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Wormholes Do Not Exist, They are Mathematical Artifacts from an Incomplete Gravitational Theory (?)

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Abstract

The Schwarzschild solution of the Einstein field equation leads to a solution that has been interpreted as wormholes. Many have been skeptical about this interpretation. However, many researchers have also been positive about it. We show that wormholes are not mathematically allowed in the spherical metric of a newly-released unified quantum gravity theory known as collision space-time [1–3]. We therefore have reasons to believe that wormholes in general relativity theory are nothing more than a mathematical artifact due to an incomplete theory, but we are naturally open for discussions about this point. That wormholes likely do not exist falls nicely into line with a series of other intuitive predictions from collision space-time where general relativity theory falls short, such as matching the full specter of the Planck scale for micro black “holes”.

Keywords: wormholes, general relativity, quantum gravity, collision space-time.

1 Background

Flamm [4] had hinted at wormholes existing as early as 1916, but in 1935, Einstein and Rosen [5] seem to be the first to take the wormhole idea seriously and to try to accomplish some mathematical physics with it by utilizing general relativity theory [6] and the Schwarzschild metric [7, 8] given by:

$$c^2 d\tau^2 = -\frac{dr^2}{1 - \frac{r_s}{r}} - r^2(d\theta^2 + \sin\theta d\phi^2) + \left(1 - \frac{r_s}{r}\right) c^2 dt^2 \quad (1)$$

Next, as often carried out, we set $c = 1$, $r_s = \frac{2GM}{c^2} = 2m$. Furthermore, as suggested by Einstein and Rosen, we define a new variable $u^2 = r - 2m$, and then replace r with $r = u^2 + m$ in the Schwarzschild metric. From this, we get

$$ds^2 = -4(u^2 + 2m)du^2 - (u^2 + 2m)^2(d\theta^2 + \sin\theta d\phi^2) + \frac{u^2}{u^2 + 2m}dt^2 \quad (2)$$

This is the result given by Einstein and Rosen in their 1935 paper, and they discuss the special case when $u = 0$. In this case, the $g_{4,4} = \left(1 - \frac{r_s}{r}\right) c^2 dt^2$ term vanishes (as it becomes zero), while the other terms in the Schwarzschild solution are still well defined. This means the change in time is no longer affected by the metric. This has been interpreted as at least a theoretical possibility for what is known as a wormhole: two points in space-time can possibly be connected with what is known as a the Einstein Rosen bridge or in more popular terms, a “wormhole” or a Schwarzschild wormhole, since it is derived using the Schwarzschild metric. This indicates that two points can be close, and even if they are billions of light years apart, they can still be connected with the Einstein Rosen bridge where it takes no time to travel between the two points. Wormholes have been investigated theoretically by a series of physicists [9–12]. Some think wormholes are a possibility, others think of it more as a mathematical artifact coming out from the theory. The book *Lorentzian Wormholes* [13] gives a good overview of the topic.

In our view, despite the success in many predictions from general relativity and the Schwarzschild metric, we still think the theory has strong limitations. For example, the Schwarzschild metric cannot match up with the full Planck scale, see [14].

2 Are wormholes allowed in the collision space-time metric?

The spherical metric in collision-space time [14] (3 time dimensions and 3 space dimensions) that takes into account gravity is give by:

$$ds^2 = - \left(1 - \frac{2GM}{rc^2} + \frac{G^2M^2}{c^4r^2} \right) c^2 dt^2 - c^2 t^2 d\theta^2 - c^2 t^2 \sin^2 \theta d\phi^2 + \frac{dr^2}{1 - \frac{2GM}{rc^2} + \frac{G^2M^2}{c^4r^2}} + r^2 d\theta^2 + r^2 \sin^2 \theta d\phi^2 \quad (3)$$

Next, we will also be setting $c = 1$ for this metric. The radius where the escape velocity is c in this theory is $r_h = \frac{GM}{c^2}$ when $v_e = c$, for notation purpose we can set $m = \frac{GM}{c^2}$. Furthermore, we can also here define a new variable $u^2 = r - m$. The choice of u is such that we end up with the dt^2 term vanishing, that is we can replace r with $r = u^2 + m$ in the space-time metric. From this, we get:

$$ds^2 = - \left(\frac{u^2}{u^2 + m} \right)^2 dt^2 - t^2 d\theta^2 - t^2 \sin^2 \theta d\phi^2 + \frac{4(u^2 + m)^2}{u^2} du^2 + (u^2 + m)^2 (d\theta^2 + \sin^2 \theta d\phi^2) \quad (4)$$

If we next set $u = 0$, then as expected, the dt^2 element disappears in a similar way to the way it did in the Schwarzschild metric, but in our metric, the du^2 term now goes on to be infinite or is actually mathematically undefined (a singularity). The fact that the du^2 term is no longer mathematically valid can be interpreted as no valid solution being available when the dt^2 element disappears. The interpretation of this must be that wormholes are forbidden in our theory. This is in contrast to the Schwarzschild metric where the du^2 term and other parts of the metric were well behaved even after the dt^2 term vanished. One should not only look for what a theory predicts and what is confirmed by observations, but also for what it predicts that not has been observed and also sounds very unlikely. If a theory predicts that pink elephants fly back and forth between the moon and the earth, then I cannot prove they do not exist as one always could claim there only a few of them hiding somewhere in a jungle, but since they have not been observed and in addition, they have properties that seem extremely unlikely, a theory that shows they not can exist would perhaps be preferable.

The fact that wormholes do not exist in our theory has little to do with the fact that we are using a 6-dimensional theory. It is connected to the fact that Einstein abandoned relativistic mass. In his famous special relativity theory paper Einstein [15] suggested relativistic mass, but got it wrong, while Lorentz gave a likely correct relativistic mass formula already in 1904 ($m_r = m\gamma$). The fact that Einstein and some of his followers [16–19] abandoned relativistic mass leads to an escape velocity in general relativity theory, which is identical to that of Newton mechanics $v_e = \sqrt{\frac{2GM}{r}}$. See [20] that formally show why the escape velocity in general relativity is the same as that in Newton mechanics. On the other hand, we take into account relativistic mass in our escape velocity and space-time metric, and our escape velocity is given by $v_e = \sqrt{\frac{2GM}{r} + \frac{G^2M^2}{c^2r^2}}$. This is what leads to wormholes being forbidden in our theory. We could also have formulated a four dimensional space-time metric and simply replaced the general relativity escape velocity with our full relativistic escape velocity. However, then, we would not be able to make it fully consistent with the quantum world, but this is outside the scope of this paper.

3 Conclusion

In the Schwarzschild solution, we are able to allow the dt^2 term to vanish, while the other parts of the Schwarzschild metric are still well defined and well behaved, this has lead to speculations about wormholes being possible in general relativity theory. In our collision space-time theory, the metric does not allow wormholes as demonstrated in this paper. In addition, we have previously shown that our metric matches up with all properties of the Planck scale for micro black holes, while general relativity theory and the Schwarzschild metric can only match one or two properties of the Planck scale for micro black holes. In addition, our metric is consistent with a new universe equation that seems more logical [21]. Most importantly, our metric is also consistent with a quantum gravity theory that unifies gravity with quantum mechanics.

References

- [1] E. G. Haug. Collision space-time: Unified quantum gravity. *Physics Essays*, 33(1):46, 2020. URL <https://doi.org/10.4006/0836-1398-33.1.46>.
- [2] E. G. Haug. Rethinking the foundation of physics and its relation to quantum gravity and quantum probabilities: Unification of gravity and quantum mechanics. *Preprints.org*, 2020. URL <https://www.preprints.org/manuscript/202012.0483/v2>.

- [3] E. G. Haug. *Quantum Gravity Hidden In Newton Gravity And How To Unify It With Quantum Mechanics*. in the book: *The Origin of Gravity from the First Principles*, Editor Volodymyr Krasnoholovets, NOVA Publishing, New York, 2021.
- [4] L. Flamm. Beiträge zur einsteinschen gravitationstheorie. *Phys. Z.*, (17), 1916.
- [5] A. Einstein and N. Rosen. The particle problem in the general theory of relativity. *Phys. Rev.*, (48), 1935. URL <https://journals.aps.org/pr/pdf/10.1103/PhysRev.48.73>.
- [6] A. Einstein. Näherungsweise integration der feldgleichungen der gravitation. *Sitzungsberichte der Königlich Preussischen Akademie der Wissenschaften Berlin*, 1916.
- [7] K. Schwarzschild. Über das gravitationsfeld eines massenpunktes nach der einsteinschen theorie. *Sitzungsberichte der Deutschen Akademie der Wissenschaften zu Berlin, Klasse für Mathematik, Physik, und Technik*, page 189, 1916.
- [8] K. Schwarzschild. über das gravitationsfeld einer kugel aus inkompressibler flüssigkeit nach der einsteinschen theorie. *Sitzungsberichte der Deutschen Akademie der Wissenschaften zu Berlin, Klasse für Mathematik, Physik, und Technik*, page 424, 1916.
- [9] M. Morris, M and K. T. Thorne. Wormholes in spacetime and their use for interstellar travel: A tool for teaching general relativity. *American Journal of Physics*, 56:395, 1988. URL <https://doi.org/10.1119/1.15620>.
- [10] J. Prat-Camps, C. Navau, and A. Sanchez. A magnetic wormhole. *Nature Scientific Reports*, 5:12488, 2015. URL <https://doi.org/10.1038/srep12488>.
- [11] P. Gao, D. L. Jafferis, and A. C. Wall. Traversable wormholes via a double trace deformation. *Journal of High Energy Physics volume*, 2017:151, 2017. URL [https://doi.org/10.1007/JHEP12\(2017\)151](https://doi.org/10.1007/JHEP12(2017)151).
- [12] Paul. B. C. Traversable wormholes in the galactic halo with MOND and non-linear equation of state. *Classical and Quantum Gravity*, 38:145022, 2021. URL <https://doi.org/10.1038/srep12488>.
- [13] Matt Visser. *Lorentzian Wormholes*. AIP Press, Springer, 1996.
- [14] E. G. Haug. Three dimensional space-time gravitational metric, 3 space + 3 time dimensions. *Journal of High Energy Physics, Forthcoming, Gravitation and Cosmology*, 2021.
- [15] A. Einstein. Zur elektrodynamik bewegter körper. *Annalen der Physik*, (17), 1905.
- [16] C. G. Adler. Dose mass really depends on velocity dad? *American Journal of Physics*, 55:739, 1987. URL <https://doi.org/10.1119/1.15314>.
- [17] L. B. Okun. The concept of mass. *Physics Today*, 42, 1989. URL <https://doi.org/10.1063/1.881171>.
- [18] E. Hecht. Einstein never approved the relativistic mass formula. *The Physics Teacher*, 47:336, 2009.
- [19] Edwin F. Taylor and J. A. Wheeler. *Spacetime Physics, Introduction To Special Relativity*. W. H. Freeman and Company, New York, 1992.
- [20] A. T. Augousti and A. Radosz. An observation on the congruence of the escape velocity in classical mechanics and general relativity in a Schwarzschild metric. *European Journal of Physics*, 376:331–335, 2006. URL <https://doi.org/10.1088/0143-0807/27/2/015>.
- [21] E. G. Haug. A new full relativistic escape velocity and a new Hubble related equation for the universe. *Hal archives*, 2021. URL <https://hal.archives-ouvertes.fr/hal-03240114>.

Appendix: Derivations

The dt^2 term is given by

$$\left(1 - \frac{2GM}{c^2 r} + \frac{G^2 M^2}{c^4 r^2}\right) dt^2 \quad (5)$$

After replacing $c = 1$ and $\frac{GM}{c^2}$ with m and $r = u^2 + m$, we get

$$\begin{aligned}
& \left(1 - \frac{2GM}{c^2 r} + \frac{G^2 M^2}{c^4 r^2}\right) dt^2 \\
& \left(1 - \frac{2m}{r} + \frac{m^2}{r^2}\right) dt^2 \\
& \left(1 - \frac{2m}{r} + \frac{m^2}{r^2}\right) dt^2 \\
& \left(1 - \frac{m}{r}\right)^2 dt^2 \\
& \left(1 - \frac{m}{u^2 + m}\right)^2 dt^2 \\
& \left(\frac{u^2}{u^2 + m}\right)^2 dt^2
\end{aligned} \tag{6}$$

Next, we set $u = 0$ and we now see the dt^2 term vanish as it is multiplied by zero. Furthermore, the dr^2 term is given by:

$$\begin{aligned}
& \frac{1}{1 - \frac{2m}{r} + \frac{m^2}{r^2}} dr^2 \\
& \frac{1}{1 - \frac{2m}{r} + \frac{m^2}{r^2}} 4u^2 du^2 \\
& \frac{1}{\left(1 - \frac{m}{r}\right)^2} 4u^2 du^2 \\
& \frac{1}{\left(1 - \frac{m}{u^2 + m}\right)^2} 4u^2 du^2 \\
& \frac{1}{\left(\frac{u^2}{u^2 + m}\right)^2} 4u^2 du^2 \\
& \frac{1}{\frac{u^4}{u^4 + 2u^2 m + m^2}} 4u^2 du^2 \\
& \frac{u^4 + 2u^2 m + m^2}{u^4} 4u^2 du^2 \\
& \frac{4u^4 + 8u^2 m + 4m^2}{u^2} du^2 \\
& \left(4u^2 + 8m + 4\frac{m^2}{u^2}\right) du^2 \\
& 4\left(u^2 + 2m + \frac{m^2}{u^2}\right) du^2 \\
& \frac{4(u^4 + 2u^2 m + m^2)}{u^2} du^2 \\
& \frac{4(u^2 + m)^2}{u^2} du^2
\end{aligned} \tag{7}$$

when we set $u = 0$, we see this leads to division by zero, which is mathematically undefined, in other words, a singularity (pole). That is our solution and cannot be valid for when dt^2 vanishes as this would mean we have to move into infinite space, which is impossible. In other words, wormholes cannot exist in our spherical metric, and can likely not exist at all in our new unified quantum gravity theory. This is in strong contrast to general relativity theory where this is a mathematical possibility as the du^2 terms and other terms are well defined and valid even after the dt^2 term vanishes there.