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General Theory of Black Holes (Preliminary Draft)

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I. Introduction: Two-Dimensional Riemann Geometry

a) Euclidean Space

The distance between two points separated in the Cartesian coordinates, (X,Y), by (dX,dY) is,

$$\delta s^2 = dX^2 + dY^2.$$

Transforming to curvilinear coordinates, (u,v), we have,

$$\delta s^2 = \left[\left(\frac{\partial X}{\partial u}\right)^2 + \left(\frac{\partial Y}{\partial u}\right)^2\right] du^2 + 2\left[\frac{\partial X}{\partial u}\frac{\partial X}{\partial v} + \frac{\partial Y}{\partial u}\frac{\partial Y}{\partial v}\right] du dv + \left[\left(\frac{\partial X}{\partial v}\right)^2 + \left(\frac{\partial Y}{\partial v}\right)^2\right] dv^2$$

$$\coloneqq g_{mn} du^m du^n.$$

b) Non-Euclidean Space

Generally speaking, where we call the X_m^r the tetrads, defining the directions δX^r, where now the δX^r are differential forms and not, as in the Euclidean case, exact differentials of quantities, X^r, where,

$$\delta s^2 = \delta X^2 + \delta Y^2 = \delta_{rs} X_m^r X_n^s du^m du^n \coloneqq g_{mn} du^m du^n.$$

The boundary conditions on a real two-dimensional Riemannian space is that the coordinates, (u,v) and the tetrads be real and nonsingular functions, and that g_{mn} be of full rank (rank two).

Moreover, the conditions on the space being extended into a certain region is that the gmn have signature (+1,+1), that is, they are given by the expression implied by the above relation.

Therefore, if we solve the eigenvalue problem, $g_{mn}U^n = \begin{bmatrix}\lambda_1 & 0\\ 0 & \lambda_2\end{bmatrix}\boldsymbol{U}$, and either of the eigenvalues, λn, equals zero, and g_{mn} is of rank one. The corresponding point is a pole of the coordinate system.

For example, in polar coordinates in Euclidean space, $\delta s^2 = dr^2 + r^2 d\theta^2$, and the eigenvalues of gmn are 1 and r^2. When $r^2=0$ (or $r=0$), that is the origin of coordinates is a pole of the coordinate system. No one has ever suggested that the space could be extended into regions below $r=0$ where r was imaginary and the signature of gmn was (+1,-1) and θ was in some sense time-like. No one has ever even suggested that regions where r was real and < 0 exist (even though the signature of g_{mn} would remain (+1,+1)). *Any* pole of the coordinate system—defined by one of the eigenvalues being zero—is similar to this elementary pole: it represents a terminus of the coordinate system. (By the way, of course we are *not* using the word "pole" in the sense of the theory of functions of a complex variable, that is, as an infinity of a function asymptotically equal to some negative integral power of z, but in the sense of "the North Pole.") Some coordinate systems (exempli gratia, Cartesian coordinates in a Euclidean space) do not have any poles, while others (polar coordinate system on a Euclidean plane or the axis of spherical polar coordinates in Euclidean space or the latitude-longitude coordinate system on a spherical surface) do. Everyone understands this in the context of ordinary geometry, but the mainstream scientific community seems to be confused about this in the context of general relativity and space-time geometry, as we will examine at greater length below.

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By the way: the resolution, $\delta s^2=\delta X^2+\delta Y^2$, for a general Riemannian space is correct, because Riemann assumed that at any point, g_{mn} could be locally transformed to the form δ_{mn} by a coordinate transformation.

Note: in this paper, our practice is to denote exact differentials by the symbol "d" and differential forms by the symbol "δ." Thus, an exact differential, df, can be integrated to give a well-defined function of the coordinates, f(u,v), which is not path-dependent, while integrating a differential form, δf, would generally yield a result dependent upon the path, C, between the endpoints $(u_0,v_0),(u_1,v_1)$. Thus, for example, we denote the spatial distance differential by δs rather than ds because the distance between two points was proven by Euclid to be path dependent: the distance between two vertices, A, B, of a triangle ABC is always shorter if we go directly along the line connecting A and B than if we take the route from A to B through C—something that Epicurus said Euclid hadn't needed to "prove" because this fact was known already to an ass. Place an ass at point A, some fodder at point B, and when the ass becomes hungry, he will not proceed along the route through C!

c) *Relativistic Space-Time*

Here, we must have the space-time metric, $G_{\mu\nu}$, resolvable into the form $\eta_{\rho\sigma}X^{\rho}_{\mu}X^{\sigma}_{\nu}$, where the tetrads, X^{ρ}_{μ}, and the coordinates, u^{μ}, are real and non-singular, and,

$$\eta_{\rho\sigma} := \begin{bmatrix} -\delta_{mn} & 0 \\ 0 & c^2 \end{bmatrix},$$

that is, $G_{\mu\nu}$ must possess signature (-1,-1,-1,+1), and points where its signature degenerates into, for example, (-1,-1,-1,0) (where one of the eigenvalues of $G_{\mu\nu}$ becomes zero) are poles of the coordinate system, not regions of transition to realms in which $G_{\mu\nu}$ has the signature, for example, (-1,-1,-1,-1) and the time variable becomes somehow spacelike, or signature (-1-1,+1,-1), where the rôles of space and time are mysteriously reversed and exotic physical effects occur.

II. Schwarzschild Point Mass Solution [Schwarzschild, *Sitzungsberichte*, 1916, p. 313]

The space-time line element is given as,

$$\delta\sigma^2 = c^2(1-2GM/c^2\hat{r})(du^0)^2 - \frac{d\hat{r}^2}{1-2GM/c^2\hat{r}} - \hat{r}^2 d\theta^2 - \hat{r}^2 sin^2\theta d\varphi^2,$$

where we have denoted by the symbol $\hat{r}$ what Schwarzschild denoted by r, reserving the symbol r for the radial distance from the point mass singularity at the origin,

$$r = \int \frac{d\hat{r}}{\sqrt{1-2GM/c^2\hat{r}}} = \int \frac{\sqrt{\hat{r}}d\hat{r}}{\sqrt{\hat{r}-2GM/c^2}},$$

which is an elementary quadrature that can be looked up in standard tables.

One eigenvalue of $G_{\mu\nu}$ is G_{00}, which equals zero when $r{*}=2GMc^2$. This is therefore a pole of the coordinate system, the origin of coordinates, and not a surface at some remove from the physical mass-point singularity at the origin, but coincident with it. There is no space-time in the region $\hat{r}<2GMc^2$ - no baby universes, time warps, multiverse or any other such stupidities. The point $\hat{r}=2GMc^2$ is a pole of the coordinate system coincident with and identical with the point $r=0$. The relationship between $\hat{r}$ and r is that of a coordinate transformation. There is no region in real space-time corresponding to $0\leq\hat{r}\leq 2GMc^2$, nothing lying below the point $\hat{r}=2GMc^2$ any more than there is a region $r<0$ below the pole of the polar coordinates of the ordinary two-dimensional Euclidean plane. I appear to be the first person with a clear understanding of this trivial fact, amazingly enough, after 109 years of research by supposedly brilliant minds.

There are other poles at $\hat{r}^2=0$ and $\hat{r}^2 sin^2\theta=0$; that is, $\hat{r}=0$ and $\theta=0,\pi$. The one at $\hat{r}=0$ is superceded by the one at $\hat{r}=2GMc^2$; that is, it is never realized because there is no space below the pole at $\hat{r}=2GMc^2$.

Writing,

$$r = \int_{2GM/c^2}^{\hat{r}} \frac{\sqrt{r'}dr'}{\sqrt{r'-2GM/c^2}},$$

we see that the point $\hat{r} = 2GMc^2$ is coincident with the origin, r = 0—just another coordinate representation of the origin.

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The function r(r̂), or its inverse r̂(r), defined by the relation (1) is just a coordinate transformation between r and r̂ and the point a the origin can be equivalently represented by the equation r = 0 or r̂ = $2GMc^2$—it is the same point, just by two different names.

Moreover, interpreting the equation of motion of a particle subject only to gravity,

$$\ddot{u}^{\mu} + \Gamma^{\mu}_{\rho\sigma}\dot{u}^{\rho}\dot{u}^{\sigma} = 0,$$

we see that it is appropriate to define the gravitational field strength as $g^m = -\Gamma^m_{00}$, which in this case leads to $g^1 = -\frac{c^2\partial G_{00}/\partial r}{2G_{00}}$. This can be seen to lead to the correct Newtonian Limit ($c\rightarrow\infty$). Then at the point where G_{00}=0 we see that the gravitational field strength becomes infinite—another impossibility.
Moreover, there is the following curious effect of the singularities at the origin, r = 0, r̂ = 2GM/c^2:-

The radius of the point is zero, but the equatorial circumference, $\int_0^{2\pi} \hat{r} d\varphi = 4GM/c^2$, is finite. Not only is there a singularity in the gravitational field strength here, but—more relevantly, there is a singularity in the spatial Ricci curvature, a singularity in the structure of space itself (this is due to the fact that the density is a Dirac delta function, infinite at the origin and zero everywhere else; calculations of my own indicate that the spatial Ricci curvature of a static, rotationally symmetric solution of the Einstein Field Equations is $16\pi G\rho/c^2$. This calculation is confirmed by Schwarzschild's result that the spatial radius of curvature of the distributed mass solution [dicussed in section III, below. It corresponds to the section of a hypersphere.] is $R = \sqrt{3c^2/8\pi G\rho}$, while the Ricci curvature [the contraction of the spatial Ricci tensor, that is the Ricci tensor calculated with the spatial metric rather than the space-time metric] is $6/R^2$).

Point particles simply cannot occur in Nature—not only do they introduce infinities in the gravitational and electromagnetic field strengths, but, as we see here, they also introduce singularities into the very structure of space. And, any particle has a gravitational field, described by general relativity, even if it may be of small enough magnitude that it may be ignored in practical calculations.

It is well known, for example, that if we attribute a finite, non-zero radius to the electron, the renormalization infinities appearing in quantum electrodynamics disappear because it introduces an upper energy cutoff (caused by the uncertainty principle: a small, nonzero, Δr leads to a large Δp_r in the momentum, and therefore a related one in the energy) in the relevant energy integrals.

Point particles do not occur in Nature, categorically. End of story. They exist only as mathematical abstractions, and even that leads to difficulties, as we see here. Let us therefore banish the use of them from fundamental theories! This means that even elementary quantum mechanics needs to be repurposed (the particles are point particles; it is only their probability distribution, $|\psi(\boldsymbol{x},t)|^2$, that has a finite Δx).

Therefore, the mainstream picture of what a point-mass black hole is has been completely transformed with a few strokes of the pen, and much of what has been written on this subject has been shown to be rubbish. There are no event horizons, baby universes, time warps or multiverse. The eminent scientists who promulgated this sort of garbage (and we know who their names are!), really should have exhibited a little more common sense. I always have—I have been posting articles online for years stating my suspicions that there are no true black holes in Nature. It is only now that I can defend my opinions against those with the most esteemed of credentials with rigorous theoretical arguments.

III. Schwarzschild Distributed Mass Black Hole or Star [Schwarzschild, *Sitzungsberichte*, 1916, p. 424].

Introduction:

Of course, there are no point masses or singularities in Nature, so rather than the theory of § II, we must use for a more realistic model of a star a distributed mass of finite density and size that contains no singularities.

In 1916, Schwarzschild found such a solution of the Einstein Field Equations corresponding to the section of a hypersphere of radius of curvature $R = \sqrt{3c^2/8\pi G\rho}$ (where ρ is the density of a star, taken to be, for the purposes of modeling, which is at least qualitatively valid, an incompressible perfect fluid) of radius r_a.

The space-time line element for this solution is,

$$\delta\sigma^2 = c^2\left(\frac{3cos\chi_a - cos\chi}{2}\right)^2 - R^2 d\chi^2 - R^2 sin^2\chi d\theta^2 - R^2 sin^2\chi sin^2\theta d\varphi^2,$$

where χ_a is a parameter defining the surface of the star.
The poles of the hypersphere are defined by $sin^2\chi = 0$ and $sin^2\theta = 0$, or $\chi = 0, \pi$; $\theta = 0, \pi$.
In this case, from $dr = Rd\chi$, we have, $r = R\chi$ and $r_a = R\chi_a$.

Therefore, in this case, we have the following picture: the star is represented by density ρ on the "polecap" of the hypersphere of radius R (actually, πR; that is, more precisely, because $r=R\chi$ and χ extends from 0 to π, r extends from 0 to πR) from $\chi=0$ to $\chi=\chi_a:=r_a/R$, while the outer vacuum solution is found by fitting this solution to the appropriate Schwarzschild vacuum solution (point mass solution outside the ball $r\geq r_a$, with M appropriately chosen to satisfy the boundary conditions [in general, *not* the mass of the star]).

If $\chi a=cos^{-1}(1/3)$ then $G_{00}=0$ at $\chi=0$, which is the pole of the coordinate system. It is also a point where the gravitational field strength $(-\frac{c^2\partial G_{00}/\partial r}{2G_{00}})$ becomes infinite. This can never occur; therefore, we have the restriction $cos\chi_a>1/3$, or $\chi_a<cos^{-1}(1/3)\sim1.23$, which is a *strict* inequality.

This much was completely understood by Schwarzschild in 1916. His only error was his interpretation of the point mass solution, which I have corrected above.

The mystique vis-á-vis "black holes" remains—to this day—centered on Schwarzschild's incorrect interpretation of the point mass solution. I repeat: there are no event horizons or black holes in the original sense of the term (as something possessing an event horizon). What was imaged in 2019 would, more properly, be called a supermassive dead star.

IV. The Kerr Problem: Rotating Stars. [Reference: Mike Guidry, "Modern General Relativity," Cambridge University Press (2019)]

Many authors (including Guidry) make the erroneous assumption that $g_{mn}=-G_{mn}$, but according to a formula of Tolman ["Relativity, Thermodynamics and Cosmology," Clarendon Press, 1934],

$$g_{mn} = -G_{mn} + \frac{G_{0m}G_{0n}}{G_{00}}.$$

If, based upon this formula applied to the Kerr space-time metric, we calculate the eigenvalues of $G_{\mu\nu}$, we find that they are $(-g_{mn}, G_{00})$.

The pole that we are principally interested in is represented by $G_{00}=0$, the ergosphere. Nothing lies below this point (it is a point, not a surface, just as is the case for the point $r*=2GM/c^2$ in the Schwarzschild point mass solution—and it is unattainable, the gravitational field strength being infinite there by very reason of $G_{00}=0$).

Calculating g_{33} on the ergosphere, we find that it is infinite: the radius of this point is zero, but its equatorial circumference is infinite, while its polar circumference is finite and non-zero! Certainly, a curious mix!

Of course, this represents an unphysical singularity in the structure of space, indicating once again that point particles do not occur in Nature, nor even in an acceptable fundamental theory.
What we need is, of course, a distributed mass, rotating star solution. This remains unavailable to this day.

I think that it is a fair bet that if an analytic solution to this problem existed, it would have already been found—it's been about 62 years since Kerr found his solution.

Therefore, numerical methods/machine computation is probably a necessary approach for this problem, and with that, a solution would be trivial and should be forthcoming shortly (if anyone cares to follow my advice).

Because all supermassive dead stars observed to date have been rotating, this calculation would give refined values of the estimates of their masses.

V. Conclusion

I have been studying black hole theory for many years, finding irregularities now and then, here and there along the way. This month what happened was that I began to understand what I had been doing in bits and pieces, but now I understood it all comprehensively—and a new gestalt formed in my mind. That is what has been accomplished in this paper: the description of a new gestalt, replacing the one that Schwarzschild (erroneously) formed in 1916.

I now understand consciously what I had been saying all along: that there are no event horizons or black holes (in the sense of an object possessing an event horizon), just supermassive dead black stars. No baby universes, time warps, multiverse—in short, no psychotic fantasies.

It took many years to form this gestalt, but when it came together at last, it formed suddenly—like a bolt from the blue. But this was a process having roots going back some thirty years (that is when I first began to seriously investigate the nature of *time* in relativity. My explicit study of black hole theory, motivated by this investigation, began many years later.)

The most difficult object of the subconscious to disinter is an assumption that we do not even realize we are making—a subliminal assumption, as it were—particularly when its truth is being asserted by all the leading authorities. Who was an ordinary mortal such as myself to go against all *that*?

Psychological experiments have shown that, when presented with two straight lines of obviously unequal length, an individual, who has heard everyone else in the room assert that they are of equal length, will very likely affirm that, yes, they are of equal length, and not merely affirm it, but in fact *perceive* it.

It took me thirty years to come to my senses, and today I shout the obvious: "The Emperor has no clothes!"