

# COULD OUR UNIVERSE HAVE FEATURES OF A GIANT BLACK HOLE?

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Proposed Running Head: An Interpretation of Data Derived from the 2013 Planck Survey

## ABSTRACT

The 2013 Planck Survey results yielded the following estimates for mass ( $1.46 \times 10^{53}$  kg), radius ( $4.3 \times 10^{26}$  m) and average density ( $4.08 \times 10^{-28}$  kg/m<sup>3</sup>) for the visible portion of our universe. These mass and density numbers are for the baryonic (“ordinary”) matter portion only. These data can be plotted in close proximity (within approximately a factor of 2) to the projection lines of a logarithmic graph of calculated black hole mass vs. Schwarzschild radius and black hole average density vs. Schwarzschild radius, respectively. The Schwarzschild formula,  $r_s = 2GM/c^2$ , and a simple black hole average density formula,  $\rho = 3c^2/8\pi Gr_s^2$ , are used to calculate mass and average density for theoretical black holes ranging from microscopic to the radius of our visible universe, and these values are plotted on the logarithmic graph. The possible implications of these findings are discussed, including a rationale for the possibility that the largest black holes (giant “dark black holes”) may be beyond our capability to detect them. It remains to be seen whether adding in dark matter mass and average density contributions to the graph would put our universe exactly on the black hole projection lines, or within the shaded territory exclusive to black holes, but the possibility of this happening is not ruled out at the present time.

Key Words: Black Hole, Visible Universe, Planck Survey, Schwarzschild Formula, Baryonic Matter, Dark Matter

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The 2013 Planck Survey results yield the following estimates for mass ( $1.46 \times 10^{53}$  kg), radius ( $4.3 \times 10^{26}$  m) and average density ( $4.08 \times 10^{-28}$  kg/m<sup>3</sup>) for the visible portion of our universe.<sup>1</sup> These mass and density numbers are for the baryonic (“ordinary”) matter portion only. These data can be plotted in close proximity to the projection lines of a logarithmic graph of calculated black hole mass vs. Schwarzschild radius and black hole average density vs. Schwarzschild radius, according to rearranged Schwarzschild formula  $M = r_s c^2 / 2G$  and average density formula  $\rho = 3c^2 / 8\pi G r_s^2$ , respectively. If one solves for average density  $\rho$  of a simple black hole of  $r_s = 4.3 \times 10^{26}$  m, the solution is  $8.71 \times 10^{-28}$  kg/m<sup>3</sup>, which is slightly more than twice the Planck Survey result for universal baryonic matter average density. However, because the Schwarzschild formula is derived from the law of conservation of energy (see below), the latter black hole calculation would be expected to include all mass  $M$ , not just that attributable to baryonic matter.

Using conservation of energy, one can derive the Schwarzschild formula. By equating absolute magnitude of gravitational potential energy ( $GMm/r$ ) with the

magnitude of kinetic energy ( $mv^2/2$ ), one can see that  $M/r = v^2/2G$ . And, for the scenario of a black hole,  $M/r = c^2/2G$ . The use of  $c$  for velocity of mass treated as at the black hole center is believed to be justified by special relativity because receding light photons can be viewed as stationary relative to orthogonal space-time geodesics at the event horizon (i.e., no light can escape the event horizon).

General relativity places no limits on the size potential of a black hole with zero angular momentum. While some observers may have assumed that galactic supermassive black holes must be some sort of upper size limit, one can make the case that considerably larger black holes should have features making them virtually impossible to detect from Earth. The reasoning goes as follows: giant black holes which have consumed all, or nearly all, of the matter within their vicinity should be relatively quiescent, having no appreciable accretion disc; they would also be expected to have considerably smaller surface  $g$ 's and considerably flatter topologies relative to galactic supermassive and smaller black holes, owing to extremely low average density. Hence, in the absence of detectable aberrant orbital motions (of nearby stars), absence of accretion disc phenomena (X-rays, etc.), and weak to non-existent gravitational lensing, these giant "dark black holes" might exist and yet be completely

undetectable. Such “dark black holes,” due to their extremely massive nature, could conceivably contribute considerable matter to the universal mass-energy account ledger, although they would not be expected to contribute the dark matter presumably responsible for peculiarities of galactic rotation with respect to Newtonian gravitational mechanics.

Giant black holes, by the nature of their extremely low average densities, would be expected to have considerably flatter topologies than their much smaller brethren. It is estimated that a giant black hole the radius of our visible universe would have a nearly flat topology, similar to that of our universe, and a surface  $g$  at the event horizon of less than  $10^{-11}$  Earth surface  $g$ . Furthermore, while a microscopic black hole would be expected to have extremely high average internal density, pressure, and temperature (with corresponding black body Hawking radiation), a giant black hole would be expected to have opposite internal features and no significant Hawking radiation (owing to the magnitude of  $r_s$ ). The following is a table of calculations of these expected properties according to the conventional Schwarzschild radius  $r_s$ :

Table 1

<b>BLACK HOLE FEATURES FOR A GIVEN SCHWARZSCHILD RADIUS</b>			
<b>RADIUS</b> (METERS)	<b>MASS</b> (Kg) ( $M = c^2 R/2G$ )	<b>DENSITY</b> (Kg/m <sup>3</sup> ) ( $3c^2/8\pi G R^2$ )	<b>RELATIVE INTERNAL TEMP</b>
$10^{-12}$	$.675 \times 10^{15}$	$1.61 \times 10^{50}$	Extremely High ( $10^9$ K?)
$10^{-6}$	$.675 \times 10^{21}$	$1.61 \times 10^{38}$	Less Extremely High ( $10^8$ K?)
$10^0$	$.675 \times 10^{27}$	$1.61 \times 10^{26}$	Exceedingly High ( $10^7$ K?)
$10^6$	$.675 \times 10^{33}$	$1.61 \times 10^{14}$	Moderately High ( $10^6$ K?)
$10^{12}$	$.675 \times 10^{39}$	$1.61 \times 10^2$	Cool ( $10^2$ K?)
$10^{18}$	$.675 \times 10^{45}$	$1.61 \times 10^{-10}$	Extremely Cold (10 K?)
$10^{26}$	$.675 \times 10^{53}$	$1.61 \times 10^{-26}$	Near Absolute Zero (2.7 K?)

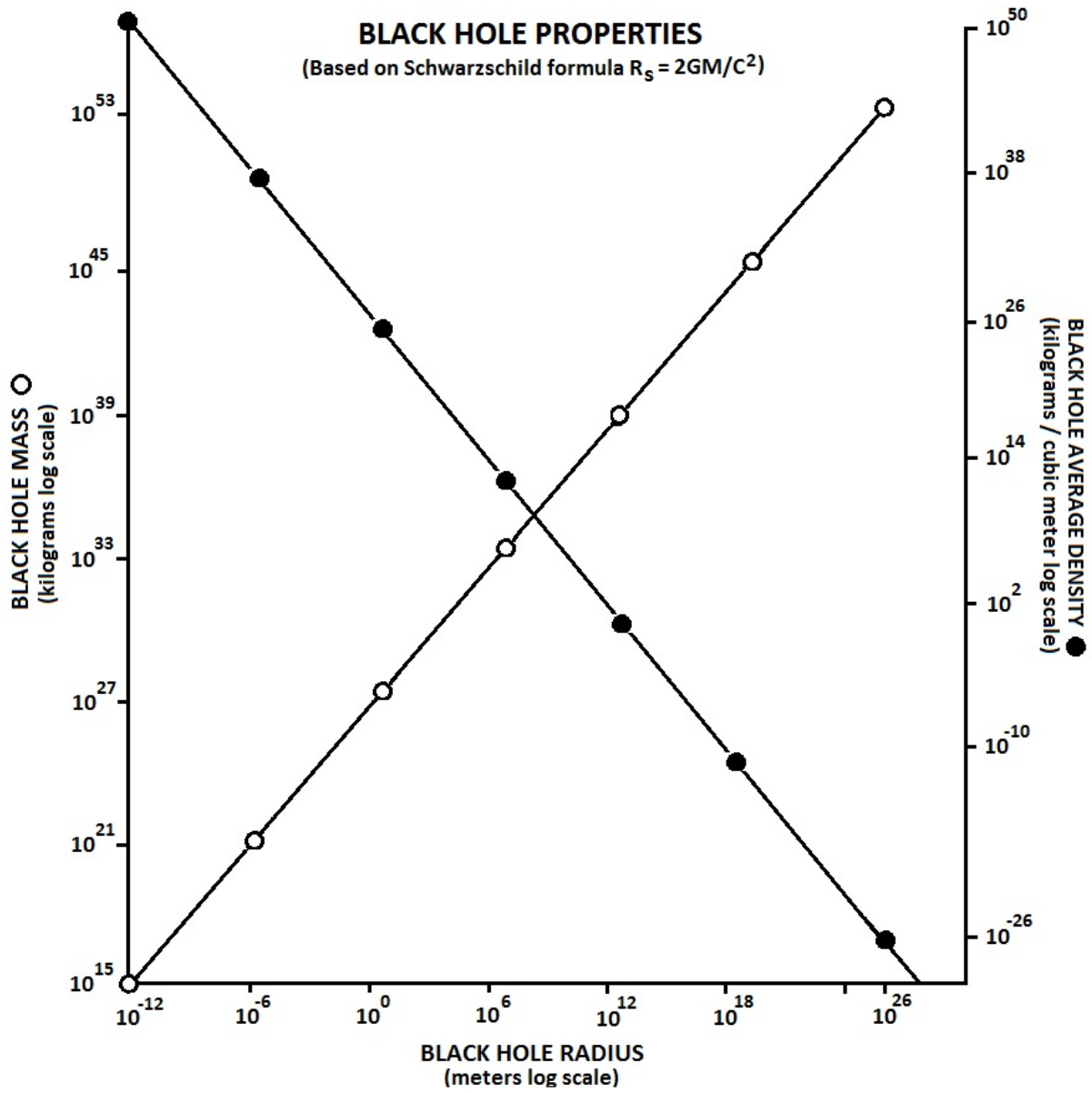
It is interesting to note that the smooth progression from extremely small, dense and hot to extremely large, sparse and cold follows the expected forward sequence of standard big bang cosmology.

Admittedly, there is some license taken with the last column of the table (relative internal temperature). After all, the internal conditions of a black hole are unmeasurable and unknowable with any certainty. However, we do presume to know something about the material a black hole feeds on, which should give us some clues about the interior, simply by observation and modelling of the immediate surroundings of the event horizon. Scientists who study black holes and suspected black holes believe that “active” black holes have an accretion disc of extremely hot material which swirls around the event horizon at astonishing velocity, approaching the speed of light. Due to friction and conversion of gravitational potential energy into kinetic (including heat) energy, this material is believed to reach temperatures in the hundreds of million degrees Kelvin. High energy photon emissions (X rays) have been observed from suspect black hole candidates, in support of these temperature estimates. As such, the material from the accretion disc which falls past the event horizon into the black hole must have very similar properties and contribute considerable heat energy to the black hole

interior, despite our inability to measure the interior. It is also notable that black holes, in their younger (smaller) stages are believed to be considerably more “active” in ingesting the relatively abundant surrounding matter, in contrast to older (larger) black holes which reach more intermittent stages of ingestion due to their own prior activity (the “low hanging fruit” has already been “eaten”). It does not seem unreasonable to postulate that the oldest and largest black holes become nearly or completely inactive (and, therefore, considerably colder internally from their previous expansion) due to scarcity of matter within their gravitational reach. Hence, there is good reason to believe in the relative comparisons within the internal temperature column, despite the guesswork as to the absolute magnitude of these temperatures.

The following is an extended logarithmic graph of black hole features according to the calculations in the preceding table:

Figure 1

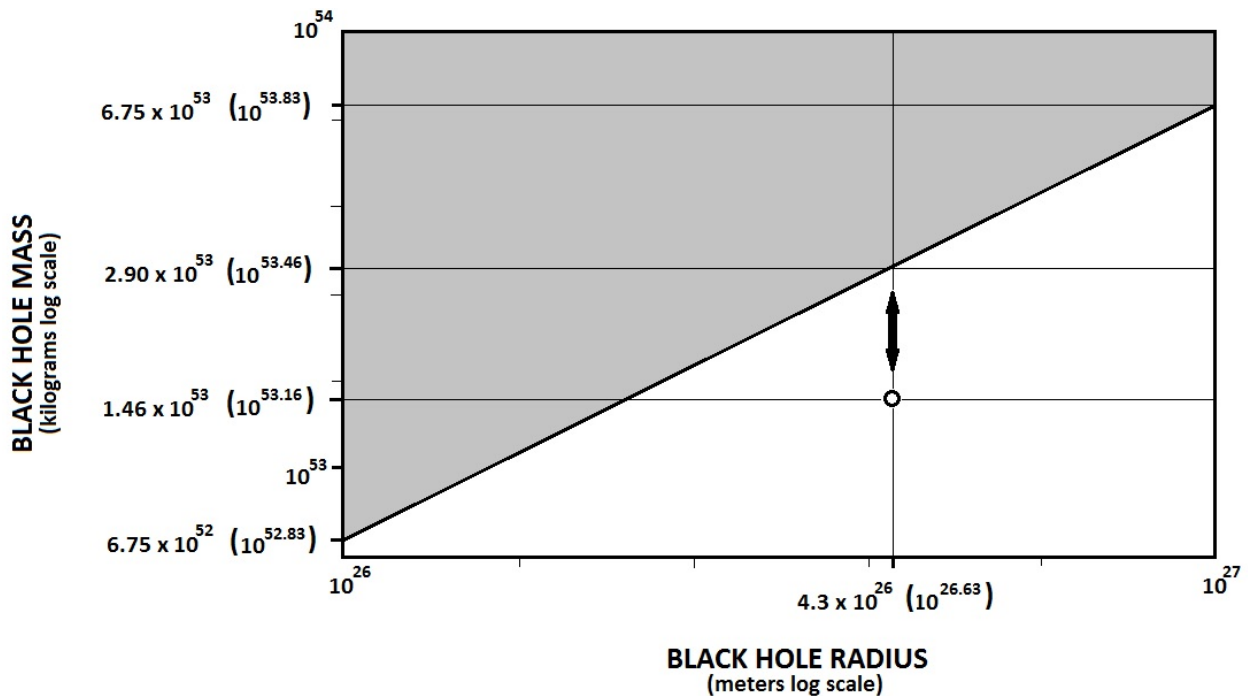


While not falling exactly on the black hole mass and average density lines, the Planck Survey values of  $M = 1.46 \times 10^{53}$  kg and ordinary matter average density of  $4.08 \times 10^{-28}$  kg/m<sup>3</sup> are close enough to these lines to fall within the perimeters of the far right circles plotted for a radius of  $10^{26}$  meters.

A highly magnified view of the contents of the far right mass-vs-radius circle (open circle) in Fig. 1 is shown below:

Figure 2

Black Hole Mass vs. Schwarzschild Radius

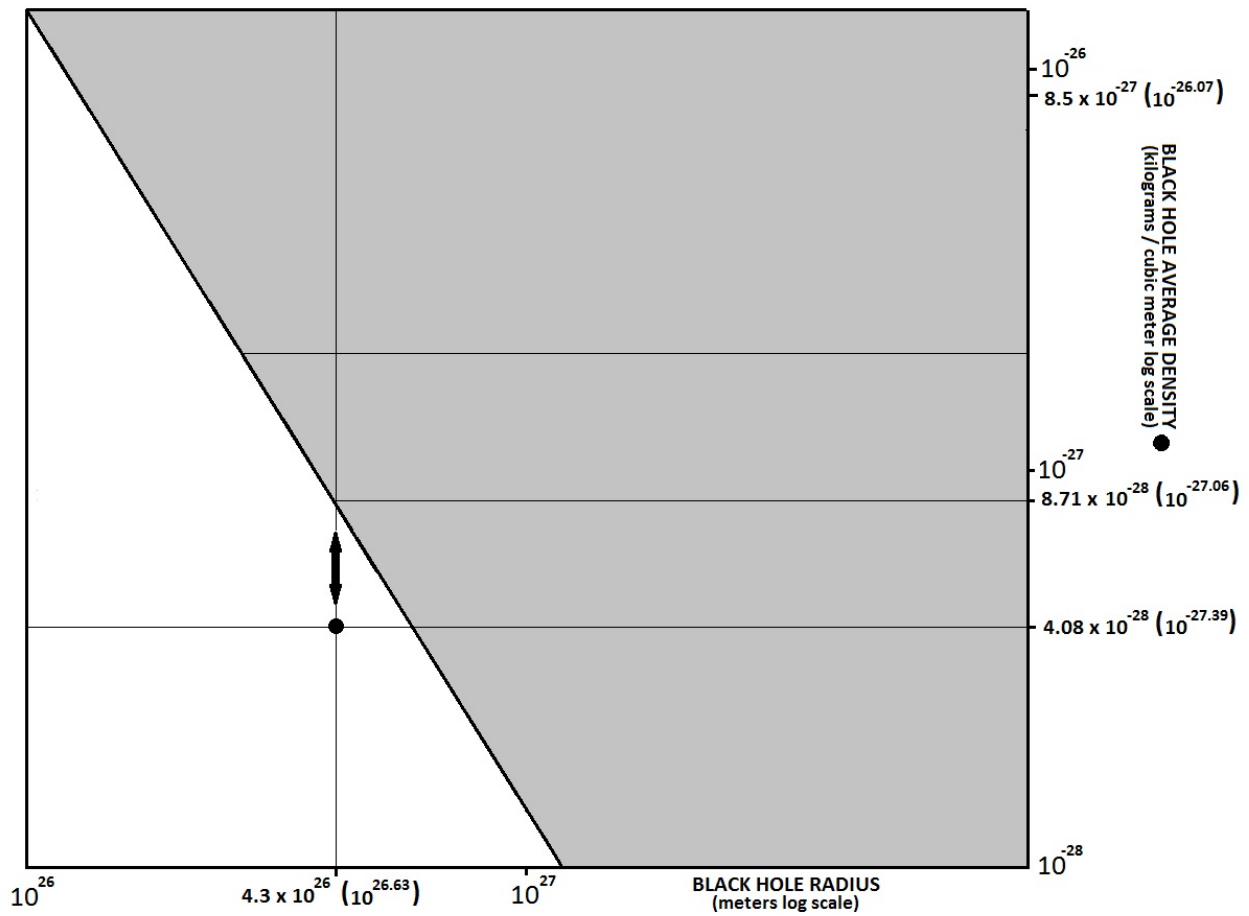


The double arrow shows the close proximity of the visible universe values to the bold diagonal (Schwarzschild black hole) line. The diagonal line and shaded area represent black hole conditions.

A highly magnified view of the contents of the far right average density-vs-radius circle (black circle) from Fig. 1 is shown below:

Figure 3

Black Hole Average Density vs. Schwarzschild Radius



The double arrow shows the close proximity of the visible universe values to the bold diagonal (Schwarzschild black hole) line. The diagonal line and shaded area represent black hole conditions.

One can see that adding in the contribution of dark matter would move both the mass and average density numbers upward, in the direction of both black hole diagonal lines. It remains to be seen whether the final result would put our universe exactly on these Schwarzschild black hole diagonal lines, or into the shaded territory exclusive to black holes, but the possibility of this happening is not ruled out at the present time.

## REFERENCES

1. Planck Collaboration. 2013, arXiv:1303.5076 [astro-ph.CO]

TABLES

Table 1

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# FIGURES

Figure 1

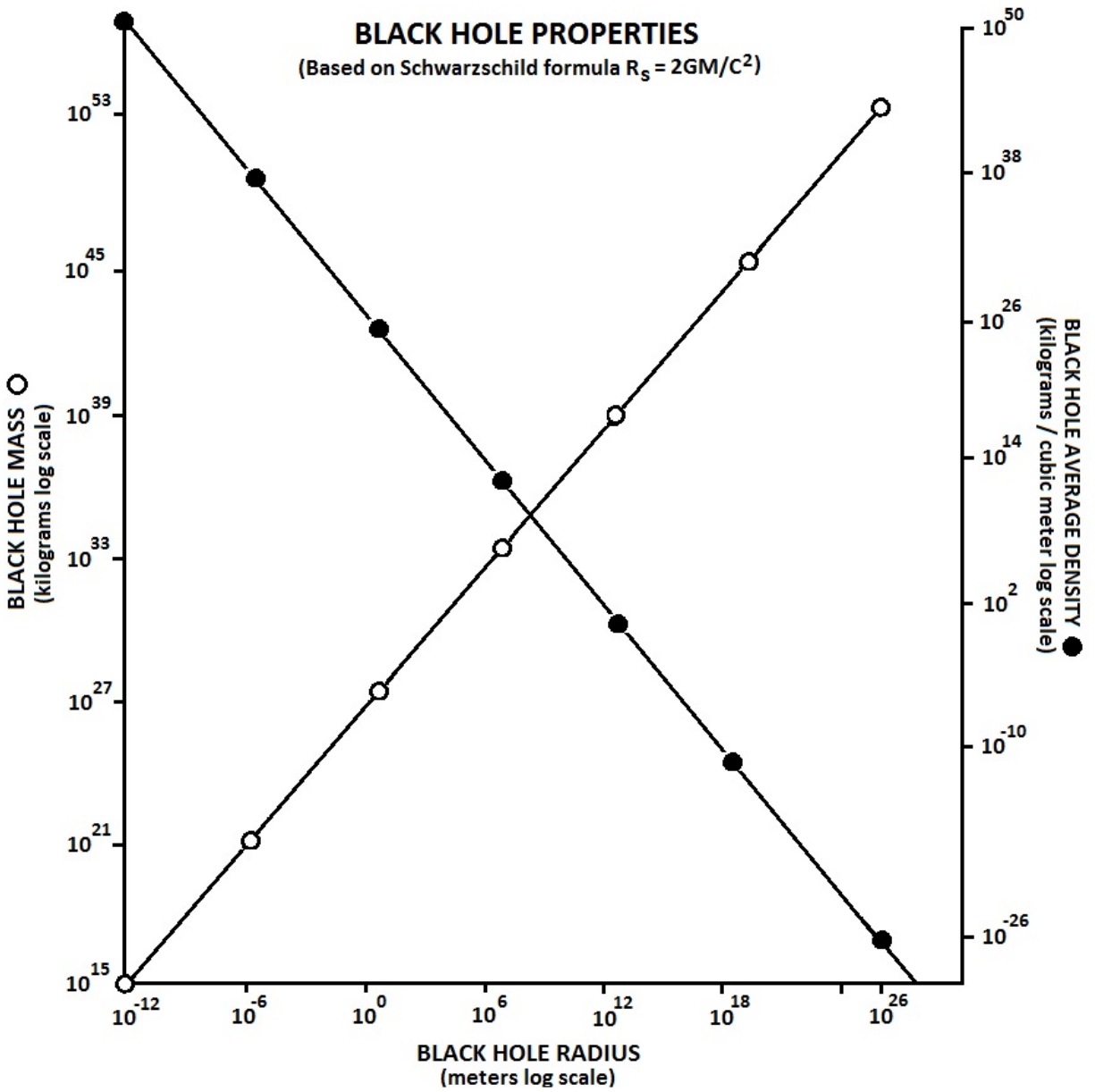


Figure 2

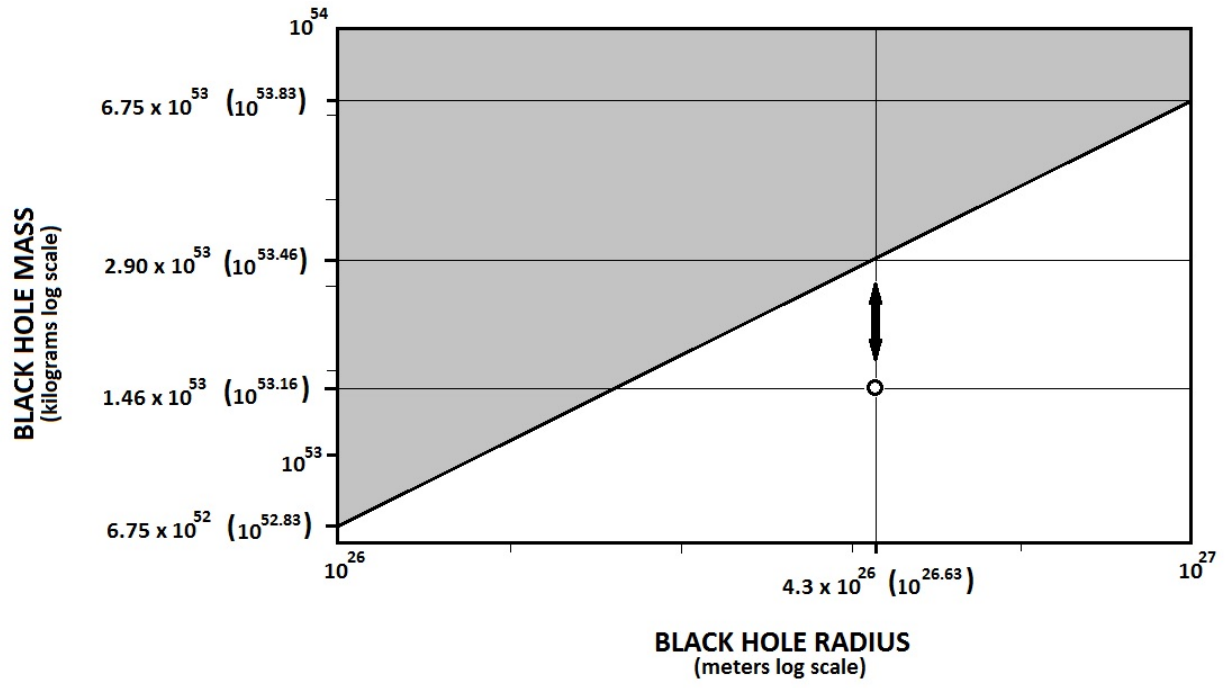


Figure 3

