Black Holes Follow From Newton's Gravitation Alone, Not From the Paradoxical Schwarzschild Metric of General Relativity

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Abstract: A black hole is a supermassive star whose gravitational field is so strong that light cannot escape from it.

Such stars were explained in 1784 by Michell, and in 1796 by Laplace

The path of an escaping photon, will curve, and end up in the ball.

That picture was compatible with Newton's belief that light is made of particles.

Then, light diffraction contradicted the particle nature of light, and discredited the 18th century discovery of black hole.

Now, that the quantum nature of light is well-known, the concept

of a black hole follows directly from Newton's Gravity.

It does not need General Relativity. And it does not confirm it.

Moreover, Schwarzschild attempt to relate Black Holes to General Relativity demonstrates a deficiency of General Relativity

The Schwarzschild Time-Radial distance is

$$(ds)^2 \approx -(1 - \frac{R_G}{R})(cdt)^2 + \frac{1}{1 - \frac{R_G}{R}}(dR)^2 .$$

The Schwarzschild Metric singularity at $R \approx R_G$ renders it meaningless, and points to a fundamental flaw in General Relativity.

The deduction of a Black Hole from the time component of the Schwarzschild metric does not resolve the question of what is happening with the radial component of the metric.

The singularity is referred to as "spurious singularity", is described as "pseudo-singularity", as if name calling can give credibility to division by zero, and make it comprehensible

In conclusion, Schwarzschild did not re-discover black holes. These supermassive object are predicted from Newton's Gravity, and do not confirm General Relativity.

Schwarzschild attempt to derive black holes from General Relativity, only reveals a paradox in that theory.

Keywords: Black Holes, Newton Gravity, Escape speed, Gravity Radius, Lorentz Transformation, Schwarzschild Metric, General Relativity, Red Shift, Schwarzschild singularity,

Physics & Astronomy Classification Scheme: **97.60.Lf**, ***04.70.-s***

Contents

1.

Black Holes in Newton's Gravity

A black hole is a supermassive star whose gravitational field is so strong that light cannot escape from it.

Such objects were presented in 1784 by Michell, and in 1796 by Laplace

A mass m at distance R from a mass M has the gravitational energy

$$G\frac{Mm}{R}.$$

If m moves at speed v, its kinetic energy is

$$\frac{1}{2}mv^2.$$

To escape the gravitational attraction of M, the kinetic energy of m has to be greater than its gravitational energy. That is,

$$\frac{1}{2}\cancel{m}v^2 > G\frac{M\cancel{m}}{R}$$

Thus, at speed

$$v > \sqrt{2G\frac{M}{R}}$$

m will escape the gravitational attraction of M.

A photon cannot escape the gravitation of M if

$$c < \sqrt{2G\frac{M}{R}}.$$

That is, if M is in a ball of **Gravity Radius**

$$R_{gravity} = 2G\frac{M}{c^2},$$

light will stay in the ball.

The path of an escaping photon, will curve, and end up in the ball.

That picture, which suits our perception of a photon, was compatible with Newton's belief that light is made of particles.

Then, light diffraction contradicted the particle nature of light, and discredited the 18th century discovery of black hole.

Now, that the quantum nature of light is well-known, the concept of a black hole follows directly from Newton's Gravity.

It does not need General Relativity. Hence, it does not confirm General Relativity.

In fact, Schwarzschild attempt to relate Black Holes to General Relativity demonstrates a deficiency of General Relativity

2.

The Schwarzschild Metric

In 1916, Schwarzschild believed that he obtained the gravity radius of a black hole by using a space-time metric in spherical coordinates

$$(ds)^2 = -(cdt)^2 + (dR)^2 + (Rd\theta)^2 + (R\sin\theta d\phi)^2 .$$

If there is no change in the angles θ, and ϕ, this reduces to

$$(ds)^2 = -(cdt)^2 + (dR)^2 .$$

In a coordinate system Σ_0, with time t_0, and radial distance R_0,

$$(ds_0)^2 = -(cdt_0)^2 + (dR_0)^2$$

We will show that under gravity, this transforms to the so called Schwarzschild space-time metric

$$(ds)^2 = -(1 - \frac{R_G}{R})(cdt)^2 + \frac{1}{1 - \frac{R_G}{R}}(dR)^2$$

At $R = R_G$, this differential form is singular, and leads to no meaningful conclusions.

To eliminate its cover-up with tensors, and churned equations. we give an elementary derivation of this form:

3.

Time Transformation Under The Schwarzschild Metric

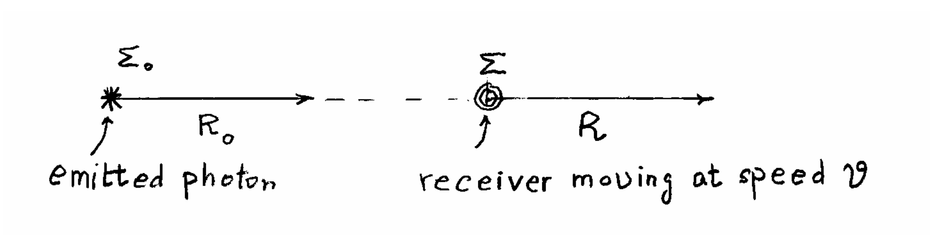
3.1 Doppler Shift of Light to the Red

If a photon emitted with frequency

$$\nu_0,$$

is detected by a receiver that moves at speed

$$v,$$



The frequency received is shifted to the red, and by [Woan, p.65]

$$\frac{\nu}{\nu_0} = \frac{1}{\sqrt{1 - \frac{v^2}{c^2}}}(1 - \frac{v}{c}).$$

For $v \ll c$,

$$\sqrt{1 - \frac{v^2}{c^2}} \approx 1,$$

and

$$\frac{\nu}{\nu_0} \approx 1 - \frac{v}{c}.$$

$$\boxed{\nu \approx \nu_0(1 - \frac{v}{c})}$$

That is, the frequency at the receiver is lower, shifted to the red.

3.2 Gravity Shift of Light to the Red

Suppose that the emitted photon is moving away from a Mass

$$M.$$

A receiver at distance

$$R,$$

is attracted to M by the force

$$G\frac{M}{R^2} \times (\text{receiver's mass})$$

That is, the receiver accelerates towards M with

$$a = G\frac{M}{R^2} \quad \text{m/sec}^2$$

The photon crosses the distance R in time

$$\frac{R}{c} \text{ sec}$$

If the receiver falls on M, its speed after time $\frac{R}{c}$ is

$$v = a\frac{R}{c} = G\frac{M}{R^2}\frac{R}{c} = G\frac{M}{Rc} \quad \text{m/sec.}$$

At the moving receiver the emitted photon's frequency is

$$\nu_0 .$$

Relative to the moving receiver, a receiver at the distance R, is moving away, at speed

$$v = G\frac{M}{Rc}$$

from a photon emitted with frequency

$$\nu_0 .$$

At that receiver, the photon has frequency

$$\nu ,$$

By Doppler effect,

$$\frac{\nu}{\nu_0} \approx 1 - \frac{v}{c}$$

$$= 1 - \frac{G\frac{M}{Rc}}{c}$$

$$\frac{\nu}{\nu_0} \approx 1 - \frac{GM}{Rc^2}$$

$$\boxed{\nu \approx \nu_0(1 - \frac{GM}{Rc^2})}$$

Thus, gravity shifts the frequency at the receiver to the red.

3.3 Gravity Slows Time

For the wave associated with a photon,

$$\frac{c}{\nu} = \lambda = cT \Rightarrow \nu = \frac{1}{T}$$

Therefore,

$$1 - \frac{GM}{Rc^2} \approx \frac{\nu}{\nu_0} = \frac{\frac{1}{T}}{\frac{1}{T_0}} = \frac{T_0}{T} = \frac{\Delta t_0}{\Delta t}$$

$$\boxed{\Delta t \approx \frac{\Delta t_0}{1 - \frac{GM}{Rc^2}}}$$

That is,

$$\text{for } R \approx \infty,\ \Delta t \approx \Delta t_0,$$

$$\text{for } R \approx \frac{GM}{c^2},\ \Delta t \approx \infty$$

3.4 $(cdt_0)^2$ Transformation Under the Schwarzschild Metric

$$(cdt_0)^2 \approx (1 - \frac{GM}{Rc^2})^2 (cdt)^2$$

$$= (1 - 2\frac{GM}{Rc^2} + \frac{G^2M^2}{R^2c^4})(cdt)^2$$

$$\approx (1 - 2\frac{GM}{Rc^2})(cdt)^2$$

Hence,

$$(cdt_0)^2 \approx (1 - 2\frac{GM}{Rc^2})(cdt)^2$$

That is,

$$dt \approx \frac{dt_0}{\sqrt{1 - 2\frac{GM}{Rc^2}}}$$

$$\boxed{dt \approx \frac{dt_0}{\sqrt{1 - \frac{R_G}{R}}}}.$$

Thus, for $R \approx R_G$, a photon stays forever in the ball of mass M, and never comes out.

This made Schwarzschild believe that his metric described a black hole.

In fact, the Radial-distance part of the Schwarzschild metric blows up at the Gravity radius R_G, rendering the Schwarzschild metric hopelessly incomprehensible, and the Black Hole discovery based on it, totally meaningless.

4.

Radial Distance Transformation Under The Schwarzschild Metric

In the spherical coordinates, ct, and R,

$$(ds_0)^2 = -(cdt_0)^2 + (dR_0)^2$$

Under Lorentz Transformation,

$$\begin{pmatrix} dR \\ cdt \end{pmatrix} = \frac{1}{\sqrt{1-\frac{v^2}{c^2}}}\begin{bmatrix} 1 & -\frac{v}{c} \\ -\frac{v}{c} & 1 \end{bmatrix}\begin{pmatrix} dR_0 \\ cdt_0 \end{pmatrix} = \frac{1}{\sqrt{1-\frac{v^2}{c^2}}}\begin{bmatrix} dR_0 - vdt_0 \\ -\frac{v}{c}dR_0 + cdt_0 \end{bmatrix}.$$

Then,

$$(dR)^2 - c^2(dt)^2 = \frac{1}{1-\frac{v^2}{c^2}}[(dR_0 - vdt_0)^2 - (-\frac{v}{c}dR_0 + cdt_0)^2]$$

$$= \frac{1}{1-\frac{v^2}{c^2}}\left[(1-\frac{v^2}{c^2})(dR_0)^2 - \frac{(c^2-v^2)}{c^2}c^2(dt_0)^2\right]$$

$$= (dR_0)^2 - (cdt_0)^2$$

Thus, the Lorentz Matrix is a space-time rotation. That is, its determinant equals 1.

General Relativity replaces the Lorentz transformation with a <u>diagonal</u> matrix

$$\begin{bmatrix} -g_{tt} & 0 \\ 0 & g_{RR} \end{bmatrix},$$

so that

$$(ds)^2 = (cdt, dR)\begin{bmatrix} -g_{tt} & 0 \\ 0 & g_{RR} \end{bmatrix}\begin{pmatrix} cdt \\ dR \end{pmatrix}.$$

The diagonal matrix is required to be a rotation. That is,

$$\underbrace{\det\begin{bmatrix} -g_{tt} & 0 \\ 0 & g_{RR} \end{bmatrix}}_{-g_{tt}g_{RR}} = 1$$

Since

$$-g_{tt} \approx 1 - \frac{R_G}{R},$$

we have

$$g_{RR} = \frac{1}{-g_{tt}} \approx \frac{1}{1 - \frac{R_G}{R}}.$$

This means that

$$\boxed{dR \approx \sqrt{1 - \frac{R_G}{R}}\, dR_0}$$

5.

The Paradoxical Schwarzschild Metric

The Schwarzschild Time-Radial distance is

$$(ds)^2 \approx -(1 - \frac{R_G}{R})(cdt)^2 + \frac{1}{1 - \frac{R_G}{R}}(dR)^2 .$$

This Time-Radial distance is invariant because substitution of

$$dt \approx \frac{dt_0}{\sqrt{1 - \frac{R_G}{R}}},$$

$$dR \approx \sqrt{1 - \frac{R_G}{R}} dR_0,$$

gives

$$(ds)^2 \approx -(cdt_0)^2 + (dR_0)^2$$

In [Dan], we have shown that the Lorentz transformation is the only linear coordinate transformation under which Space-time distance is invariant.

The Schwarzschild Metric is not linear, and preserves the Time-Radial distance.

But its singularity at $R \approx R_G$ renders it meaningless, and points to a fundamental flaw in General Relativity.

The deduction of a Black Hole from the time component of the Schwarzschild metric does not resolve the question of what is happening with the radial component of the metric.

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References

[Adler] Ronald Adler, Maurice Bazin, Menahem Schiffer, "*Introduction to General Relativity*" McGraw Hill, Second Edition, 1975

[Chandrasekhar] S. Chandrasekhar, "*The Mathematical Theory of Black Holes*", Oxford University press, 1983.

[Dannon] H. Vic Dannon, "*The Invariance of the Energy-Momentum Under the Lorentz Transformation*", Gauge Institute Journal of Math and Physics, Vol. 14, No. 4, November 2018

[Ohanian] Hans Ohanian, Remo Ruffini, "*Gravitation and SpaceTime*", Second Edition, Norton, 1994

[Schutz] Bernard Schutz, "*Gravity from the Ground Up*" Cambridge University Press, 2003

[Shapiro] Stuart Shapiro, Saul Teukolsky, "*Black Holes, White Dwarfs, and Neutron Stars, The Physics of Compact Objects*", Wiley, 1983

[Woan] Graham Woan, "*The Cambridge Handbook of Physics Formulas*", Cambridge University Press, 2000.