Author's responses to the rebuttal are in red.

Referee Report (Gemini)

Recommendation: Reject

1. Summary of the Manuscript

The author argues that massive compact objects (MCOs) do not contain black holes, event horizons, or singularities. Instead, the author proposes that these objects should be modeled as "space blisters"—bodies in a state of permanent, asymptotic collapse. The manuscript asserts that the scientific consensus incorrectly relies on stationary metrics, such as the Schwarzschild and Kerr solutions, which falsely assume the metric and matter distribution are constant over time.

Relying on the 1939 Oppenheimer-Snyder (OS) model, the author argues that from the perspective of an outside observer, gravitational collapse slows infinitely, meaning time effectively ends before an event horizon can form. Applying this framework to Sagittarius A*, the author concludes that time has "practically stopped" at its center and flows extremely slowly at its boundary, preventing the formation of a singularity. Finally, the author claims that current observational evidence only supports the existence of objects with strong gravitational fields, not event horizons.

This summary seems accurate.

2. Critique and Verification of Claims

While the author's motivation to conceptually simplify MCOs and resolve the genuine theoretical complexities of singularities is commendable, the manuscript's core arguments stem from foundational misunderstandings of General Relativity and disregard recent empirical data.

A. Stationary Metrics vs. Dynamic Collapse

- **The Claim:** The author states that modeling black holes using stationary solutions is a fundamental mistake and that these solutions do not describe physical reality because Einstein's equations are dynamical.
- **Verification (False):** This claim misinterprets how these metrics are applied to collapse scenarios. According to Birkhoff's theorem, any spherically symmetric solution of the vacuum field equations must be static and asymptotically flat. Therefore, the spacetime exterior to a dynamically collapsing, spherically symmetric star is exactly and correctly described by the stationary Schwarzschild metric. The scientific consensus does not ignore dynamics; rather, the stationary external metric is a rigorous mathematical consequence of relativity during a dynamic collapse.

Yes, I agree that the exterior of the star during a collapse phase may be described by a stationary metric, but this is not relevant. The article is concerned with the interior, not the exterior of the star.

B. Misinterpretation of the Oppenheimer-Snyder Model

- **The Claim:** The author uses the OS model to assert that time itself ends before an event horizon forms, resulting in a state where there is "no after". The author calculates that for Sagittarius A*, time has practically stopped at the center, meaning there is no singularity and no event horizon.
- **Verification (False):** This argument confuses coordinate time with proper time, reviving the obsolete "frozen star" concept popular in the 1960s. It is true that, relative to the coordinate time of a distant observer ($t \to \infty$), a falling object appears to slow down and never cross the Schwarzschild radius ($r_s = \frac{2GM}{c^2}$). However, the original 1939 OS model mathematically proves that for a comoving observer (falling with the collapsing matter), the star collapses through its Schwarzschild radius and forms a central singularity in a finite amount of proper time (τ). The author's assertion that time "ends" for the falling observer is an arbitrary philosophical assumption that directly violates the Equivalence Principle, which dictates that a freely falling observer experiences no local cessation of physical laws at the horizon.

Three points need to be addressed here:

1. **The article clearly separates perspective of the outside observer from the perspective of the comoving observer and analyzes them appropriately. The discussed events are coordinate-invariant, i.e. if they happen in one coordinate frame then they happen in any other. There is no confusion of coordinates in the article. If so, please explain exactly, where it is.**
2. **"OS model mathematically proves that for a comoving observer (…), the star collapses through its Schwarzschild radius and forms a central singularity in a finite amount of proper time" – this is not true. The spacetime they describe has no singularities and no event horizon and the paper contains no claims about their formation. These claims were made later by other physicists and require 1) extending the OS spacetime and 2) using the "the flow of time must continue" assumption, none of which was originally done by O&S.**
3. **Please explain how ending time violates the equivalence principle? In the article, I provided an example of a flat spacetime in which time ends and the equivalence principle is not violated. "assertion that time ends (…) directly violates EP" is itself an empty (and false) assertion.**

C. Dismissal of Coordinate Transformations

- **The Claim:** The author argues against coordinate extensions, labeling systems like the Kruskal-Szekeres coordinates as "dodgy coordinate transformations" that unscrupulously extend spacetime into unphysical regions.
- **Verification (False):** Rejecting well-behaved coordinate systems merely because they describe regions inaccessible to a distant observer is physically ungrounded. Coordinates like Eddington-Finkelstein and Kruskal-Szekeres were developed precisely to demonstrate that the apparent barrier at the event horizon is merely a coordinate singularity (an artifact of the distant observer's reference frame), proving that the spacetime manifold itself remains smooth and continuous across the horizon.

I do not reject them because they describe regions inaccessible to a distant observer. I argue that one has to be careful when using them because they do sometimes describe unphysical spacetimes, such as regions III and IV of the Kruskal-Szekeres diagram. Clearly, extending spacetime through every coordinate singularity is not physically grounded. The question is how do we determine whether such an extension is warranted. And to address this question I use arguments provided in the "Which model is better?" section.

D. Observational Evidence

- **The Claim:** The manuscript claims that observational evidence (such as the movement of stars in galaxy centers and gravitational waves) only proves the existence of strong gravity, not event horizons.
- **Verification (False):** This claim is factually outdated.
    - The Event Horizon Telescope (EHT) collaboration released direct radio-interferometric images of the event horizon shadow of M87* in 2019, and Sagittarius A* in 2022. These observations are highly consistent with the presence of a Kerr black hole and an event horizon.
    - The ringdown phase of gravitational waves detected by LIGO and Virgo perfectly matches the theoretical predictions of perturbed black holes equipped with event horizons, effectively ruling out objects with a physical surface (which would produce entirely different echo signatures).

That the existence of event horizon has not been definitely proved yet is not the claim made by my article, but a claim made by any reputable modern textbook on general relativity – I provided references to two of them. As for the examples given above: the first example is consistent with space blisters as well, because they mimic the external metric of a black hole to a very high degree. The second example indicates that the referee did not understand the article – there is no traditional physical surface in the model of a space blister.

3. Conclusion

The manuscript relies on long-resolved coordinate paradoxes and dismisses vital mathematical tools of General Relativity. Furthermore, it ignores modern, direct observational evidence that corroborates the existence of event horizons. While questioning scientific consensus is a vital part of physics, the alternative framework proposed here is demonstrably inconsistent with both the mathematical structure of relativity and current empirical data. Consequently, I recommend rejecting the manuscript.

Below is a referee-style report assessing the manuscript *"Black holes do not exist."* I focus on the physics, mathematical reasoning, interpretation of the literature, and consistency with current observational evidence.

Referee Report (ChatGPT)

Manuscript title: *Black holes do not exist*
Recommendation: Reject (major conceptual and technical flaws)

Summary

The manuscript argues that black holes do not exist and proposes replacing them with "space blisters," i.e. compact objects undergoing eternal asymptotic collapse without event horizons or singularities. The author claims that the scientific consensus on black holes arose from inappropriate reliance on stationary metrics (primarily Schwarzschild and Kerr), improper coordinate extensions, and an unjustified assumption that proper time must continue beyond finite limits.

The manuscript further claims that the Oppenheimer–Snyder gravitational collapse model supports this view and that observational evidence—including that for Sagittarius A*—is compatible with horizonless alternatives.

While the manuscript raises philosophical concerns familiar from black hole debates (information loss, singularities, coordinate dependence), the central claims are not supported mathematically or physically. The argument repeatedly conflates coordinate artifacts with invariant geometric properties, misinterprets the Oppenheimer–Snyder solution, and ignores strong observational constraints favoring black holes over horizonless alternatives.

Major Comments

1. Central claim ("black holes do not exist") is unsupported

The author's main claim is that observed massive compact objects lack:

1. collapse below Schwarzschild radius
2. event horizons
3. singularities

This conclusion does not follow from the presented arguments.

In my analysis of Sagittarius A* its interior metric is evaluated at the relevant points and specific numerical values are provided. These results rule out the items (1)-(3) listed above.

Therefore, in the article, I show with a specific example how the conclusion follows from the presented arguments. And this example is just an illustration; the OS model can be applied in a similar way to any currently known "black hole."

The existence of an event horizon is **not a coordinate-dependent statement**. It is defined globally in spacetime as the boundary separating events that can communicate with future null infinity from those that cannot.

This is a geometric invariant—not an artifact of Schwarzschild coordinates.

I agree with these statements.

The manuscript repeatedly treats horizons as if they arise merely from using a static distant observer's coordinate system. This is incorrect.

Repeatedly? Can you point me to a single example? I think this doesn't happen even once.

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2. Misinterpretation of Schwarzschild and Kerr metrics

The author argues that black hole theory is fundamentally based on stationary solutions and therefore physically suspect.

This is misleading.

The Schwarzschild metric and Kerr metric are vacuum exterior solutions. They describe spacetime outside compact objects once transient dynamics settle.

Modern black hole physics includes:

- gravitational collapse
- accretion
- mergers
- perturbation theory
- numerical relativity

These are all dynamical.

Black hole formation is not inferred solely from stationary metrics.

The author presents a false dichotomy:

- stationary models → black holes
- dynamical models → no black holes

This is incorrect.

Dynamic collapse models in GR routinely produce horizons.

First, I don't deny that there are dynamical models involving black holes. But anybody who once picked up a book about black holes knows that critical concepts such as "Schwarzschild radius," "event horizon," or "singularity" came about by analyzing stationary models. Secondly, these arguments misrepresent what is written in the article. The article makes no such implications and presents no such dichotomy. The statement that "dynamic collapse models in GR routinely produce horizons" has no bearing on my arguments. Fine, let them produce. But are they correct? To answer this, I don't use the simple "stationary models bad" argument. The arguments I actually use are listed in the "Which model is better?" section.

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3. Serious misrepresentation of the Oppenheimer–Snyder model

This is the manuscript's most serious technical issue.

The author repeatedly claims the Oppenheimer–Snyder gravitational collapse model supports horizonless eternal collapse.

It does not.

The Oppenheimer–Snyder solution is the classic GR model of dust collapse **into a black hole**.

In proper time of infalling matter:

- the collapsing surface crosses the Schwarzschild radius in finite time
- collapse proceeds to singularity in finite proper time

This is textbook GR.

If you read the OS model carefully, you will see that in the spacetime they analyze there is no singularity and no event horizon. In other words, the spacetime they analyze does not include an event which we can identify with the formation of a horizon or a singularity. And because they do not appear in their model, Oppenheimer and Snyder make no remarks about their existence in the text of their paper. To obtain a singularity and an event horizon, their spacetime must be extended. And so, somebody else, sometime later made an assumption that their spacetime can be extended. And then, somebody else, sometime later, extended their spacetime and found the singularity and the event horizon. So, no, the referee's interpretation of their paper, although popular, is incorrect. Moreover, in my article, I argue that their spacetime should never have been be extended.

I do agree that what you mention is textbook GR, but this is the point of the article: textbooks have been wrong.

The “eternal collapse” interpretation comes from Schwarzschild coordinate time seen by a distant observer, where infalling matter appears to asymptotically approach the horizon due to infinite redshift.

This is a coordinate effect.

No, the slowing of time (and resulting redshift, asymptotic collapse, etc.) is not a “coordinate effect.” It is a real phenomenon, which can be measured e.g. in the way shown in the movie Interstellar (or, more closely to the home, by corrections to the GPS signals).

Using horizon-regular coordinates (e.g. Eddington–Finkelstein, Kruskal–Szekeres), horizon crossing is perfectly regular.

The author dismisses these coordinates as unjustified extensions. This is mathematically and physically incorrect.

Yes, crossing the horizon is perfectly regular if you can justify the existence of the horizon in the first place. And how is the existence of the event horizon justified? “The flow of time must continue.” “Let’s arbitrarily extend the spacetime here but not there.” – I discuss such justifications in the article, but the referee seems to have skipped them. Please engage with my reasoning instead of simply labeling it as “mathematically and physically incorrect.”

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4. Confusion between coordinate singularities and physical singularities

The manuscript suggests that because Schwarzschild coordinates become singular at (r=2M), black holes are suspect.

The manuscript nowhere does such a thing.

This is a basic misunderstanding.

At the Schwarzschild radius:

- metric coefficients in Schwarzschild coordinates diverge
- curvature invariants remain finite

For example, the Kretschmann scalar remains finite at the horizon and diverges only at (r=0).

Thus:

- (r=2M) → coordinate singularity
- (r=0) → physical singularity

These are fundamentally different.

I agree with that distinction.

The manuscript treats them as conceptually similar, which invalidates several arguments.

No, it does not treat them as similar. This is completely made up. This point is entirely bogus.

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5. "Time ends" argument is physically unclear and mathematically underdeveloped

A central claim is that proper time simply terminates before horizon formation and this avoids black hole paradoxes.

This is not demonstrated.

The author asserts:

"The time itself ends just before it can happen."

This is not derived from Einstein's equations.

Geodesic incompleteness in GR must be established by:

- specifying spacetime manifold
- metric
- causal structure
- proving maximal geodesics terminate

The manuscript does not provide a rigorous spacetime construction for "space blisters."

Without this, the proposal is speculative.

Everything you request is present in the article. Spacetime manifold is the same as in the OS model. Metric is the same as theirs. Causal structure is the same as theirs. And the OS model already proved that geodesics terminate: in their model tau tends to a finite limit.

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6. Claims about paradox resolution are unsupported

The manuscript claims abandoning black holes solves:

- Hawking radiation issues
- information paradox
- firewall paradox
- cosmic censorship
- wormholes

- white holes

This is asserted without derivation.

Even if one considers horizonless compact objects, one still must explain:

- thermodynamics
- entropy scaling
- merger ringdowns
- quantum effects near compact surfaces
- accretion signatures

These are not addressed.

All these problems/paradoxes stem from the existence of an event horizon and/or the singularity. "Derivation" is obvious. No event horizon and no singularity = no problem. For example, how would you expect me to "derive" that there is no question of cosmic censorship in a universe where singularities do not exist? Or, in other words: in a universe with no singularities can the problem of cosmic censorship still occur? Obviously not. No further derivation needed.

And sure, there are many things that should be addressed to complete the theory of space blisters, but you cannot expect me to address everything in one paper. All those things for black holes have been "addressed" by many people over several decades. Expecting me to immediately provide corresponding analysis on every topic is ridiculous.

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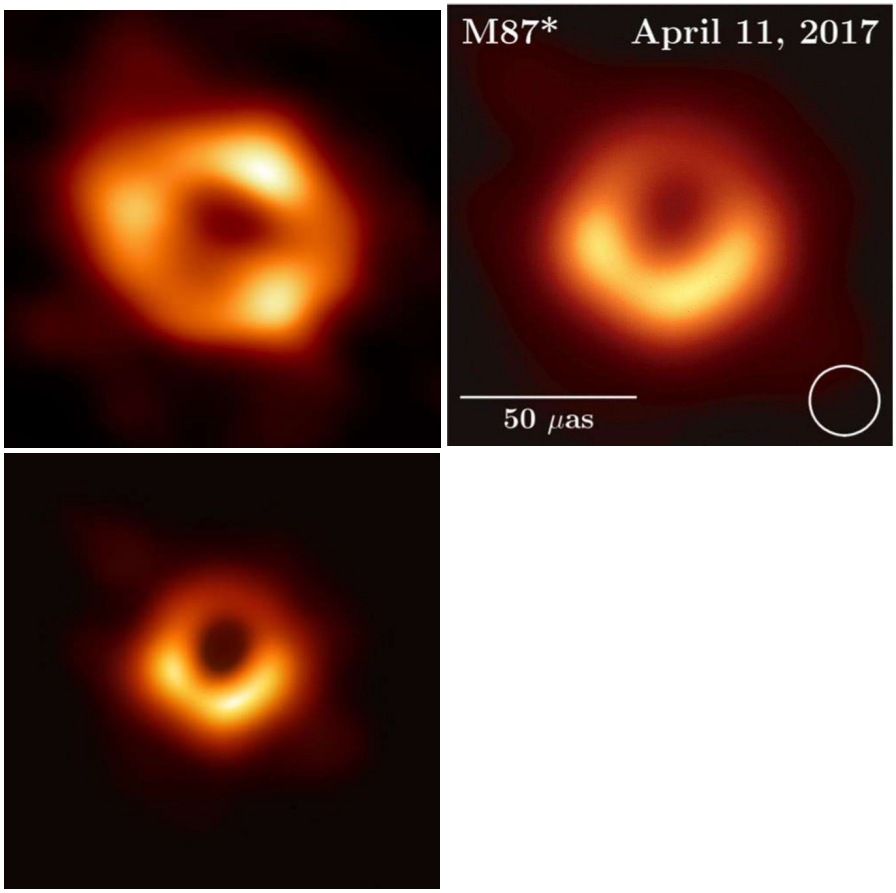
7. Observational evidence is understated

The manuscript claims evidence for black holes is "strong but circumstantial."

This significantly understates current evidence.

Important observations include:

A. Event Horizon Telescope imaging



Both Sagittarius A* and Messier 87* show compact emission morphologies consistent with horizon-scale lensing around black holes.

Please note that these are pictures from 2017 – these pictures were available long before the textbooks I cite (Guidry, 2019; Chruściel, 2020) made statements about lack of definitive evidence. Please point me to a reputable textbook that states that evidence for black holes is definitive and that existence of an event horizons has been scientifically proven. You know you cannot do it – because such textbooks do not exist.

B. Gravitational-wave ringdowns

GW150914 and subsequent detections match black hole merger predictions from numerical relativity with remarkable precision.

Horizonless ultracompact alternatives often predict:

- echoes
- altered ringdowns
- surface emission

No compelling evidence supports these alternatives.

Okay, but this is not for space blisters but for other theoretical objects. So, not relevant.

C. Stellar orbits near Sgr A*

Stars such as S2 star orbit a mass of ~4 million solar masses confined to an extremely small volume.

Alternatives must reproduce all these observations quantitatively.

The manuscript does not.

What am I supposed to reproduce? The movement of S2? If so, this is not what the article is about. Or that Sgr A* is confined nearly to its Schwarzschild radius? This is a prediction of the space blister model. The same as for a black hole model. So, what should be reproduced? Please clarify.

Specific Claim Verification

Claim	**Assessment**	**Comments**
Black holes are based on stationary solutions	False / misleading	Collapse and mergers are dynamical in GR **Still, black holes are based on stationary solution.**
Oppenheimer–Snyder does not form black holes	False	It is the classic collapse-to-BH model **There is nothing about that in their paper. Read it.**
Event horizon is coordinate artifact	False	Horizon is coordinate-invariant **No such claim is ever made.**
No evidence for horizons	Misleading	Strong indirect evidence exists **Yes, but circumstantial.**
Coordinate extensions to Kruskal are unphysical	Unsupported	Standard and well-justified **No, especially region III and IV.**
“Time can simply stop” avoids paradoxes	Unsupported	No rigorous model provided **It is unnecessary.**

Minor Comments

1. Tone is not appropriate for scholarly publication

Statements such as:

- “irrational love for black holes”
- “wasted effort is heartbreaking”
- “scientific consensus went down the wrong path”

are polemical and unsuitable for a scientific article.

This is true. But the article is not intended for such a publication.

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2. Important literature omitted

The manuscript ignores major work on:

- singularity theorems
- numerical relativity
- black hole thermodynamics
- horizonless compact objects
- observational constraints

This omission weakens the analysis substantially.

Why exactly is that necessary? What point is weakened by this omission? This is just uninformative neat-picking.

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3. Mathematical derivations are incomplete

The calculations for Sagittarius A* are presented without sufficient derivation or error analysis.

The manuscript explicitly admits the model is “crude” and quantitatively unreliable, which undermines strong conclusions.

There is no error analysis because it is not an empirical work. Strong conclusions rely only on qualitative results. Calculations are just an example.

Overall Assessment

The manuscript raises philosophical objections to black holes that have long been discussed in gravitational physics. However, the core argument relies on misunderstandings of general relativity, especially regarding:

- event horizons
- coordinate systems
- gravitational collapse
- the Oppenheimer–Snyder solution

The proposed “space blister” concept is not formulated rigorously enough to serve as a viable physical alternative to black holes.

At present, the manuscript does not provide a scientifically credible basis for rejecting black holes.

Recommendation: Reject

Publication would require:

1. a rigorous spacetime model for “space blisters”
2. explicit Einstein-equation solutions
3. comparison with black hole observables
4. correction of major GR misconceptions.