What Can a Pillar of Salt Teach Us about Black Holes?

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Abstract: Biblical exegetes have interpreted the story of the destruction of Sodom and Lot's wife turning back to look at it as a godly act of punishment, along with a theological realization about God's might, the worthiness of His creatures to witness it, and moral implications of disobeying God's instructions. In this paper, I offer a different interpretation of why God turned Lot's wife into a pillar of salt, one based upon God's traits of mercy and compassion. I continue by relating the story to astrophysical findings of black holes, and claim that the biblical account holds relevance to Roger Penrose's cosmic censorship conjecture and to why scientists have not yet found naked black hole singularities in the universe.

Keywords: Black Hole, Event Horizon, Gravitational Singularity, Sodom and Gomorrah, Lot's Wife, Pillar of Salt, Science and Theology, Karen Armstrong, General Relativity, Roger Penrose, Cosmic Censorship Conjecture.

Part 1: Introduction

The Gospel of Matthew tells of a bright star that appeared in the sky around the time of Jesus' birth. The star had prompted three wise men from the East (the "Magi") to arrive in Jerusalem in search of the "King of the Jews."[1] Since the Bible reports that Jesus was born in Bethlehem, the star was named the "Star of Bethlehem."

[1] Matthew 2:1-2.

In his 1955 story "The Star," writer Arthur C. Clarke debates the moral implications of the Star of Bethlehem.[2] Clarke assumes that the biblical star was nothing less than a cataclysmic celestial event seen from earth around the time of the birth of Christ. He then debates the moral implications arising from such a possibility by intertwining the religious narrative with a phenomenon known to exist throughout the universe and which is well described by astrophysicists today – a supernova. In this article, I wish to follow in Clarke's footsteps and discuss the implications of the biblical stories of the destruction of Sodom and the fate of Lot's wife upon a phenomenon described by astrophysicists and partially observed by astronomers: cosmic black holes and their event-horizon clad singularities.

I contend that the biblical story of Lot's wife holds a moral which is relevant to our exploration of cosmic black holes. I make this claim despite the biblical narrative's lack of historical authenticity. I will not discuss the historicity of the destruction of Sodom and Lot's wife, but will refer to the story as one whose purpose is to guide our thinking about God and His relation to human choices. To this end, I will briefly describe Karen Armstrong's understanding of religious symbolism and use it to gain insight into how the biblical narrative of Lot's wife may guide us in our quest for further knowledge about black holes, their structure and occurrence. Furthermore, the morals gained from the story of Lot's wife link directly to Roger Penrose's Cosmic Censorship Conjecture. The two have a common conceptual basis that may spawn certain understandings regarding the phenomena we observe in the universe, both those already described by astrophysicists as well as those not yet found.

I will start by delineating the biblical story surrounding the destruction of the cities of Sodom and Gomorrah and the subsequent indiscretion by Lot's wife, which resulted in her

[2] https://sites.uni.edu/morgans/astro/course/TheStar.pdf

turning into a pillar of salt (Part 2). I will then explain what cosmic black holes are and how they are formed and structured, followed by an explanation of why we cannot find a specific type of black hole and how the Cosmic Censorship Conjecture explains this (Part 3). In the final part, I will explain how the biblical narrative is relevant to our understanding of the conjecture and what theological conclusions we may draw from such an analysis (Part 4).

Part 2: Lot's Wife and the Destruction of Sodom

The *Genesis* Narrative

The book of *Genesis* describes three men who visit Abraham and his wife and tell them that Sarah will bear a child. Two of the men (about whose divinity and angelhood interpretations vary[3]) then leave Abraham's encampment and turn toward the city of Sodom, in the south of Canaan. The visitor who stayed behind was God's messenger. He speaks to Abraham and tells him that God had decided to destroy the city of Sodom because of its sinful inhabitants. Abraham tries to persuade God to spare the lives of citizens of Sodom and ultimately returns to his camp, unsuccessful.[4]

Lot is yet another patriarch mentioned in the book of *Genesis* (Chapters 11–14 and 19). The Bible describes him as Abraham's nephew who, following their joint travels together, settled in the city of Sodom.[5] During their time there, Lot, his wife and their two daughters invite the two men who had previously visited Abraham and who have now reached the city to stay with them. The people of Sodom (depicted as evil), having heard of the visitors' arrival at Lot's house, demand that those come out, intending to assault them sexually. Lot pleads with them and even offers his own two daughters for the

[3] Armstrong, *A History of God*, 15.

[4] *Genesis* 18:16-32.

[5] *Genesis* 14:11-12.

people's abuse instead of his visitors. When the people refuse, the visitors are said to strike and blind the Sodomites. The visitors then tell Lot that the city dwellers are wicked and that they have been sent there by God to facilitate the destruction of Sodom. They advise Lot to take his family and flee the city, for he is the only righteous man within it, and that they must not look back upon its destruction.

Lot thus flees the city with his wife and two daughters, just before God rains sulfur and fire upon the cities of Sodom and Gomorrah. He destroys "the city, its inhabitants, and the plant of the earth."[6] While fleeing the city, Lot's wife (who remains unnamed in the *Genesis* narrative) looks back upon the city's destruction and is turned into a pillar of salt. When Abraham wakes up in the morning and looks upon Sodom and Gomorrah, he sees steam coming out of the place where the cities have been, similar to smoke coming out of a furnace.[7]

Interpretations

The angels instructed Lot and his family not to look back. However, Lot's wife transgressed and looked upon Sodom as God destroyed it and turned into a salt pillar.[8] Adherents of the Abrahamic religions have speculated about these occurrences:

Jewish exegetes call Lot's wife Edith. Some believe she looked back to see if her daughters, who were married to Sodomite men, were following her. Others interpret her looking back as an attempt to find out what happened to her father's house in Sodom. While looking back, she saw God "rain brimstone and fire" upon the city, and because no mortal is to see God, He turned her into a pillar of salt.[9] A different Jewish interpretation claims God punished Lot's wife not because she saw Him but

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[6] *Genesis* 19:25.

[7] *Genesis* 19:28.

[8] *Genesis* 19:26.

[9] Howard Schwartz, *Tree of souls*, 467.

because she disobeyed the angels' instruction not to look back upon the destruction of Sodom.[10]

According to the Gospel of Luke, the Son of God's future revelation will be as traumatic as the destruction of Sodom. The Lord's disciples are not to look back upon the life they had prior to this event. The imagery employed is that of the destruction of Sodom, instructing Jesus' followers to remember Lot's wife's infraction and its consequences.[11]

According to Islam, Lot's wife never left Sodom and was killed during its destruction.[12] Hence, the Islamic point of view is not pertinent to this essay's thesis.

To these interpretations, I offer a different point of view: according to Jewish sources, the "Thirteen Attributes of Mercy" described in *Exodus* 34:6-7 portray God's demeanor by thirteen dimensions of compassion[13]:

1. Compassionate before a person's sin
2. Compassionate following a person's sin
3. Compassionate to all according to their needs
4. Allowing for humankind's peace of mind
5. Able to relieve humankind's angst
6. Slow to anger
7. Infinitely kind
8. Infinitely truthful
9. Able to be kind and truthful to thousands
10. Forgiving inequity
11. Forgiving transgression
12. Forgiving sin
13. Allowing for pardon

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[10] Scharfstein, *Torah and commentary: the five books of Moses*, 71.

[11] Luke 17:28-32.

[12] Surah 26:171.

[13] https://www.jewishencyclopedia.com/articles/10802-middot-shelosh-esreh

In light of these attributes of God described in *Exodus*, I wish to raise the possibility that, although Lot's wife disobeyed the angels' instruction not to look back at the destruction of Sodom, God's treatment of the situation was not vengeful and punitive but merciful and compassionate. The Bible describes the destruction of Sodom as a terrible, godly act of destruction, evidenced by a biblical description reminiscent of the worst wars man has ever fought. We know that many soldiers returned from the field of battle suffering from shell shock and that they continued to be tormented by their memories throughout their lives. I, therefore, suggest that Lot's wife was turned to a pillar of salt in order that she does not keep on living and suffering, having seen the tremendous destructive power of God and its effects on the cities of Sodom and Gomorrah. By turning her into a pillar of salt (hence ceasing her earthly existence), God spared Lot's wife and saved her from a life filled with traumatic memories of the destruction she witnessed.

In order to show how this interpretation fits into our understanding of black holes, I turn to a description of what black holes are, their structure and formation.

Part 3: Black Holes and Their Horizons

The phenomena now known as black holes were first conceived of in the 18th century by John Mitchell and Pierre-Simon Laplace.[14] A black hole is a region of space where gravity is so powerful nothing entering it will ever be able to leave.[15] The gravitational force is produced within such a region by an infinitely dense mass, called a singularity, deforming spacetime around it.[16]

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[14] Montgomery; Orchiston; Whittingham, "Mitchell, Laplace and the origin of the black hole concept", 90.

[15] Wald, *General Relativity*, 298.

[16] Wald, Gravitational Collapse and Cosmic Censorship, 71.

A Brief History

In 1915, Einstein developed his theory of general relativity. It included a description of the way gravity affects the behavior of light. General Relativity was first used to describe what would later be named a black hole by Karl Schwarzschild in 1916.[17] Schwarzschild's equations produced an infinite gravitational value at a distance called the Schwarzschild radius and which corresponds to what we call an Event Horizon today. In 1933 the Belgian astronomer and priest George Lemaître described this radius as one where no local physical phenomenon occurs. He described it as a "fictitious singularity," meaning it only had a special meaning in relation to the distance from the actual black hole singularity itself, rather than owing to some inherent trait of its own.[18]

In 1931 the Indian American physicist Subrahmanyan Chandrasekhar calculated that a non-rotating body composed of free fermions (e.g., electrons, protons, and neutrons) would undergo an implosion if its mass is larger than 1.4 times the mass of our sun, and end up as a black hole.[19] This figure was amended several times and ultimately established in 1996 as 2.2 to 2.9 solar masses.[20] By 1958, the American physicist David Finkelstein described the event horizon as a membrane-like region out of which no matter or electromagnetic radiation can escape, including light. He was also the one who termed the Schwarzschild radius "Event Horizon."[21] The first black hole was discovered in 1971 and named Cygnus X-1.[22]

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[17] Schwarzschild, On the Gravitational Field of a Mass Point according to Einstein's Theory.

[18] 't Hooft, Introduction to the Theory of Black Holes, 47.

[19] Venkataraman, *Chandrasekhar and his limit*, 89.

[20] Kalogera; Baym, The Maximum Mass of a Neutron Star.

[21] Finkelstein, Past-Future Asymmetry of the Gravitational Field of a Point Particle.

[22] Bolton, C. T., Identification of Cygnus X-1 with HDE 226868; Shipman, The implausible history of triple star models for Cygnus X-1 Evidence for a black hole.

How Are Black Holes Formed?

Black holes form mainly when stars collapse onto themselves in a process called gravitational collapse. However, they may also form by way of different phenomena, which I will not discuss here.[23] Gravitational collapse happens when the star's internal pressure is insufficient to counteract the gravitational pull of the star's own mass. This condition may form because of a lack of sufficient nucleosynthesis to maintain the star's temperature or because the star has accreted more mass that does not support an increase in the star's temperature. It then collapses under its own weight.[24] Suppose the original star was very heavy (over 3-4 solar masses) or has accreted additional mass late in its lifetime. In that case, almost no mechanism exists that will prevent it from imploding and collapsing unto itself, forming a singularity encased in an event horizon.[25]

The ensuing black hole then grows by absorbing matter drawn to it from its surroundings. Two or more black holes may even attract each other and merge to form a larger black hole. The largest of such known entities contains a mass equivalent to billions of times that of our sun's. Such black holes are termed "supermassive," and evidence indicates they form the black holes we observe at galaxy centers. For instance, in the center of the Milky Way galaxy lies a supermassive black hole designated Sagittarius A*, which is about 4.3 million times larger than our sun.[26]

Astronomers can infer a black hole's location from its gravitational effect on surrounding visible matter or by observing light arriving from stars behind it. The black hole's gravitation bends such light in what is called a "lensing effect."

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[23] Pacucci; Ferrara; Grazian; Fiore; Giallongo, First Identification of Direct Collapse Black Hole Candidates in the Early Universe in CANDELS/GOODS-S, 1432.

[24] Carroll, *Spacetime and Geometry*, 234.

[25] *Ibid*, 235.

[26] https://www.nobelprize.org/prizes/physics/2020/summary/

When matter falls into the black hole, it may form a disc just outside the event horizon and become heated. Black holes surrounded by such "accretion disks'' are called quasars and are some of the brightest entities we observe in the universe.[27]

The Structure of Black Holes: The Event Horizon and Singularity

An event horizon is a boundary in space around the black hole through which matter and energy can only pass in one direction – toward the black hole itself.[28] Its name is derived from the fact that no information about any event taking place within its limits can reach an outside observer. Such an observer would not even know that an event ever took place.[29] The event horizon exists because the mass at the center of the black hole creates loops in the space around it. Those loops do not allow for matter and energy contained in them to escape by any pathway.[30] When an object falls into the black hole, all information about it disappears forever for any outside observer. The horizon acts as a one-sided impenetrable barrier out of which no information can pass.[31]

Despite this, according to Special Relativity, a hypothetical observer falling into the black hole will notice nothing special once they pass through the event horizon. The location of the horizon can only be inferred by such an observer, as any information coming from outside the horizon will still reach their eyes and instruments. Since information emanating from closer to the singularity can reach points closer than the

[27] Clery, Black holes caught in the act of swallowing stars.

[28] Davies, *The New Physics*, 26.

[29] Wheeler, *Cosmic Catastrophes*, 179.

[30] https://plato.stanford.edu/entries/spacetime-singularities/lightcone.html

[31] Thorne; Price; The Membrane Paradigm for Black Holes.

horizon but not pass it, the observer would also receive information from within the horizon.[32]

The shape of the event horizon depends on the type of black hole it forms around: for a non-rotating black hole, the event horizon takes a spherical shape. If it forms around a rotating black hole, the horizon takes a more oblate form.[33]

According to general relativity, the curvature of spacetime becomes infinite at the center of the black hole.[34] This center has no volume but can be calculated as containing the entirety of the black hole's mass, and hence to have an infinite density. This voluminous center which infinitely curves space is called a singularity.[35] Penrose demonstrated that, assuming certain conditions, once an event horizon forms a singularity must also form along with it.[36]

The infinite values associated with a singularity can be prevented in a charged or rotating black hole, resulting in solutions depicting the black hole as a wormhole - a theoretical phenomenon connecting distant spatial points. Alternatively, the singularity may allow the following of closed timelike loops, connecting distant temporal points.[37] These are highly theoretical solutions depicting extreme states. In effect, any solution to the equations describing the center of a black hole achieves values that predict the breakdown of physics, either by describing a non-regular structure of spacetime or by denoting infinite values.[38]

Physicists have theorized about the existence of singularities lacking an encompassing event horizon. However, none have

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[32] Carroll, *Spacetime and Geometry*, 222.

[33] Smarr, Surface Geometry of Charged Rotating Black Holes, 292.

[34] Carroll, *Spacetime and Geometry*, 205.

[35] *Ibid*, 204.

[36] Penrose, Gravitational Collapse and Space-Time Singularities, 57.

[37] *Ibid*, 257-259.

[38] Wald, *General Relativity*, 212.

thus far been found. Termed "naked" singularities, they would have no event horizon out of which light cannot break away and therefore would be visible to outside observers.[39] Had such a singularity been observed, the observer would be able to see matter collapse to infinite density at the center of the event horizon - an event which General Relativity is unable to describe. Seeing and measuring a singularity unmasked by an event horizon would lead to multiple problems for the spacetime hosting the singularity, including instability and causal problems.[40]

The Cosmic Censorship Conjecture

Theories exist which try to describe gravitational singularities from a quantum perspective.[41] However, we do not know yet what happens inside a singularity, and since we cannot find any naked singularities, we have not been able to glimpse into one, either.

The Penrose-Hawking singularity theorem stipulates that gravitational singularities inevitably appear under certain physical conditions.[42] Suppose such singularities always remain hidden behind an event horizon. In that case, the rest of the universe remains deterministic (from a Laplacian perspective), and Einstein's General Relativity theory can describe it: given the state of the universe at a certain point in time, one can calculate the entire state of the universe at any other time, past or future. The only areas excluded from such calculations are the ones veiled behind event horizons (and on the quantum level, which is beyond the scope of this paper). Inside the event horizon, at the singularity, the laws of physics break down, and General Relativity reaches infinite values of

[39] Shapiro; Teukolsky, Formation of Naked Singularities: The Violation of Cosmic Censorship, 994.

[40] Hongsheng Zhang, Naked singularity, firewall, and Hawking radiation, 1.

[41] Bojowald, *Loop Quantum Cosmology*, 7.

[42] https://www.nobelprize.org/prizes/physics/2020/summary/

density, thus losing its descriptive and predictive ability.[43] In effect, the event horizon "shields" the rest of the universe from witnessing the point where the normal function of spacetime is unrecognizable.

In 1969 Penrose formulated the Cosmic Hypothesis Conjecture, which dictates that there can be no naked singularities in existence in light of a potential collapse of General Relativity. Those singularities that do exist need to hide behind a black hole's event horizon.[44] Despite different theories claiming that naked singularities could arise out of a particular set of physical conditions, we have not observed any yet.[45]

Part 4: Do Event Horizons prevent God's Wrath and/or Mercy?

Karen Armstrong on the role of religious symbols

In order to analyze how relevant the story of Lot's wife is to our observations and theoretical assumptions surrounding black holes and their horizons, I wish to employ Karen Armstrong's approach to religious symbolism, as expressed in her book *A History of God*.

Armstrong describes some of the oldest signs of spirituality - prehistoric cave paintings - as prehistoric man's attempt to express his wonder by linking tangible and visual cues with the mystery whose existence he felt but could not fully articulate. In her own words: "The symbolic stories, cave paintings and carvings were an attempt to express their wonder and to link this pervasive mystery with their own lives; ..."[46]

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[43] Earman, John, *Bangs, Crunches, Whimpers, and Shrieks: Singularities and Acausalities in Relativistic Spacetimes*, 44.

[44] Penrose, Roger, Gravitational collapse: The role of general relativity.

[45] https://www.sciencealert.com/naked-singularities-can-actually-exist-in-a-three-dimensional-universe-physicists-predict

[46] Armstrong, *A History of God*, 5.

When stories of supernatural beings and realities emerged, they served as tools used to express metaphorically that which language is inadequate to express. "Myths were not intended to be taken literally but were metaphorical attempts to describe a reality that was too complex and elusive to express in any other way."[47]

As an example, witness Armstrong's description of the Buddha's stand on the meaning of "existing" in a state of Nirvana. She cites that for the Buddha, the very notion of Existence was inadequate to express the actual state of the Unfathomable. Members of the major Abrahamic religions shared the same understanding throughout the ages: "It was equally wrong to say that a Buddha existed in nirvana as that he did not exist: the word 'exist' bore no relation to any state that we can understand. We shall find that over the centuries, Jews, Christians, and Muslims have made the same reply to the question of the 'existence' of God. The Buddha was trying to show that language was not equipped to deal with a reality that lay beyond concepts and reason."[48]

I contend that the same approach should be employed when examining the astrophysical findings of black holes, both theoretical and empirical, in light of the story of the destruction of Sodom and Gomorrah and the subsequent disobedience of Lot's wife.

Instruction Not to Look back and the Cosmic Censorship Conjecture

Utilizing this approach implies assuming a common grain of truth conveyed by the story of Lot's wife and applicable to the study of black holes. The instruction not to look back upon the city's destruction holds a common warning as the cosmic censorship conjecture may hint at: the singularity at the heart

[47] *Ibid.*

[48] *Ibid*, 34.

of the black hole never appears naked, without an event horizon. This conjecture holds a metaphorical warning much like the one conveyed by the tragic outcome that befell Lot's wife in the biblical story. She looked back upon what she was not supposed to see, and event horizons prevent us from seeing something. Could these two have a common element? Let us examine the destruction of Sodom along with what we know of gravitational singularities.

The Bible describes the destruction of Sodom as a godly act, unfathomable in its grandeur and not meant to be witnessed by humans. On the other hand, physics is presently unable to describe the inner workings of the singularity. However, it can depict them as variables reaching asymptotic values of infinite density in an infinitesimal volume. The two descriptions share conceptual limitations, one by humanity's unworthiness for witnessing God's work and the other by Physics' inability to describe singularities.

We may also compare the resulting phenomena: in the biblical narrative, the city's destruction may have been so overwhelming that Lot's wife was either punished or saved for looking at it by God, turning her into a pillar of salt. In either case, God halted her mortal existence because of her actions. When scientists describe event horizons, they describe an absolute mechanism preventing any mortal from experiencing a phenomenon similar to the destruction of Sodom in its grandiose attributes. The cosmic censorship mechanism perhaps prevents the shock Lot's wife has felt when exposed to such extreme attributes. It thus prevents the need for merciful consequences as the nature of God dictates could have been the result of disobeying the angels' instruction not to look at Sodom.

By employing Karen Armstrong's understanding of biblical symbolism, we may look upon the Cosmic Censorship Conjecture as a necessary preventive mechanism, denying an earthly observer from realizing the tremendousness of events taking place inside a black hole. Such an understanding stems

from applying lessons gained from the biblical story of the destruction of Sodom and Gomorrah to what we witness around us in the universe. What else may such an application mean?

Conclusion: an Imaginative Foray

Martin Luther suggested we may only view God through the cross of Christ and that His revealed-ness there corresponds to His choice to partially reveal Himself to Moses on Mount Sinai.[49] In much the same way, could we be witnessing yet another locus where God chooses to reveal Himself, albeit surely just partially?

The asymptotical physical variables at the singularity suggest the inadequacy of physics to describe the nature of said singularity, thus allowing for speculation about whether that is the point where a completely different reality presents itself. By concluding that a censorship mechanism is in place which prevents us from looking into the workings of such singularities, coupled with the story of Lot's wife lending itself as an understanding transmitted through the ages, could we be witnessing a possible locus of God's revealedness? I leave such exploratory endeavors to the reader's own system of belief.

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[49] *Exodus* 33:18-23; Von Loewenich, *Luther's Theology of the Cross*, 19; McGrath, *Luther's Theology of the Cross*, 203.

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