Black Holes – Fact or Fiction?

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By using mundane *static* concepts of “mass” and “gravity field” energies, it is shown that: (1) Schwarzschild’s criterion for black hole formation translates into a critical *ratio* of mass energy to gravity field energy ~rn/gF < 4; (2) Five objections to black holes are: (a) The scape velocity equation does not apply to light, (b) Curved space-time is a geometrical-physical delusion, (c) Curved space-time is incompatible with both the Lorentz transforms and pure mathematics, (d) The Doppler effect proves light is not affected by the space-time continuum, and (e) Kirchhoffs law for black body radiation is violated; (3) The Planck particle and our Universe are incompatible concepts.

Symbols & Units

E = Electrical Force Field Intensity
R = Radius
r = Distance
f = Force
m = Gravitational Mass
$\mathcal{G}_F$ = Gravitational Force Constant
g = Gravitational Force Field Intensity
U = Energy
K_m = Universal Mass Constant
u = Energy Density
c = Speed of Light
ε_e = Electrical Permittivity
ρ = Volume Density

Introduction

It is alleged that, when a star burns out, gravitational forces will cause it to shrink until the surface escape velocity equals the speed of light c, at which point the star becomes a “black hole”. This tract examines black holes by considering simply some basic static aspects of gravitational mass, *per se*.

Mathematical Formulation

1. Kibble[1] demonstrated the following correlation between the *static* electrical force field intensity **E** and the *static* gravitational force field intensity g.

$$\nabla \cdot \mathbf{E} = \frac{\rho_q}{\varepsilon_e} \quad \text{and} \quad \nabla \cdot \mathbf{g} = -4\pi \mathcal{G}_F \rho_m \tag{1}$$

where $\rho_{q/m}$ = charge/mass density, $\mathcal{G}_F$ = universal gravitational constant and ε_e = permittivity of the electrical force field.

2. One could argue that the equation giving the energy density for the gravitational force field u_{gF} is analogous to that for the electrical force field (*cf*. Stratton[2]); *viz.*,

$$u_{eF} = \frac{1}{2}\varepsilon_e \mathbf{E}^2 \quad \text{so} \quad u_{gF} = \frac{1}{2}\left(4\pi\mathcal{G}_F\right)^{-1}\mathbf{g}^2 \tag{2}$$

And assuming a spherical body of mass (m) having a uniform density *(ρ_m)* and radius (R_m), it follows that the total energy stored in the gravitational force field will be

$$U_{gF} = \frac{m^2 \mathcal{G}_F}{2R_m} . \tag{3}$$

Some Basic Static Aspects of Gravitational Mass

3. Associated with every body of mass *at rest* are two, and only two, energies: (a) a mass self-energy, U_m, and (b) the energy in its gravity force field, U_{gF}, and for a spherical body; *cf*. Eq. (3).

$$U_m = mc^2 \text{ and } U_{gF} = \frac{m^2 \mathcal{G}_F}{2R_m} \tag{4}$$

This is true for every spherical body of mass, subatomic to astronomic in size. Setting $U_m = U_{gF}$ yields

$$mc^2 = \frac{m^2 \mathcal{G}_F}{2R_m} \text{ or } \frac{m}{R_m} = \frac{2c^2}{\mathcal{G}_F} = K_m \tag{5}$$

Since it is known that the ratio m/R_m is *not* constant, Equation (5) is absurd, and *the mass energy cannot be equated to the gravity field energy*, $U_m \neq U_{gF}$.

4. However, the *ratio* of the mass energy to the gravity field energy, $\mathcal{R}_{m/gF}$, yields:

$$\mathcal{R}_{m/gF} = \frac{U_m}{U_{gF}} = \frac{2c^2}{\mathcal{G}_F}\left(\frac{R_m}{m}\right) = K_m\left(\frac{R_m}{m}\right), \tag{6}$$

where

$$K_m = \frac{2c^2}{\mathcal{G}_F} = 2.6928 \times 10^{27} \text{ kg/m} \tag{7}$$

Thus, there is a linear relationship between $\mathcal{R}_{m/gF}$ and the ratio of R_m to m that applies to any and all spherical masses in the Universe. This universal constant for gravitational mass K_m will appear later in the formulae for the Schwarzchild radius and Planck mass, length and time, Equations (12), (16), (17) & (18).

5. For a spherical body having an average mass density ρ_m,

$$m = \frac{4}{3}\pi\rho_m R_m^3 \text{ and } \mathcal{R}_{m/gF} = \frac{2K_m}{4\pi\rho_m | R_m^2} \tag{8}$$

so

$$\rho_m = \frac{3}{4\pi} R_m^{-2} \left(\frac{R_m}{m}\right)^{-1} \approx \frac{K_m}{4R_m^2 \mathcal{R}_{m/gF}} \tag{9}$$

Black Hole Theory

6. It is well known that the velocity of escape from the gravitational field of a spherical body having a mass m and a radius R_m is

$$v_{esc} = \left(\frac{2m\mathcal{G}_F}{R_m}\right)^{1/2} \tag{11}$$

Schwarzschild substituted the speed of light c into this equation to obtain his so-called "critical radius" for black hole formation.

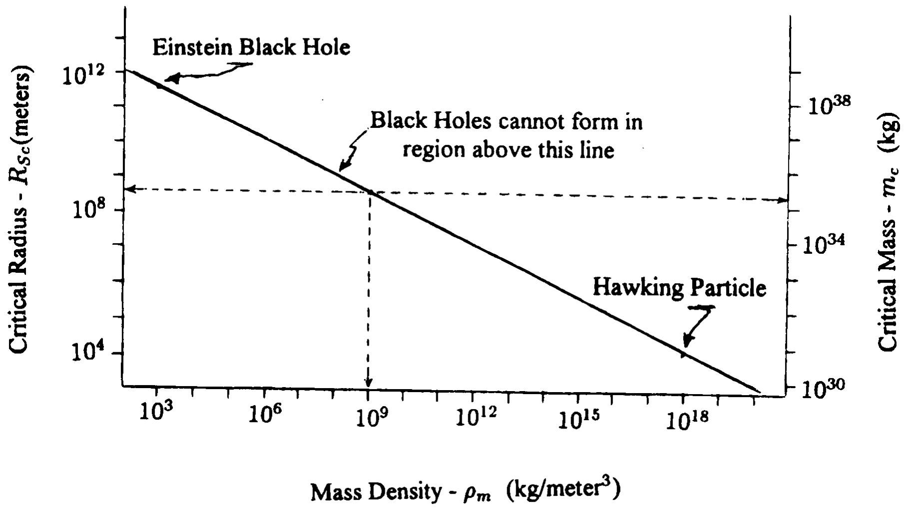

Figure 1 - Critical mass m_c, and radius R_{Sc} for black hole formation, spherical body having mass density ρ_m. Example: for $\rho_m = 10^9$, $m_c = 2.77 \times 10^{25}$ and $R_c = 4 \times 10^8$ (based upon the Schwarzschild criterion).

$$R_S \leq \frac{2m\mathcal{G}_F}{c^2} = \frac{4m}{K_m} \text{ or } \left(\frac{R_S}{m}\right) \leq \frac{4}{K_m} \tag{12}$$

Yet Schwarzschild's criterion is, strictly speaking, not a "critical radius" but a "critical ratio of radius to mass", which , according to Equation (6) translates into a "critical ratio of mass energy to gravity field energy"; *viz.,*

$$\mathcal{R}_{m/gF} \leq 4 \tag{13}$$

When this criterion is met, presumably, that body would attract all objects (including photons). Certainly it would capture any mass particles that approached its surface, but massless particles are something else.

7. Substituting Equations (12) and (13) into Equation (9) yields the critical relationship between mass and mass density; *viz.,*

$$\left(m^2\rho_m\right)_c \geq \frac{3K_m^3}{256\pi} \tag{14}$$

and with this, Equation (12) may be rewritten as

$$\left(R_S^2\rho_m\right)_c \geq \frac{3K_m^3}{16\pi} \tag{15}$$

Using Equations (14) and (15) the curve in Figure I was plotted. It shows the critical values for mass m_c and radius R_{Sc} for black hole formation for a given mass density. In the region under this curve $\mathcal{R}_{m/gF} < 4$ so such a body of mass would, presumably, be a black hole. For nuclear mass ($\rho_m \sim 10^{18}$ kg/m^3) the critical radius is roughiy 10^4 m and the critical mass nearly 6×10^{30} kg or three times that of the Sun. (This is plotted on the curve as the Hawking particle.) For atomic mass ($\rho_m \sim 10^3$ kg/m3) the critical radius and mass are $\sim 10^{11}$ m and $\sim 10^{38}$ kg, respectively. (This is shown as the Einstein black hole.) However, such a large body of mass would shrink due to the enormous pressure exerted on the atoms near its center, thus decreasing the ratio of radius to mass and increasing the mass density. Perhaps it would become a star. (*The reader is reminded that this is a treatment solely of the static aspects of mass and gravity fields*.)

8. Black hole enthusiasts insist that (a) the high concentration of mass in a black hole causes curvature of the surrounding space and (b) light energy from outside sources will propagate along these curves and be captured. As for light from within a black hole, well it would somehow remain inside. The objections to this scenario are fivefold:

Objection I - Equation (11), which Schwarzschild relied upon, was derived using Newton's law for gravity plus the kinetic energy of the escaping mass. Even though the escape velocity is independent of the mass of the escaping object, *Equation (11) does not apply to massless particles (light energy)*. And irrespective of this space curvature, light energy from within the black hole would not be restrained by any force related to gravitational mass but would be radiated outward along these same curved paths.

Objection II - The scenario for black holes is based upon a mysterious space-time medium, *sans physical matter*, but nevertheless capable of interacting with gravitational mass. How odd! It defies all logic and common sense. Anyhow, Roxburgh[3] analyzed this question of curved space and concluded that it had "no place in physical inquiry." He argued that (a) all space measurements give only the relationship between objects in space and not space, *per se*, and (b) "curved space time" is purely a "mathematical representation" and *not* "something intrinsic to the world". Roxburgh insisted that "*the physical world is no more German because Einstein expressed his theory in German than it is curved because he expressed it in curved space-time*." The simple fact is that space curvature finds its genesis in a mathematical artifice based upon the *postulate* that "mass causes curvature" as opposed to the *fact* that "mass causes gravity fields". Some major problems with curved space are: (a) It violates Euclid's axiom for parallel lines. (b) It treats infinity as if it were a real number, which it certainly is not. (c) It is incompatible with the geometric theorem for the sum of the angles of a triangle. (d) It does not allow for straight lines, rectangles and circles. (e) It violates the continuity axioms of both Eudoxus and Cantor, which are the *sine qua non* for valid mathematics. (f) It precludes the existence of irrational numbers. and (g) It has no place for transendental functions. (*cf*. Campbell[4]) Therefore, *curved space-time is not a mathematics of exactness but a geometrical-physical delusion*.

Objection III - The Xus[5] demonstrated that *the invariant geometric line element of General Relativity is logically inconsistent with the Lorentz transforms (LT)*. However, the LT have been proven to be valid using pure mathematics; *viz.*, Doppler's principle for wave motion plus the kinematic axiom for the reciprocity of relative motion. (*cf*. Campbell[4]). Hence, *curved space-time is incompatible with pure mathematics.*

Objection IV - In an article treating "Doppler Effects", Hansch[6] says: "According to the special theory of relativity, the velocity of light has the same value *c* in all inertial frames. Consequently, the optical Doppler effect, unlike its acoustical counterpart, depends only on the relative velocity *v* between source and observer". And this is verified by all observations of the Doppler frequency shift for light. If light waves were somehow coupled from a source into the space-time continuum (STC) and then de-coupled from the STC to a detector, the Doppler effect would *not* be as observed; it would be like that for sound waves. Thus, *the observed Doppler effect proves that light is not affected by the STC*. (For those who argue that "relativistic effects" are being overlooked, Hansch further asserts that a "purely relativistic effect" appearing at high velocities is of a second order and that "for small velocities, this result is essentially the same as expected classically".)

Table I

BODY	$R_m/m - m/kg$	$\mathcal{R}_{m/gF}$	$\rho_m - kg/m^3$
Neutron	$\sim 10^{12}$	$\sim 10^{39}$	$\sim 10^{18}$
Moon	$\sim 10^{-17}$	$\sim 10^{11}$	$\sim 10^{3}$
Earth	$\sim 10^{-18}$	$\sim 10^{9}$	$\sim 10^{3}$
Jupiter	$\sim 10^{-20}$	$\sim 10^{8}$	$\sim 10^{3}$
Sun	3.5×10^{-22}	10^{6}	1.5×10^{3}
Hawking	1.5×10^{-27}	4	$\sim 10^{18}$
Einstein	1.5×10^{-27}	4	$\sim 10^{3}$
Planck	3×10^{-28}	1	$\sim 10^{97}$

Objection V - A black hole is surely a “black body”, so Kirchhoff’s law for black body radiation, which is a fundamental theorem of thermodynamics, must apply. But this law states that a perfect absorber of light must also be a perfect radiator. Consequently, *black holes are of dubius darkness.*

9. In some theories of cosmology, one encounters a Planck mass m_P, length l_P and time t_P, which are defined as follows:

$$m_P = \left(\frac{hc}{2\pi\mathcal{G}_F}\right)^{1/2} = \left(\frac{hK_m}{4\pi c}\right)^{1/2} = 2.1787\times10^{-8}\,\text{kg} \tag{16}$$

$$l_P = \frac{h}{2\pi c m_P} = \left(\frac{\mathcal{G}_F}{2\pi c^3}\right)^{1/2} = \left(\frac{h}{\pi c K_m}\right)^{1/2} = 1.6161\times10^{-35}\,\text{m} \tag{17}$$

$$t_P = \frac{l_P}{c} = \left(\frac{h\mathcal{G}_F}{2\pi c^5}\right)^{1/2} = \left(\frac{h}{\pi c^3 K_m}\right)^{1/2} = 5.3906\times10^{-44}\,\text{sec} \tag{18}$$

where the universal constant K_m in the above is defined by Equations (12) & (13) and has dimensions of mass per unit of radius, so $K_m = m_P/R_P$ where R_P is the radius of a spherical body of mass m_P having uniform density ρ_P. We shall call this a Planck particle, and its radius is $R_P = rn_P/K_m = 0.80804 \times 10^{-35}$ m, which is half the length of l_P; hence, l_P is the diameter of the Planck particle. This results in a density for the Planck particle of $\rho_P = 0.985 \times 10^{-97}$ kg/m^3, and $\mathcal{R}_{m/gF} = 1$, so it meets Schwarzschild’s criterion for a black hole. However, the problem with this is that *its existence would preclude the evolutionary formation of the Universe*. So he who chooses the Planck particle, *horrible dictu*, condemns himself into non-existence.

10. Table I gives examples of three different types of mass (Nuclear, Atomic & Cosmological) along with their average densities, radius to mass ratio and the ratios of mass energy to gravity field energy. The Hawking, Einstein and Planck bodies of mass are unique because *no particle of mass, however energetic, could escape from their surface*.

References

[1] Kibble, T.W.B, *Classical Mechanics*, (Longman, London) 3rd Ed. 1985, p. 135.

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[3] Roxburgh, I.W., Is Space Curved? *The Encyclopedia of Ignorance*, Edited by R. Duncan & M. Weston-Smith (Permagon Press, Oxford) 1977, pp. 86-89.

[4] Campbell, J.O., Number, Space, Motion & Time *Galilean Electrodynamics*, v. 7, n. 4, pp. 63-70, (1997)

[5] Xu, S. & Xu, X., Investigation of the Einstein-Lorentr Group, *Physics Essays*, v. 9, n. 3, pp. 380-385, (1996)

[6] Hansch, T.W., Doppler Effect, *Encyclopedia of Physics*, Edited by R.D. Lerner & G.L. Trigg (VCH Press, NY) 1991, p. 258