid for all ring-shaped stars, defines the exterior radius of the ring-shaped spinning star for a total continuous compression at the equatorial level. Since the condition (3.9) always gives much smaller radii than the condition (3.2), explosion-free black holes are always at the same time *pure*.
Indeed, the minimum requirements for the spinning black hole, which cannot explode and which can disintegrate orbiting matter, would then be given by the combination of the metrics, given by fig. 3.2. Al these metrics can coexist mathematically.

4. Discussion: Three approaches, three important results.

Orbiting masses at the speed of light, and the Kerr metric.

The first derivation (1.6) for finding horizons resulted in the search of the orbit of matter travelling at the speed of light about the spinning star. The meaning of this orbit is however not very clear. Could this be the horizon of the star? Not really, because this equation goes about matter instead of light.
At the other hand, is seems to be correct that no more light can overpass this boundary, as far as matter effectively disintegrate at that place.

$$r_{MH+} = \frac{G\,m}{2c^2} + \sqrt{\left(\frac{G\,m}{2c^2}\right)^2 + \frac{G\,I\,\omega}{2c^3}} \tag{1.6}$$

But when the matter disintegrates, and when it transform to gamma rays, these rays obey to other rules. The gamma rays will be emitted and will –in most of the cases– not be cached by the star. The disintegration of an orbiting object near such a star will indeed emit enormous gamma bursts during seconds or minutes. Such gamma bursts are observed and (1.6) is very probably the origin of these observations. Longer bursts are not likely, because partly disintegrated masses become lighter, and will lookup slower orbits, laying at higher distances from the black hole.
Resuming, when one is purely speaking of the concept “horizon”, which is the circular bending of light, (1.6) is not exactly the expected solution.

So is the Kerr metric in contradiction with (1.6) concerning its horizon concept, because of the doubtful compliance of horizons with orbiting masses at the speed of light. From (1.6) follows moreover that for non-rotating stars the limit radius of the mass-horizon becomes:

$$\omega = 0 \quad \Rightarrow \quad r_{MH\,0} = \frac{R_s}{2} \tag{4.1}$$

Surprisingly, the Kerr metric is quasi identical to (1.6) , apart from a constant factor 2 , which allows the Kerr metric to obtain the Schwarzschild radius as a limit for $\omega = 0$. But this seems more to be an artifice.

The conclusion is that the Kerr metric simply cannot be derived by using the Maxwell Analogy. It could however have been acceptable if the two concurrent metrics were at the end almost identical, but a difference of a factor of two is not acceptable at all.

The bending of light and the Kerr metric

More likely, the bending of light should be the correct approach for defining the concept of "horizon". This happens in (2.6):

$$r_{LH} = R_s + \frac{G\,I\,\omega^2}{2\,c^4} \tag{2.6}$$

Herein, the Schwarzschild radius is obtained for the limit where $\omega = 0$. As explained before, it seems much more logical to consider the circular bending of light as the correct definition of the horizon.

The horizon concept of the Kerr metric is in total disagreement with the solution (2.6). The mathematical expression (2.6) has a very simple set-up consisting of a non-rotating term, and a term, quadratic in ω , when rotation occurs. Of course, the horizon exists only at the condition that its radius is larger than the star's radius.

Comparing both types of horizons

Comparing graphically both equations (1.6) and (2.6) gives a quite amazing picture (fig. 4.1).

The radius in the upper graphic (circular orbit at the speed of light) raises quickly with increasing spin velocity. The lower graphic (circular bending of the light), which is barely increasing, starts at the Schwarzschild radius. So, for black holes with a relatively slow rotation velocity, the "light-horizon" is nearly constant at that same radius. The "mass-horizon" graphic however moves immediately towards higher radii.

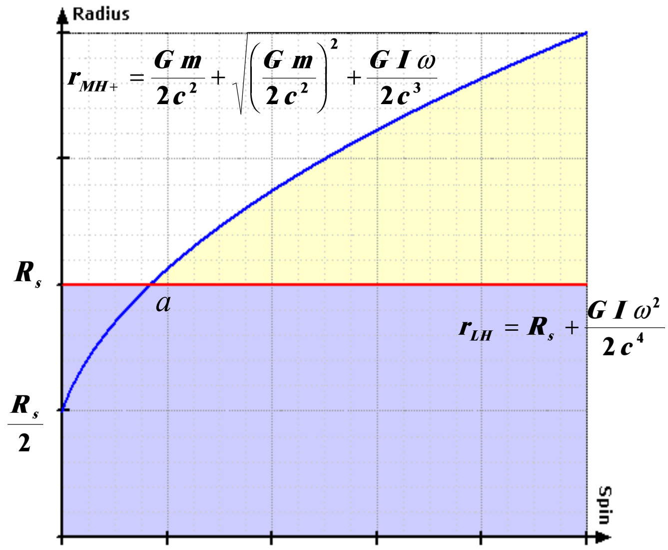


Fig. 4.1

The crossing point a is given by the equity of (1.6) and (2.6) in that point, and by considering that for low spin velocities ω, the second term of (2.6) is negligible. Hence, crossing point a is defined by :

$$\omega << \quad \Rightarrow \quad \omega_a \approx 8\frac{G\,m^2}{I\,c} \quad \wedge \quad r_a \approx R_s \tag{4.2}$$

Remark that beyond the crossing point a of both graphics, the orbiting masses will disintegrate (mass-horizon) even before they come in the light-horizon. Before the crossing point a , the orbit becomes invisible before the disintegration of the mass.

But when strongly zooming out the figure 4.1 for quite high spin velocities, say, millisecond black holes, the light-horizon graphic changes its shape (fig. 4.2).

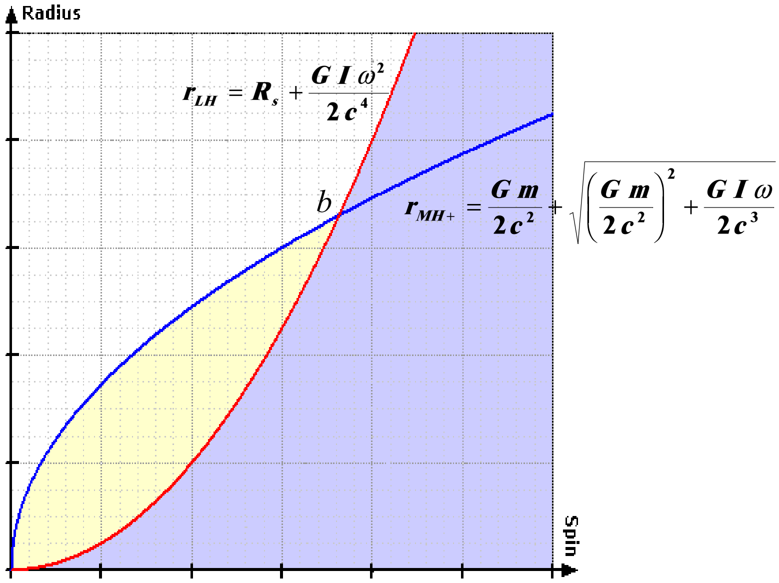


Fig. 4.2

The value of ω and r at the crossing point b also follow from the equity of (1.6) and (2.6) in that point. A simplification of the crossing-point-equation depends however from the values of m , I and ω .

At lower spins than the crossing point b , orbiting masses will disintegrate before they could be invisible. This scenario is valid for a very large range of spinning velocities. Further away from the black hole, beyond the crossing point b , the light-horizon will be attained earlier than the mass-horizon, although it is not known yet if such fast spinning black holes do really exist.

Special cases.

The special cases of chapter 3 concern *pure black holes*, defined by its partial or full obscuration, due to the total bending of the light in an orbit about the black hole. The maximum radius for *pure black holes* is $4/5.R_s$, at equatorial velocities of the speed of light. At zero velocity, still a radius of R_s is needed. Heavier, more compact stars should be *pure black holes* as well. So are the explosion-free spinning stars, which have radii of $\lambda\,R_s\,/\,2$, since it is acceptable that $\lambda \leq 1$.

4. Conclusion.

There exist two types of horizons: the first one is based on the orbital velocities of matter, orbiting at the speed of light, (called: mass-horizon) and the second is based on the bending of light towards a circular orbit (called: light-horizon). Both are purely deducted from the Maxwell Analogy theory for Gravitation.

The mass-horizon type has two mathematical solutions, whereof the one with negative sign very probably represent the inner hole of a toric black hole. This would totally comply with our former paper[8], where I found that fast spinning stars can partially explode, and that they normally end up in torus-shaped black holes. This first type of horizon (mass-horizon) allows me to find a very plausible origin of the gamma bursts which last for several seconds or minutes: the disintegration of mass at the speed of light into gamma rays, which suddenly become then visible to detectors, because the light cannot be bent as much in order to remain captured by the spinning star.

The Kerr metric is almost identical to the MAG mass-horizon, except from the factor two, which looks like being an artifice, in order to get the Schwarzschild radius as a limit for non-rotating black holes.
The MAG light-horizon defines the horizon of black holes in its correct form, as the ultimate circular boundary of visible light about the black hole.

Both horizon types can coexist, but at some very low and very high spin velocities, the light-horizon obscures the mass-horizon, so that even gamma bursts might totally be captured by the spinning black hole, which might hold these bursts invisible, unless they can escape via the poles, as I explained in an earlier paper[8].
Beyond these deductions, the radius of spinning and non-spinning *pure black holes* are found, as a special case of the light-horizon. Finally, the condition for *pure black holes* with continuous compression has been found.

5. References.

1. Feynman, Leighton, Sands, 1963, Feynman Lectures on Physics Vol 2.

2. Heaviside, O., A gravitational and electromagnetic Analogy, Part I, The Electrician, 31, 281-282 (1893)

3. Jefimenko, O., 1991, Causality, Electromagnetic Induction, and Gravitation, (Electret Scientific C^{y}, 2000).

4. Jefimenko, O., 1997, Electromagnetic Retardation and Theory of Relativity, (Electret Scientific C^{y}, 2004).

5. De Mees, T., 2003, A coherent double vector field theory for Gravitation.

6. De Mees, T., 2004, Cassini-Huygens Mission.

7. De Mees, T., 2004, Did Einstein cheat ?

8. De Mees, T., 2005, On the shape of rotary stars and black holes.

9. De Mees, T., 2006, On the orbital velocities nearby rotary stars and black holes

10. www.astro.ku.dk, Kerr Metric