Black Hole and Big Bang:
A Simplified Refutation

Stephen J. Crothers
Queensland, Australia
thenarmis@gmail.com

10 October 2013

ABSTRACT

The General Theory of Relativity is notoriously known for its complicated mathematics. This has been a great impediment to many who wish to understand such things as black hole theory and big bang cosmology. However, all the salient facts can be easily understood without any recourse to confusing mathematics. With these facts clearly explained in simple language it becomes easy to understand why black hole theory and big bang cosmology are mutually exclusive and ultimately why General Relativity is itself inconsistent.

I. INTRODUCTION

Complicated mathematics has prevented many people from understanding black hole theory and big bang cosmology. However, it is not difficult to understand all the important facts underlying these theories, and indeed underlying General Relativity itself, without any recourse to complicated mathematics. Indeed, anybody with knowledge of arithmetic and very basic high school algebra is actually equipped to also understand the salient mathematics. It is explained in what follows, mostly without mathematics, why the black hole and big bang cosmology are mutually exclusive, and why General Relativity is itself inconsistent and therefore untenable as a scientific theory.

II. BLACK HOLE AND BIG BANG ARE CONTRADICTORY

The terms *asymptotically flat* and *asymptotically curved* will be encountered a number of times and they hold a crucial place in black hole theory. Asymptotically flat simply means that with increasing distance in all directions from some massive source, spacetime continuously becomes less and less curved, i.e. it becomes flatter and flatter (the gravitational field becomes weaker and weaker). Asymptotically curved simply means that with increasing distance in all directions from some massive source, spacetime continuously gets closer and closer to some background curvature associated with an empty spacetime, such as that of anti-de Sitter spacetime. In doing so the gravitational field becomes weaker and weaker. Asymptotically flat is just a particular case of asymptotically curved since flat spacetime has a zero curvature. In General Relativity gravity is *not* a force; it is a curvature in spacetime induced by the presence of matter, and matter in General Relativity consists of mass and electromagnetic fields (Einstein 1916). According to General Relativity, the closer to a material source the more spacetime is curved, the further away the less curved. It is claimed that at the singularity of a black hole the density is infinite and the spacetime curvature is also infinite.

> "*… there must be a singularity of infinite density, within the black hole*."
>
> (Hawking 2002)

> "*Spacetime is infinitely curved at the singularity. . . .*"
>
> (Carroll and Ostlie 1996)

To illustrate the meaning of an asymptotic curve consider the graph of a right hyperbola in figure 1.

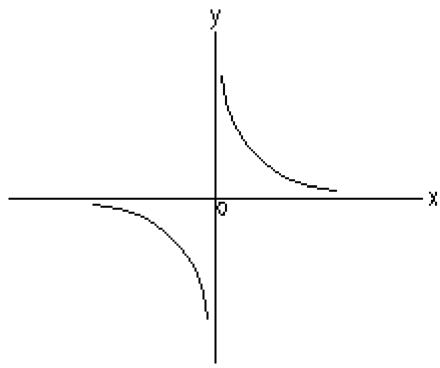

Figure 1

Figure 1 is 2-dimensional (only x and y values). The two curves in figure 1 can be extended indefinitely, but they never meet the x and y axes. So no matter how large the magnitudes of the x and y values are the curves get longer and closer to the x and y axes, but never touch the axes. Note also that there are no bumps in the curves along the way; they approach the axes smoothly. The x and y axes are then called the asymptotes of the curves and the curves are said to approach the asymptotes *asymptotically*. Some people like to say that the curves meet the axes at infinity, but this is misleading because infinity, by its definition, is never reached. The symbol for infinity is ∞. Infinity is not a real number because the real number line is endless. For example, the x and y axes in figure 1 are endless, and so they are said to be 'infinitely long'.

In the case of the black hole it is in what is called 4-dimensional spacetime. It is impossible to visualise or draw this 4-dimensional geometry. Consequently a 2-dimensional or 3-dimensional analogy must be used to attempt to illustrate its character. To somewhat visualise the spacetime related to a black hole consider the 2-dimensional representation in figure 2.

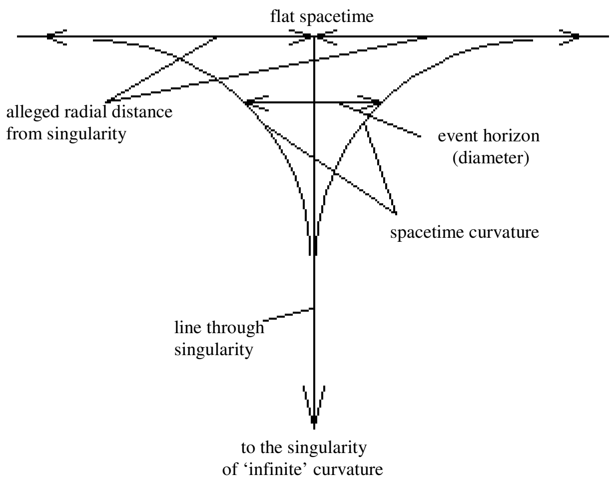

Figure 2

Spacetime curvature is represented by the two asymptotic curves. According to black hole theory as the radial distance from the singularity increases, 4-dimensional spacetime curvature becomes asymptotically flat, as indicated by the curves in figure 2. It is also claimed by black hole theory that when the radial distance is precisely zero spacetime curvature is infinite and that this infinite curvature is due to the actual presence of an infinitely dense singularity that has no volume. To visualise an asymptotically curved spacetime, that is, asymptotic to some non-zero spacetime curvature, just replace "*flat spacetime*" in figure 2 with the words "*curved spacetime*". Recall that flat spacetime is merely a spacetime with a curvature of zero. Consequently, figure 2 and its extensions herein will suffice for all cases.

Spacetime is claimed to subsist as a 4-dimensional geometry that constitutes the structure of the physical Universe. This spacetime is not simply a 4-dimensional 'space' in which masses and radiation move about. General Relativity maintains that there is a causal link between matter and spacetime so that matter acts on spacetime by causing it to curve and spacetime acts on matter by constraining the motion of matter by virtue of its curvature. Moreover, it is also claimed by big bang cosmology that spacetime itself is expanding and that galaxies are carried away from one another by this expansion of spacetime. But there is nothing into which spacetime expands; there is no void outside it. According to Davis and Lineweaver (2003),

"*The general relativistic interpretation of the expansion interprets cosmological redshifts as an indication of velocity since the proper distance between comoving objects increases. However, the velocity is due to the rate of expansion of space, not movement through space, …*"

Time in spacetime is not really just time. Inclusion of time in the spacetime construct is actually effected by means of multiplying time by speed to produce units of length, which is then attached to the usual three dimensions of length. The speed involved is that of light 'in vacuum', denoted by c. Spacetime is also what is called a non-Euclidean geometry. In fact, it is what is called a pseudo-Riemannian geometry. However, knowledge of these additional geometric complications is not required for understanding black hole theory, big bang cosmology, General Relativity, and their failings; all explained herein.

There are four different types of alleged black hole universes: (1) non-rotating, charge neutral; (2) non-rotating and charged; (3) rotating, charge neutral; (4) rotating and charged. There are three alleged types of big bang universes: (1) spatially infinite with constant negative curvature; (2) spatially infinite with constant zero curvature; (3) spatially finite with constant positive curvature. When proponents of the big bang talk of big bang they never specify which big bang they allege. Nor do they usually specify the type of black hole alleged; only sometimes claiming a rotating black hole with an 'accretion disc'.

Proving that the black hole and the big bang cosmology contradict one another is not difficult. All alleged solutions to Einstein's field equations for the black hole pertain to a universe that is spatially infinite, is eternal, contains only one mass, is not expanding, and is asymptotically flat or asymptotically curved. However, the hot big bang model pertains to a universe that is alleged to be spatially finite (one case) or spatially infinite (in two different cases), of finite age, contains radiation and many masses (including many black holes some of which are claimed to be primordial), is expanding, and is not asymptotically anything. Thus the black hole and big bang cosmology contradict one another; they are mutually exclusive. According to the Dictionary of Geophysics, Astrophysics and Astronomy (2001),

"*Black holes were first discovered as purely mathematical solutions of Einstein's field equations.*

This solution, the Schwarzschild black hole, is a nonlinear solution of the Einstein equations of General Relativity. It contains no matter, and exists forever in an asymptotically flat space-time."

Penrose (2002) remarks,

"The Kerr-Newman solutions … are explicit asymptotically flat stationary solutions of the Einstein-Maxwell equation ($\lambda = 0$) involving just three free parameters m, a and e. … the mass, as measured asymptotically, is the parameter m (in gravitational units). The solution also possesses angular momentum, of magnitude am. Finally, the total charge is given by e. When a = e = 0 we get the Schwarzschild solution."

Now Einstein's field equations are highly nonlinear and so the Principle of Superposition does not hold in General Relativity; but it does hold in Newton's theory. Landau and Lifshitz (1951) remark,

"The Einstein equations are nonlinear. Therefore for gravitational fields the principle of superposition is not valid."

Physically this means that one cannot simply by conjecture, pile up masses and radiation in any given spacetime to obtain multiple masses and other matter. Furthermore, there are no known solutions to Einstein's field equations for two or more masses and there is no existence theorem by which it can even be asserted that the field equations contain latent solutions for two or more masses (McVittie 1978, Crothers 2008, 2010, 2012a, 2012b). Consequently, all assertions that the black hole can exist in multitudes, collide or merge, be components of binary systems, form from a system of many stars, be located at the centres of galaxies, and interact with other matter, are erroneous, violating also the very definition of the black hole itself. Multiple black holes are obtained by a false analogy with Newton's theory and concomitant application of the Principle of Superposition where the Principle of Superposition does not hold. Moreover, the different types of black holes possess different spacetimes, which are also different to big bang spacetimes, which means that black hole spacetimes cannot be present in any big bang spacetimes because they relate to different sets of field equations and hence to different 'solutions', which cannot be superposed. One cannot therefore arbitrarily insert (i.e. superpose) black hole universes into big bang universes to claim the presence of multiple black holes in some big bang model. One cannot superpose any alleged black hole universe upon itself to get multiple black holes of the same type, or upon black hole universes of other types to get multiple black holes of different types. One cannot superpose any alleged big bang universe upon any other big bang universe either. Let $\boldsymbol{X}$ be an alleged black hole solution to Einstein's field equations and let $\boldsymbol{Y}$ be an alleged big bang solution to Einstein's field equations. Then the linear combination (i.e. superposition) $\boldsymbol{X} + \boldsymbol{Y}$ is not a solution to Einstein's field equations, because Einstein's field equations are nonlinear. Indeed, $\boldsymbol{X}$ and $\boldsymbol{Y}$ pertain to entirely different sets of Einstein's field equations and hence they have nothing whatsoever to do with one another.

Nonetheless the literature routinely and incorrectly claims the existence of multiple black holes, in an expanding big bang universe, and the formation of black holes from objects such as stars by means of irresistible gravitational collapse. Penrose (2002), for example, erroneously asserts that many stars can collapse into one another to form a black hole,

"For, the larger the mass involved, the smaller would be the density at which it would be expected to cross r = 2m. It could be that very large masses indeed may become involved in gravitational collapse. For m > $10^{11}M_{\Theta}$ (e.g. a good-sized galaxy), the averaged density at which r = 2m is crossed would be less than that of air!"

Hawking (2002) incorrectly assumes multiple black holes, thus,

"*Also, suppose two black holes collided and merged together to form a single black hole. Then the area of the event horizon of the final black hole would be greater than the sum of the areas of the event horizons of the original black holes*."

Schutz (1990) also incorrectly assumes multiple black holes and adds black hole binary systems,

"... *Hawking's area theorem: in any physical process involving a horizon, the area of the horizon cannot decrease in time. ... This fundamental theorem has the result that, while two black holes can collide and coalesce, a single black hole can never bifurcate spontaneously into two smaller ones*.

"*Black holes produced by supernovae would be much harder to observe unless they were part of a binary system which survived the explosion and in which the other star was not so highly evolved*."

Chandrasekhar (1972) extends the invalid assumption to very many black holes,

"*From what I have said, collapse of the kind I have described must be of frequent occurrence in the Galaxy; and black-holes must be present in numbers comparable to, if not exceeding, those of the pulsars. While the black-holes will not be visible to external observers, they can nevertheless interact with one another and with the outside world through their external fields."*

"In considering the energy that could be released by interactions with black holes, a theorem of Hawking is useful. Hawking's theorem states that in the interactions involving black holes, the total surface area of the boundaries of the black holes can never decrease; it can at best remain unchanged (if the conditions are stationary)."

"Another example illustrating Hawking's theorem (and considered by him) is the following. Imagine two spherical (Schwarzschild) black holes, each of mass ½M, coalescing to form a single black hole; and let the black hole that is eventually left be, again, spherical and have a mass M. …"

According to Oppenheimer and Snyder (1939),

"When all thermonuclear sources of energy are exhausted, a sufficiently heavy star will collapse. … this contraction will continue indefinitely. … the radius of the star approaches asymptotically its gravitational radius."

Hawking and Penrose (1970) say,

"We expect trapped surfaces to arise when a gravitational collapse of a localized body (e.g. a star) to within its Schwarzschild radius takes place, which does not deviate too much from spherical symmetry."

Penrose (2002) also says,

"We ask what qualitative peculiarity of the region $r < 2m$ (after the star has collapsed through) is present."

It is however not difficult to again see why all these claims about the existence and interactions of black holes are false. A localised body such as a star is not the only mass present in the actual Universe and since it is present amidst very many stars and galaxies its associated spacetime is not asymptotically flat. So the notion that a localised body such as a star can form a Schwarzschild black hole, and hence a trapped surface at its Schwarzschild radius (gravitational radius), or indeed any type of black hole at all, by means of irresistible gravitational collapse, is in conflict with the defining characteristics of the black hole, because the said star and its associated black hole due to gravitational collapse, is not alone and not in a universe that is spatially infinite, eternal, asymptotically flat, and not expanding. To emphasize further the invalidity of the notion of two or more black holes note that these alleged black holes disrupt the purported defining boundary condition of black hole spacetime asymptotic flatness because each black hole prevents the spacetime of the other black holes from being asymptotically flat. Indeed, each and every back hole constitutes an additional infinite spacetime curvature in the spacetime of any one of these alleged multiple black holes.

Since the many stars and radiation in the relativistic universe are erroneously postulated from General Relativity by a false analogy with Newton's theory and its associated Principle of Superposition, "*gravitational collapse*" cannot be due to Newtonian gravitation, given the resulting black hole, which does not exist in Newton's theory. And a Newtonian universe cannot collapse into a non-Newtonian universe such as that of the lonesome black hole or a cosmological singularity. Proponents of the black hole begin with a Newtonian universe owing to the a priori presence of many stars and galaxies, and allow a star therein to collapse into a black hole to form a non-Newtonian single mass universe, which is a contradiction, and also maintain that the black hole so formed is present in a universe that contains other masses, including other black holes, in contradiction of the defining characteristics of the black hole itself. This is illustrated in figure 3 in the same terms as figure 2.

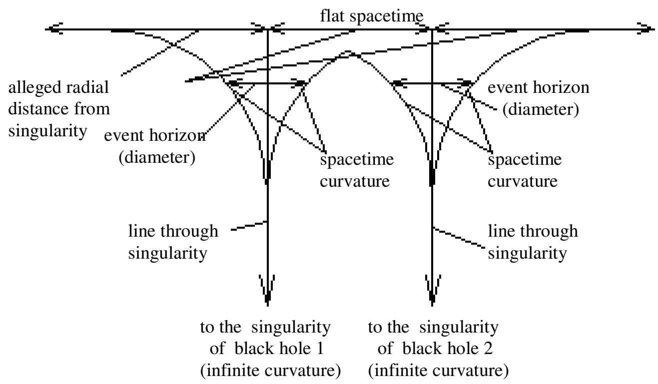

Figure 3

Note that the spacetime of each black hole is not asymptotically flat in all directions. Each black hole encounters finite non-flat spacetime between them and also an infinite curvature at the location of the other black hole. So the spacetime of each black hole is not asymptotically flat. Now consider millions of black holes. Each one encounters millions of infinite spacetime curvatures around them and no asymptotically flat spacetime or asymptotically curved spacetime between them. Consequently none of them have an asymptotically flat spacetime or asymptotically curved spacetime. But asymptotically flat spacetime or asymptotically curved spacetime is a defining condition of the black hole. Nonetheless it is claimed that, besides black holes all over the sky, there is a supermassive black hole at the centres of all galaxies. How many galaxies are there? According to Stern et al (2012),

"Determining the ratio of unobscured to obscured AGN as a function of luminosity and redshift has direct implications for the growth history of supermassive black holes in galactic centers, …"

(**Note:** AGN stands for Active Galactic Nuclei)

And according to Krauss (2013a),

"*Just the known laws of quantum mechanics and relativity can produce 400 billion galaxies each containing 100 billion stars* …"

Because the black hole solutions to Einstein's field equations contain only one mass in an asymptotically flat or asymptotically curved universe, none are capable of representing the actual Universe and so they bear no relation to reality. Big bang cosmology cannot include any black holes for the same reasons.

III. Big Bang is a one mass model

Big bang models treat the universe, after the initial bang, as being entirely filled by a single continuous indivisible spatially homogeneous distribution of matter of uniform macroscopic density and pressure. This is because, as noted in Section II above, there are no known solutions to Einstein's field equations for two or more masses and no existence theorem by which it can even be asserted that his field equations contain latent solutions for two or more masses (McVittie 1978, Crothers 2008, 2010). This continuous distribution of matter is given the form of an idealised fluid that completely fills the universe. Concerning this uniform density and pressure Tolman (1987) remarks,

"… *it must be remembered that these quantities apply to the idealized fluid in the model, which we have substituted in place of the matter and radiation actually present in the real universe*."

Of the idealized fluid so substituted Tolman (1987) says,

"*We may, however, introduce a more specific hypothesis by assuming that the material filling the model can be treated as a perfect fluid*."

The multiple black holes merging or colliding or capturing other matter or forming binary systems, the many stars and galaxies, and the radiation too that appear in big bang models is therefore inconsistent with the very basis of the models, and are obtained by invalid application of the Principle of Superposition. Tolman (1987) commits and reveals this error explicitly,

"*We can then treat the universe as filled with a continuous distribution of fluid of proper macroscopic density ρ_{oo} and pressure p_o, and shall feel justified in making this simplification since our interest lies in obtaining a general framework for the behaviour of the universe as a whole, on which the details of local occurrences could be later superposed*."

However, as explained in Section II above, the Principle of Superposition is not valid in General Relativity. Consequently, big bang models also do not bear any relation to the actual Universe and are invalid. Nonetheless, superposition is inadmissibly applied to obtain multiple masses, radiation and multiple black holes in big bang models.

IV. False analogy with Newton's theory

The *Schwarzschild radius*, sometimes called the *gravitational radius*, features prominently in black hole theory. Although it is associated with the name of the German scientist Karl Schwarzschild (1916), who was the first to solve Einstein's field equations (for a static empty spacetime), it is actually obtained from an alleged solution determined later by the German mathematician David Hilbert (Abrams 1989, Antoci 2001). Hilbert's solution is a corruption of the earlier solution obtained by Schwarzschild. Schwarzschild had nothing to do with the notion of the black hole. In relation to the black hole the *Schwarzschild radius* is the alleged radius of the so-called 'event horizon' of the black hole (see figures 2 and 3). The event horizon of the black hole is just a spherical surface in spacetime from which it is alleged that nothing can leave. This event horizon spherical surface is not the surface of a massive body, but a region in spacetime associated with the black hole. The black hole begins at the event horizon which is said to be the upper boundary of a spherical volume of spacetime at the centre of which is the infinitely dense point-mass singularity. It is claimed that masses and radiation can cross the event horizon into the black hole but cannot get out of the black hole. All masses and radiation falling into the black hole end up in the infinitely dense singularity to increase the mass of the black hole. According to black hole theory all spherically symmetric bodies, such as stars, planets, and black holes, have a Schwarzschild radius, but in the cases of stars and planets it is claimed that their Schwarzschild radius is buried deep inside them.

"*For ordinary stars, the Schwarzschild radius lies deep in the stellar interior.*" (McMahon 2006)

It is to be noted that the interior of a star is not described by Hilbert's solution because Hilbert's solution is alleged to apply either to a black hole or the exterior of a star. Thus Hilbert's solution cannot say anything about the interior of stars or planets. Consequently, the so-called Schwarzschild radius inside stellar interiors has no relevance whatsoever. The interior of a star must be described by an entirely different solution to Einstein's field equations. Application of Hilbert's solution to the stellar interiors is invalid.

The event horizon is often called a 'trapped surface' and is claimed to form when a massive body undergoes irresistible 'gravitational collapse' (Hawking and Penrose 1970, Chandrasekhar 1972, Penrose 2002) to form a black hole. However, it is actually obtained by inadmissibly inserting Newton's expression for escape velocity into Hilbert's solution which is almost always and incorrectly called 'Schwarzschild's solution'. Furthermore, the idea of a black hole escape velocity is obtained by the very inclusion of Newton's expression for escape velocity. Schwarzschild's (1916) solution is different to Hilbert's solution and does not contain Newton's expression for escape velocity and so it does not contain a black hole.

Although Newton's expression for escape velocity contains only one mass term, it is implicitly a two-body relation: one body escapes from another body. But the alleged black hole solutions to Einstein's field equations pertain to a universe that contains only one mass, and so Newton's expression for escape velocity cannot rightly appear in any mathematical expression for a black hole or other one-body universe. Newton's expression for escape velocity is inserted *post hoc* into Hilbert's solution (2) in order to satisfy the misleading words "*gravitational field outside a body*" or "*point-mass*" when in fact there is no mass present since the related Einstein field equations contain no matter by mathematical construction because they are set to eliminate all material sources (Crothers 2008, 2010, 2012a, 2012b).

Since the Principle of Superposition holds in Newton's theory one can postulate the presence of any number of masses such as stars and galaxies. This cannot be done with General Relativity, as explained in Section I above and so multiple black holes and indeed the planets, stars and galaxies have no basis in General Relativity. These multitudes are also obtained by a false analogy with Newton's theory. General Relativity can only deal with one body.

Although gravity is not a force in General Relativity, and although multiple black holes, multiple stars and galaxies, and black hole 'escape velocity' are obtained by an inadmissible insertion of Newton's expression for escape velocity into Hilbert's solution, Chandrasekhar (1972) nevertheless says,

> "*Let me be more precise as to what one means by a black hole. One says that a black hole is formed when the gravitational forces on the surface become so strong that light cannot escape from it. ... A trapped surface is one from which light cannot escape to infinity*."

According to the Dictionary of Geophysics, Astrophysics and Astronomy (2001),

> "**black hole** *A region of spacetime from which the escape velocity exceeds the velocity of light. In Newtonian gravity the escape velocity from the gravitational pull of a spherical star of mass M and radius R is*
>
> $$v_{esc} = \sqrt{\frac{2GM}{R}},$$
>
> *where G is Newton's constant. Adding mass to the star (increasing M), or compressing the star (reducing R) increases v_{esc}. When the escape velocity exceeds the speed of light c, even light cannot escape, and the star becomes a black hole. The required radius R_{BH} follows from setting v_{esc} equal to c:*
>
> $$R_{BH} = \frac{2GM}{c^2}$$
>
> *"In General Relativity for spherical black holes (Schwarzschild black holes), exactly the same expression R_{BH} holds for the surface of a black hole. The surface of a black hole at R_{BH} is a null surface, consisting of those photon trajectories (null rays) which just do not escape to infinity. This surface is also called the black hole horizon."*

According to Hawking (2002),

> *"Eventually when a star has shrunk to a certain critical radius, the gravitational field at the surface becomes so strong that the light cones are bent inward so much that the light can no longer escape. According to the theory of relativity, nothing can travel faster than light. Thus, if light cannot escape, neither can anything else. Everything is dragged back by the gravitational field. So one has a set of events, a region of space-time from which it is not possible to escape to reach a distant observer. Its boundary is called the event horizon. It coincides with the paths of the light rays that just fail to escape from the black hole."*

In the Collins Encyclopædia of the Universe (2001),

> "**black hole** *A massive object so dense that no light or any other radiation can escape from it; its escape velocity exceeds the speed of light*."

But on the other hand it is also claimed that nothing at all can even leave the black hole. Chandrasekhar (1972) says,

> "*The problem we now consider is that of the gravitational collapse of a body to a volume so small that a trapped surface forms around it; as we have stated, from such a surface no light can emerge*."

Hawking (2002) says,

> *"I had already discussed with Roger Penrose the idea of defining a black hole as a set of events from which it is not possible to escape to a large distance. It means that the boundary of the black hole, the event horizon, is formed by rays of light that just fail to get away from the black hole. Instead, they stay forever hovering on the edge of the black hole."*

Taylor and Wheeler (2000) say,

> "... *Einstein predicts that nothing, not even light, can be successfully launched outward from the horizon ... and that light launched outward EXACTLY at the horizon will never increase its radial position by so much as a millimeter*."

If the black hole event horizon has an escape velocity c, then, by definition, light can escape, contrary to the frequent claim that it cannot. Furthermore, material bodies can leave the black hole but not escape since in Relativity Theory no material body can acquire the speed c and because 'escape velocity' does not mean bodies cannot leave, only that if they leave they cannot escape. If the escape velocity of the black hole event horizon is greater than c then light cannot escape and no material body can escape, but once again that does not mean that material bodies and light cannot leave, only that they cannot escape. Yet black hole theory also maintains that neither light nor material bodies can even leave the event horizon of the black hole. The idea of black hole escape velocity is just a play on the words 'escape velocity' (McVittie 1978). The black hole has no escape velocity. This fact also invalidates the Hawking-Penrose concept of 'trapped surface' and hence the Hawking-Penrose Singularity Theorem (Hawking and Penrose 1970).

The equations adduced in the quotation above from the Dictionary of Geophysics, Astrophysics and Astronomy have nothing to do with the black hole whatsoever; they are related only to Newton's theory of gravitation, and the equation given for the radius of the black hole event horizon is actually the critical radius for the formation of the theoretical Michell-Laplace dark body, which is not a black hole because it does not possess the signatures of the black hole. It is a Newtonian theoretical object, not a Relativistic theoretical object (McVittie 1978, Crothers 2005, 2008, 2010). The theoretical Michell-Laplace dark body forms when,

$$r < \frac{2GM}{c^2}$$

Despite these facts it is also falsely asserted that the theoretical Michell-Laplace dark body, which is consistent with Newton's theory, is a black hole. According to Hawking and Ellis (1973),

"Laplace essentially predicted the black hole…"

In The Cambridge Illustrated History of Astronomy (1997) it is asserted that,

"*Eighteenth-century speculators had discussed the characteristics of stars so dense that light would be prevented from leaving them by the strength of their gravitational attraction; and according to Einstein's General Relativity, such bizarre objects (today's 'black holes') were theoretically possible as end-products of stellar evolution, provided the stars were massive enough for their inward gravitational attraction to overwhelm the repulsive forces at work*."

In part C of Box 24.1 in their book 'Gravitation', Misner, Thorne and Wheeler (1970) include the Michell-Laplace dark body under the heading of 'BLACK HOLES'. In section 24.2 they include a copy of the cover of Laplace's paper '*Exposition du Syetème du Monde*', and a page from his paper, in French, beside two papers, one by Oppenheimer and Volkov the other by Oppenheimer and Snyder, on neutron stars and gravitational contraction respectively, and a paper by Baade and Zwicky on neutron stars. All these papers are denoted as 'Figure 24.1' with this caption:

"Two important arrivals on the scene: the neutron star (1933) and the black hole (1795, 1939). No proper account of either can forego general relativity."

Chandrasekhar (1972) says,

"That such a contingency can arise was surmised already by Laplace in 1798. Laplace argued as follows. For a particle to escape from the surface of a spherical body of mass M and radius R, it must be projected with a velocity v such that $\frac{1}{2}v^2 > GM/R$; and it cannot escape if $v^2 < 2GM/R$. On the basis of this last inequality, Laplace concluded that if $R < 2GM/c^2 = R_s$ (say) where c denotes the velocity of light, then light will not be able to escape from such a body and we will not be able to see it!

"By a curious coincidence, the limit R_s discovered by Laplace is exactly the same that general relativity gives for the occurrence of the trapped surface around a spherical mass."

But it is not surprising that General Relativity gives the same R_s "*discovered by Laplace*" because the Newtonian expression for escape velocity is deliberately inserted post hoc into Hilbert's solution by the proponents of the black hole.

V. Michell-Laplace Dark Body Not a Black Hole

The Michell-Laplace dark body is not a black hole (McVittie 1978, Crothers 2006c, 2008, 2010). It possesses an escape velocity, but the black hole has no escape velocity; masses and light can leave the Michell-Laplace dark body, but nothing can leave the black hole; it does not require irresistible gravitational collapse, whereas the black hole does; it has no infinitely dense singularity, but the black hole does; it has no event horizon, but the black hole does; there is always a class of observers that can see the Michell-Laplace dark body, but there is no class of observers that can see the black hole; the Michell-Laplace dark body persists in a space which by consistent theory contains other Michell-Laplace dark bodies and other matter and they can interact with themselves and other matter, but the spacetime of all types of black hole pertains to a universe that contains only one mass (but actually contains no mass by mathematical construction) and so cannot interact with any other masses; the space of the Michell-Laplace dark body is 3-dimensional and Euclidean, but the black hole is in a 4-dimensional non-Euclidean spacetime; the space of the Michell-Laplace dark body is not asymptotically flat whereas the spacetime of the black hole is asymptotically flat. Therefore, the Michell-Laplace dark body does not possess the characteristics of the black hole and so it is not a black hole.

VI. Infinitely dense singularities meaningless

According to Hawking (2002),

"*The work that Roger Penrose and I did between 1965 and 1970 showed that, according to general relativity, there must be a singularity of infinite density, within the black hole*."

Hilbert's metric is said to have a point-mass singularity at $r = 0$. However, Hilbert's metric is undefined at this value, owing to division by zero in Newton's expression for escape velocity which is inadmissibly inserted into Hilbert's solution by the astrophysical scientists. Thus r can never be zero. Moreover, this r is neither a radius nor a distance in Hilbert's metric (Crothers 2005, 2008, 2010, 2012a). Furthermore, a point is a mathematical entity that by definition has no extension and so has no volume. A mass however, is a physical entity, not a mathematical entity, and so it is not a point. A point therefore cannot contain mass or possess density or temperature. Nonetheless, the proponents of the black hole maintain that the point-mass singularity is a real object. According to Dodson and Poston (1981),

"Once a body of matter, of any mass m, lies inside its Schwarzschild radius $2m$ it undergoes gravitational collapse . . . and the singularity becomes physical, not a limiting fiction."

Carroll and Ostlie (1996) say,

"A nonrotating black hole has a particularly simple structure. At the center is the singularity, a point of zero volume and infinite density where all of the black hole's mass is located. Spacetime is infinitely curved at the singularity. . . . The black hole's singularity is a real physical entity. It is not a mathematical artifact . . . "

Penrose (2002) says,

"As r decreases, the space-time curvature mounts (in proportion to r^{-3}), becoming theoretically infinite at $r = 0$."

"Thus, the true space-time singularity, resulting from a spherically symmetrical collapse, is located not at $r = 2m$, but at $r = 0$."

Density is defined as mass divided by its volume. Mathematically this is expressed as, $D = M/V$. So the proponents of the black hole maintain that,

$$D = \frac{M}{0} = \infty$$

This is false. Division by zero is undefined and so it does not produce ∞. Similarly the spacetime curvature referred to above by Penrose is not only undefined at $r = 0$ but r is not even able to be equal to or go below the value of $2m$.

The Reissner-Nordström solution for a charged black hole is also said to contain an infinitely dense point-mass singularity. The Kerr solution for the rotating black hole is claimed to have an infinitely dense singularity that is concentrated into the circumference of a circle (Mould 1994). The circumference of a circle has no volume and therefore cannot manifest as a mass.

Consider the centre of mass of a body. Sometimes it is called the centre of gravity. It is conceived of as a point at which all the mass of the body is concentrated when the distribution of the mass is not relevant to the problem at hand. A centre of mass is not a physical object. It is an artifice; a figment of the imagination. A ponderable body such as a star or a planet has a shape and a finite non-zero volume as well as finite non-zero mass. Its density is thus well-defined.

The big bang singularity is claimed on the one hand to have no extension yet on the other hand to also have had an infinite density, infinite pressure and infinite temperature. According to Hawking (1988),

"At the big bang itself, the universe is thought to have had zero size, and to have been infinitely hot."

According to Misner, Thorne and Wheeler (1970),

"One crucial assumption underlies the standard hot big-bang model: that the universe 'began' in a state of rapid expansion from a very nearly homogeneous, isotropic condition of infinite (or near infinite) density and pressure."

How close to infinite must one get to be "*near infinite*"?

Although the big bang singularity from which the universe is allegedly spawned is claimed on the one hand to have no extension, on the other hand it is assigned physicality by means of alleged infinite density, infinite pressure and infinite temperature. Yet it is also claimed that the universe came into existence from nothing; creatio ex nihilo. However, nothingness cannot be "*infinitely hot*", and cannot have a "*condition of infinite (or near infinite) density and pressure.*" Nonetheless, for example, on the evening of Monday 18th February 2013, American physicist Professor Lawrence Krauss (2013a) appeared on the television show Q&A on station ABC1 in Australia. On that show Professor Krauss expounded creatio ex nihilo. He maintained that the Universe came into existence from nothing. Professor Krauss made the following convoluted and contradictory remarks.

"*Quantum mechanics will allow particles to suddenly pop out of nothing and it doesn't violate any laws of physics. Just the known laws of quantum mechanics and relativity can produce 400 billion galaxies each containing 100 billion stars and then beyond that it turns out when you apply quantum mechanics to gravity, space itself can arise from nothing, as can time.*"

"*It is amazing that our universe looks exactly like a universe that could have come from nothing. Does that prove it? No. But it makes it plausible and that is amazing.*"

"*There's no real particles but it actually has properties but the point is that you can go much further and say there's no space, no time, no universe and not even any fundamental laws and it could all spontaneously arise and it seems to me if you have no laws, no space, no time, no particles, no radiation, it is a pretty good approximation of nothing.*"

"*But is that, in fact, because of discovering that empty space has energy, it seems quite plausible that our universe may be just one universe in what could be almost an infinite number of universes and in every universe the laws of physics are different and they come into existence when the universe comes into existence.*"

"*But I would argue that nothing is a physical quantity. It's the absence of something.*"

These claims contradict the allegation that the big bang singularity had zero size (i.e. no extension) and was infinitely hot, infinitely dense and of infinite pressure since temperature, density and pressure, if they are present, are not nothing. Professor Krauss' claim that "*quantum mechanics and relativity can produce 400 billion galaxies each containing 100 billion stars*" is also incorrect because General Relativity, upon which big bang cosmology relies, treats the universe as a single indivisible continuous homogeneous distribution of matter after the bang, from which multiple masses cannot arise without applying the Principle of Superposition which is invalid in General Relativity. The way the Universe looks does not support his claim that it could have come from nothing. There is no connexion between the appearance of the Universe and *creatio ex nihilo* other than wishful thinking in order to attempt justification of the usual claims made for General Relativity, which is not scientific method. If without the bang there was "*no space, no time, no universe and not even any fundamental laws*" there was truly nothing, and so his assertion that this "*is a pretty good approximation of nothing*" is rather meaningless. How can nothing be a good approximation to nothing? Yet Professor Krauss also says that *"nothing is a physical quantity*". So according to Professor Krauss nothing is both nothing and a physical quantity. However, nothing and physical are mutually exclusive notions.

Professor Krauss (2013b) appeared a second time on the television show Q&A on station ABC1 on the evening of Monday 27th May 2013. He again expounded creatio ex nihilo. In response to a question about the big bang he said,

"*There was nothing there. There was absolutely no space, no time, no matter, no radiation. Space and time themselves popped into existence which is one of the reasons why it is hard...*"

Professor Krauss also made the following false assertion,

"... *the multiverse is well-motivated by evidence.*"

There is however no evidence at all for the idea of multiple universes. The multiverse is entirely a figment of the imagination. It has no basis in any experiment or observation. Professor Krauss added this fanciful remark,

"*Almost all the theories we have suggest our universe isn't unique.*"

This claim is fanciful because it too has no supporting evidence whatsoever. Theories can be, and often are, posited at will, ignoring physical evidence or lack thereof, and ignoring inconsistencies in both physical principles and related mathematical formulations.

VII. The black hole 'solutions' contain no mass

In Einstein's field equations there is a causal link between spacetime curvature and matter. Matter induces spacetime curvature. Spacetime curvature is Einstein's 'gravitational field'. This is why gravity is not a force in General Relativity.

Einstein's field equations,

"*couple the gravitational field (contained in the curvature of spacetime) with its sources.*" (Foster and Nightingale 1995)

"*Since gravitation is determined by the matter present, the same must then be postulated for geometry, too. The geometry of space is not given a priori, but is only determined by matter.*" (Pauli 1981)

"*Again, just as the electric field, for its part, depends upon the charges and is instrumental in producing mechanical interaction between the charges, so we must assume here that the metrical field (or, in mathematical language, the tensor with components g_{ik}) is related to the material filling the world.*" (Weyl 1952)

"*In general relativity, the stress-energy or energy-momentum tensor T^{ab} acts as the source of the gravitational field. It is related to the Einstein tensor and hence to the curvature of spacetime via the Einstein equation*." (McMahon 2006)

"*Mass acts on spacetime, telling it how to curve. Spacetime in turn acts on mass, telling it how to move*." (Carroll and Ostlie 1996)

Qualitatively Einstein's field equations are:

$$\textit{spacetime geometry} = -\kappa \times \textit{material sources} \qquad (1)$$

where $-\kappa$ is a coupling constant.

In Einstein's field equations the *material sources* or *causative matter* of his gravitational field are mathematically described by the energy-momentum tensor $T_{\mu\nu}$ whilst the gravitational field or *spacetime geometry* (curved spacetime) is described by the Einstein tensor $G_{\mu\nu}$. According to expression (1) spacetime and matter are causally linked so that if there is no material source, not only is there no gravitational field, there is also no spacetime; no universe! Einstein (1916) includes in matter both mass and electromagnetic fields. According to Einstein (1916) if there are no material sources present his field equations reduce to,

$$\textit{spacetime geometry} = 0 \qquad (2)$$

Since material sources are removed mathematically by setting the energy-momentum tensor to zero, there is no causative matter present.

Einstein and proponents of the black hole say that expression (2) describes a static vacuum field or static empty spacetime. Indeed, Einstein (1916) says that expression (2) constitutes "*The Field Equations of Gravitation in the Absence of Matter*". Nonetheless, Einstein and the proponents of the black hole claim that material sources are still present despite their removal from the field equations by setting the energy-momentum tensor to zero. So on the one hand all *material sources* are removed from Einstein's field equations at the outset by setting the energy-momentum tensor to zero then on the other hand it is claimed that sources are still present by asserting simultaneously that expression (2) describes the gravitational field *outside a mass* or "*for the space between the planets in the solar system*" (Dirac 1996) or "*exterior to a spherically symmetrical body*" (Penrose 2002), and that Hilbert's solution (Abrams 1989, Antoci 2001) for expression (2) describes the gravitational field outside a body such as a star. Indeed, in relation to Hilbert's solution Einstein (1967) says,

"*M denotes the sun's mass, centrally symmetrically placed about the origin of co-ordinates; the solution (109a) is valid only outside of this mass, where all the $T_{\mu\nu}$ vanish. If the motion of the planet takes place in the $x_1 - x_2$ plane then we must replace (109a) by*

$$ds^2 = \left(1 - \frac{A}{r}\right)dt^2 - \frac{dr^2}{\left(1 - \frac{A}{r}\right)} - r^2 d\phi^2 \text{ "}$$

wherein $A = \kappa M/4\pi$. In relation to Hilbert's solution

McMahon (2006) says that $r = 2m$,

"*… is known as the Schwarzschild radius. In terms of the mass of the object that is the source of the gravitational field, it is given by*

$$r_s = \frac{2GM}{c^2} \text{ "}$$

Of Hilbert's solution Dirac (1996) says,

"*It is known as the Schwarzschild solution. It holds outside the surface of the body producing the field, where there is no matter. Thus it holds fairly accurately outside the surface of a star*."

Penrose (2002) says of Hilbert's solution,

"*This solution represents the gravitational field exterior to a spherically symmetrical body.*"

However, a material source cannot be removed on the one hand by setting the energy-momentum tensor to zero to get expression (2) and on the other hand be reinstated with the misleading words '*outside a body*' or '*outside a mass*' or '*point-mass*' or "*outside the surface of a star*", because there is no material source present for anything to be outside of by virtue of the energy-momentum tensor being set to zero. Einstein's argument violates elementary logic and is therefore false; nothing but a subtle play on the words *outside a body*. Expression (2) actually describes nothing physical because it contains no matter and so it is physically meaningless. Indeed, owing to the causal link between matter and spacetime, if all matter is removed there is no spacetime. Since expression (2) has no physical meaning, Hilbert's solution has no physical meaning either. Hence, the black hole is, again, not predicted by General Relativity.

Furthermore, both Einstein (1967) and Dirac (1996) for example, have not only introduced a material source where there is none, by means of the words "*outside of this mass*" and "*the body producing the field … outside the surface of a star*", they have also arbitrarily and in violation of expression (2) introduced multiple masses where there are actually none, by means of the words "*motion of the planet*" and "*the space between the planets in the solar system*". These additional masses have no theoretical basis either because they too are inserted linguistically and *post hoc* into a universe that by mathematical construction contains no matter since there are no *material sources* present by virtue of setting the energy-momentum tensor to zero to obtain expression (2). In addition, multiple masses are obtained by applying the Principle of Superposition; but the Principle of Superposition does not hold in General Relativity (it does hold in Newton's theory).

Since Hilbert's solution contains no mass, the Reissner-Nordström solution for a charged black hole contains no mass, and neither do the Kerr solution for a rotating black hole and the Kerr-Newman solution for a charged rotating black hole. The latter three black hole solutions reduce to Hilbert's solution when there is 'no charge' and 'no angular momentum' as the case may be, but Hilbert's solution contains no material sources whatsoever.

VIII. The black hole violates the physical principles of general relativity

Einstein (1967) asserted that his Principle of Equivalence and his laws of Special Relativity must hold in sufficiently small finite regions of his gravitational field, and that these regions can be located anywhere in his gravitational field. According to Einstein (1967),

> "*Let now K be an inertial system. Masses which are sufficiently far from each other and from other bodies are then, with respect to K, free from acceleration. We shall also refer these masses to a system of co-ordinates K', uniformly accelerated with respect to K. Relatively to K' all the masses have equal and parallel accelerations; with respect to K' they behave just as if a gravitational field were present and K' were unaccelerated. Overlooking for the present the question as to the 'cause' of such a gravitational field, which will occupy us later, there is nothing to prevent our conceiving this gravitational field as real, that is, the conception that K' is 'at rest' and a gravitational field is present we may consider as equivalent to the conception that only K is an 'allowable' system of co-ordinates and no gravitational field is present. The assumption of the complete physical equivalence of the systems of coordinates, K and K', we call the 'principle of equivalence'; this principle is evidently intimately connected with the law of the equality between the inert and the gravitational mass, and signifies an extension of the principle of relativity to co-ordinate systems which are in non-uniform motion relatively to each other. In fact, through this conception we arrive at the unity of the nature of inertia and gravitation. For, according to our way of looking at it, the same masses may appear to be either under the action of inertia alone (with respect to K) or under the combined action of inertia and gravitation (with respect to K').*
>
> "*Stated more exactly, there are finite regions, where, with respect to a suitably chosen space of reference, material particles move freely without acceleration, and in which the laws of special relativity, which have been developed above, hold with remarkable accuracy*."

Foster and Nightingale (1995) succinctly state the Principle of Equivalence thus:

> "*We may incorporate these ideas into the principle of equivalence, which is this: In a freely falling (nonrotating) laboratory occupying a small region of spacetime, the laws of physics are the laws of special relativity*."

According to Pauli (1981),

> "*We can think of the physical realization of the local coordinate system K_o in terms of a freely floating, sufficiently small, box which is not subjected to any external forces apart from gravity, and which is falling under the influence of the latter. ... It is evidently natural to assume that the special theory of relativity should remain valid in K_o*.

Taylor and Wheeler (2000) state,

> "*General Relativity requires more than one free-float frame*."

Carroll and Ostlie (1996) write,

> "***The Principle of Equivalence**: All local, freely falling, nonrotating laboratories are fully equivalent for the performance of all physical experiments. … Note that special relativity is incorporated into the principle of equivalence. … Thus general relativity is in fact an extension of the theory of special relativity*."

According to the Dictionary of Geophysics, Astrophysics and Astronomy (2001),

> "*Near every event in spacetime, in a sufficiently small neighborhood, in every freely falling reference frame all phenomena (including gravitational ones) are exactly as they are in the absence of external gravitational sources*."

Clearly both the Principle of Equivalence and Special Relativity are defined in terms of the a priori presence of multiple arbitrarily large finite masses and photons. It is therefore impossible for the Principle of Equivalence and Special Relativity to manifest in a spacetime that by mathematical construction contains no matter. But *spacetime geometry* = 0 is a spacetime that by mathematical construction contains no matter. Thus expression (2) violates the physical principles of General Relativity and so it is inadmissible and therefore has no physical significance. Since Hilbert's solution is for *spacetime geometry* = 0 it is also of no physical significance. But it is from Hilbert's solution that the black hole was first generated. It is also impossible for the Principle of Equivalence and Special Relativity to manifest in a universe that, allegedly, contains only one mass. Therefore the black hole and big bang models are again inconsistent with the physical principles of General Relativity.

IX. THE ALLEGED 'RADIAL' QUANTITY IN HILBERT'S SOLUTION IS NEITHER A RADIUS NOR A DISTANCE

A solution to Einstein's field equations is called a metric or line-element, which are just other names for a distance formula. So Hilbert's solution is a metric or line-element. It is given by

$$ds^2 = c^2\left(1-\frac{2GM}{c^2 r}\right)dt^2 - \left(1-\frac{2GM}{c^2 r}\right)^{-1} dr^2 - r^2 d\Omega^2$$

$$d\Omega^2 = \left(d\theta^2 + \sin^2\theta d\varphi^2\right)$$

$$0 \le r \qquad (3)$$

The right-hand side of this equation is composed of two principle parts; a time related part and a spatial section subtracted from it. The time related part is,

$$c^2\left(1-\frac{2GM}{c^2 r}\right)dt^2$$

and the spatial section is all the rest. In words equation (3) can therefore be expressed as,

distance element = *time related part – spatial section* (4)

Now the quantity r in Hilbert's metric (3) has never been correctly identified by the astrophysical scientists. It has been variously and vaguely called a '*distance*', '*the radius*' (see Sections IV, VI and VII above), the '*radius of a 2-sphere*', the '*coordinate radius*', the '*radial coordinate*', the '*radial space coordinate*', the '*areal radius*', the '*reduced circumference*', '*the shortest distance a ray of light must travel to reach the center*', and even '*a gauge choice: it defines the coordinate r*'. In the particular case of $r = 2m = 2GM/c^2$ it is invariably referred to by proponents of the black hole as the '*Schwarzschild radius*' or the '*gravitational radius*'. Dirac (1996) calls $r = 2m$ "*the critical radius*" and also says,

> "*It would seem that $r = 2m$ gives a minimum radius for a body of mass m.*"

Penrose (2002) gives r two different definitions in the one sentence,

> "*The radial coordinate r has been chosen so that each sphere r = const, t = const has intrinsic surface area $4\pi r^2$.*"

(Thus, according to Penrose, r is the '*radial coordinate*' and is also the '*areal radius*'.)

However, none of the foregoing various and vague conceptions of what r is are correct because the irrefutable geometric fact is that r in Hilbert's metric is the inverse square root of the Gaussian curvature of the spherically symmetric geodesic surface in the spatial section (Crothers 2008, 2010), and so it is neither a radius nor a distance therein. It must also be emphasized that a geometry is fully determined by the form of its line-element. Indeed,

> "*And in any case, if the metric form of a surface is known for a certain system of intrinsic coordinates, then all the results concerning the intrinsic geometry of this surface can be obtained without appealing to the embedding space.*" (Efimov 1980)

> "*… the entire nature of a geometry is known to be determined by the form of its line element…*" (Tolman 1987)

Thus the ground-form of Hilbert's metric fixes the geometry and hence its intrinsic properties. In other words, the properties of a geometry are contained in the associated metric itself. Consequently the correct geometric identity of r in Hilbert's metric is determined from the metric, not by any extraneous names foisted upon the metric. One of the most important geometric features of a surface is its Gaussian curvature. Gaussian curvature is an intrinsic property of a surface[1]. Since it is easily proven that r in Hilbert's metric is the inverse square root of the Gaussian curvature of the spherically symmetric geodesic surface in the spatial section thereof, it is neither a radius nor a distance in Hilbert's solution. Thus, the many and varied vague 'definitions' of r given in the literature are invalid. Since r is neither a radius nor a distance in Hilbert's metric it can never be treated as such therein, contrary to the proponents of the black hole. Once again, the Schwarzschild radius is the radius of nothing in Hilbert's solution. The actual radius in the spatial section of Hilbert's solution is calculated from his metric (Crothers 2005, 2008, 2010).

Celotti, Miller and Sciama (1999) make the following incorrect assertion,

> "*The mean density $\overline{\rho}$ of a black hole (its mass M divided by $\frac{4}{3}\pi r_s^3$) is proportional to $1/M^2$*"

[1] Theorema Egregium – Gauss' Most Excellent Theorem.

where r_s is the Schwarzschild radius. But the volume of a sphere given by Celotti, Miller and Sciama cannot be calculated from Hilbert's solution. It is in fact the volume of a sphere in Newton's theory.

Transforming Hilbert's metric into the so-called isotropic coordinates does not change the intrinsic geometry of the metric (Crothers 2006a), does not change the fact that material sources are not present by mathematical construction, does not change the fact that *r* is neither a radius nor a distance in the metric, and does not change the fact that Newton's expression for escape velocity appears: a two-body relation in what is alleged to be a solution for a one-body problem. Use of the Eddington-Finkelstein coordinates and the Kruskal-Szekeres coordinates make no difference for the same reasons (Crothers 2006b). After all, each of these sets of so-called 'coordinates' is founded upon Hilbert's physically meaningless metric to begin with and therefore inherit the same meaninglessness. Change of coordinates on a meaningless solution does not impart meaning.

X. INVALIDITY OF EINSTEIN'S FIELD EQUATIONS

Recall that Einstein's field equations take the form,

spacetime geometry = - κ x *causative matter* (5)

In relation to expression (5) Einstein (1916) asserts that the total energy of his gravitational field is given by the sum of the energy of the gravitational field and the energy associated with its material sources,

total energy = *gravitational energy* + *source energy* (6)

where the gravitational energy is described by his so-called pseudotensor and that of the material sources by his energy-momentum tensor. Einstein's pseudotensor is denoted by the mathematical symbol t^{σ}_{μ}. Owing to Einstein's claims, expression (6) can therefore be rewritten equivalently as,

total energy = *pseudotensor* + *energy-momentum tensor* (7)

According to Einstein (1916) the components of his pseudotensor are the

"*energy components … of the gravitational field*".

Note that expression (7) is not a tensor sum because the pseudotensor is not a tensor. This violates Einstein's requirement that all equations must be tensorial. For energy and momentum to be conserved a mathematical operation called the divergence of the expression for the total energy of the gravitational field must be zero. But the divergence of Einstein's expression for the conservation of energy - momentum is an ordinary divergence, not a tensor divergence, again contrary to his requirement that all the equations must be tensorial. Einstein cannot take a tensor divergence of expression (7) because the pseudotensor is not a tensor and so he can only take an ordinary divergence, thus,

ordinary divergence of (total energy) = 0 (8)

where *total energy* is given by expression (7). Since he gets a divergence of zero Einstein (1916) then says of equation (8),

> *"Thus it results from our field equations of gravitation that the laws of conservation of momentum and energy are satisfied."*
>
> *"… we have to introduce the totality of the energy components of matter and gravitational field."*

Dirac (1996) remarks,

> *"It is not possible to obtain an expression for the energy of the gravitational field satisfying both the conditions: (i) when added to other forms of energy the total energy is conserved, and (ii) the energy within a definite (three dimensional) region at a certain time is independent of the coordinate system. Thus, in general, gravitational energy cannot be localized. The best we can do is to use the pseudotensor, which satisfies condition (i) but not condition (ii). It gives us approximate information about gravitational energy, which in some special cases can be accurate."*

Now Einstein's allegation that by equation (7) "… *the laws of conservation of momentum and energy are satisfied"* is not true because Einstein's pseudotensor is a meaningless collection of mathematical symbols and so it cannot be used to make any calculations or to represent any physical entity or to model any physical phenomena. Thus, Einstein's total energy expression (7) and the ordinary divergence of it, expression (8), are totally meaningless both physically and mathematically. The reason why Einstein's pseudotensor is entirely meaningless is as follows. There is an operation that can be performed on Einstein's pseudotensor tensor: it is called contraction, and consists of setting a superscript equal to a subscript and evaluating. When this is done to Einstein's pseudotensor the result is what is called a 1st-order intrinsic differential invariant (Levi-Civita 1917, Crothers 2008, 2010). But the pure mathematicians G. Ricci-Curbastro and T. Levi-Civita, inventors of the tensor calculus, proved in 1900 (Ricci-Curbastro and Levi-Civita 1900) that such invariants do not exist! Therefore, the assumption that Einstein's pseudotensor is meaningful produces an invariant that has no mathematical existence, and so the assumption of the validity of Einstein's pseudotensor is false (*reductio ad absurdum*). Similarly, Dirac's assertions on Einstein's pseudotensor are also incorrect.

Taking this fact into account, the fact that *spacetime geometry* = 0 is physically meaningless because it contains no material sources, and rightly considering the conservation of energy and momentum, Einstein's field equations (2) must take the following form (Lorentz 1916, Levi-Civita 1917, Crothers 2008, 2010),

$$\frac{spacetime\ \ geometry}{\kappa} + material\ \ sources = 0 \qquad (9)$$

Rewrite expression (7) as follows,

pseudotensor + *energy-momentum tensor*= *total energy* (10)

Compare expression (9) to expression (10). It is now clear that not only is expression (9) the correct form of Einstein's field equations but it is also the total energy of Einstein's gravitational field. It is also noted from expressions (9) and (10) that the term (*spacetime geometry*)/κ actually constitutes the components of a gravitational energy tensor, not the pseudotensor, since the latter is invalid. Then according to expressions (9) the total energy of Einstein's gravitational field is always zero. This means that the (*spacetime geometry*)/κ and the *material sources* must vanish identically (Levi-Civita 1917), i.e. when *material sources* is zero then (*spacetime geometry*)/κ is also zero, to yield the identity 0 = 0, so that when the energy-momentum tensor is zero there is no matter, no spacetime, no universe, and hence no gravitational field, and so Einstein's claim that his field equations reduce to *spacetime geometry* = 0 when there are no *material sources* is false; which is not surprising because *spacetime geometry* = 0 contains no matter by mathematical construction. It also means that gravitational energy cannot be localised i.e. Einstein gravitational waves do not exist (Levi-Civita 1917, Crothers 2008, 2009, 2010, 2012a); and that Einstein's field equations violate the usual conservation of energy and momentum and are therefore in conflict with experiment on a deep level rendering them invalid.

Addition of the so-called 'cosmological constant' Λ makes no difference to this result. Consider Einstein's field equations with Λ included. In words, they are usually given as,

spacetime geometry + Λ *term* = -κ x *material sources* (11)

Now 'Λ *term*' is not an energy-momentum tensor and so it is not a source of Einstein's gravitational field. It can only therefore contribute to the curvature of spacetime contained in the term *spacetime geometry*. In relation to expression (11) Tolman (1987) remarks that it,

> *"… connects the distribution of matter and energy with the geometry of space-time, by relating the energy-momentum tensor* $T_{\mu\nu}$ *to the fundamental metric tensor* $g_{\mu\nu}$ *and its derivatives."*

In view of expression (9) the field equations must be expanded to the following:

$$\frac{(spacetime\ \ geometry + \Lambda\ term)}{\kappa} + material\ \ sources = 0 \qquad (12)$$

where (*spacetime geometry* + Λ *term*)/κ now gives the components of a gravitational energy tensor, so that (*spacetime geometry* + Λ *term*)/κ and *material sources* must vanish identically, with all the consequences related to expression (9). So the cosmological constant also has no physical meaning.

XI. Recapitulation and Conclusion

The black hole and the big bang model are mutually exclusive. The black hole has no valid basis in General Relativity or Newton's theory of gravitation. The alleged escape velocity of a black hole and the 'radius' of its event horizon (Schwarzschild radius) are obtained from Newton's expression for escape velocity which is inserted post hoc into Hilbert's solution in order to obtain a material source: this is a two-body relation in what is alleged to be the solution for a one-body problem, and so it is inadmissible. The idea of multiple black holes violates the defining boundary condition of spacetime asymptotic flatness of the alleged black hole, which necessarily excludes the possibility of multiple black holes. The Principle of Superposition is invalid in General Relativity and so additional masses and radiation cannot be superposed upon any solution to Einstein's field equations in order to obtain multiple masses and photons. When there are no material sources present for the gravitational field Einstein's field equations must vanish. The total energy of Einstein's gravitational field is always zero so that Einstein's field equations violate the usual conservation of energy and momentum and cannot localise energy to produce Einstein gravitational waves. Einstein's pseudotensor representing the energy of the gravitational field is a meaningless collection of mathematical symbols because it implies the existence of a 1st-order intrinsic differential invariant, which does not in fact exist. The Hawking-Penrose Singularity Theorem is invalid (Crothers 2013). The cosmological constant has no physical meaning, and so expansion of the Universe "*from Negative* Λ" (Hartle, Hawking and Hertog 2012) or otherwise, has no physical meaning (Crothers 2013). Einstein's General Theory of Relativity is riddled with mathematical falsehoods and logical inconsistencies that cannot be rectified, rendering it an untenable theory.

DEDICATION

I dedicate this paper to my beloved late brother:

Paul Raymond Crothers

12TH MAY 1968 – 25TH DECEMBER 2008

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