Different approaches to compute Hawking Black Holes Decay

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Abstract

This paper discusses the comments presented in "Yes, Stephen Hawking Lied To Us All About How Black Holes Decay" published by Forbes. It shows that there are actually two contributions to, or two ways to characterize, Hawking radiations: the one from particles pairs created on the horizon of the black hole, with one particles falling behind the horizon, and the one from particle pairs created between the horizon and infinity, which have one particle reach infinity. We thought it is worth making sure all realize this, and doing so, correcting the article.

1. Introduction

The short paper analyzes the statement made in [5] and argues that both approaches are correct ways to estimate the effect of the Hawking radiations. It also argues that both effects contribute in reality.

Comments added August 1, 2022: The paper was originally published as [7], intended as a web page only. Since, a new paper [8] further details the analysis. Hence our re-publication as a paper.

2. Comments to the Popular Science Article [5]

The article [5] is astoundingly strong as are tweets surrounding it about the biggest error from "a brief history of time" that would have misinformed generations of physicists [6].

Here are our main considerations. The author of [5] is wrong in its technical analysis. Indeed,

- Hawking discusses both effects in a 1975 paper. The effects horizon capture is a portion of overall particle emission described asymptotically modeled in the 1974 paper [2]. Both intensities are prop. to area of horizon. The capture process is easier to convey as understanding the ambiguity of the number of particles in a curved spacetime is not intuitive.
- Both effects of capture by the horizon and particle creation by gravity (curved spacetime) exist and contribute the asymptotic total [3].
    - It is true that Hawking does not explicitly state that both effects are contributing

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    - This second considerations may have confused again the author of [5], who after, per his own admission, learning that he did not understood black hole evaporation, now thinks that what he had read is now false. It is not false; it is just a partial description!

- Also the second effect is a gravity effect, not specific to black holes while the capture effect by the horizon happens only with black holes.
- Furthermore, with a process focused on capturing gravitational collapse one should ask what is really relevant in terms of characterizing the blackhole radiation:
    - From past null infinity to future null infinity, a significant part of the changing gravitational field is the collapse rather than the black hole radiation. One could therefore argue that the most relevant portion to the collapse is the gravitational creation of particle and that the black hole radiation (especially static or spherically symmetric) is therefore the one due to pair companion capture. The problem is that formalism used does not allow quantitative separation of the two outcome in the tally model by Hawking. We need some other approach (e.g. [3] - although that is specific to multi-fold universes, yet these recover General relativity at large scales [4]; so it may not matter) to get a level down.
    - It seems that Hawking was right to focus on this.

Furthermore, we would argue that in a popular science communication, an author like Hawking can certainly take literary license to simplify intuitive explanations. Everything in his book consist of simplified explanations.

3. Conclusions

The fact that Hawking's explanation was correct, albeit incomplete, and addressed the feature really proper to black holes shows appropriateness of the proposal.

Overall, the article could have emphasized the "often missed" aspects and questions why they were not mentioned. But it may not have warranted the sensational title and statements. Especially as, ironically, the author of [5] still got his description wrong, and, as a result, its judgment of Hawking may not be that appropriate.

References:

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[3]: Stephane H Maes, (2020), "Particles, Especially Virtual Particles, in a Multi-fold Universe vs. QFT", https://shmaesphysics.wordpress.com/2020/07/11/particles-especially-virtual-particles-in-a-multi-fold-universe-vs-qft/ , July 10, 2020.

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[5]: Ethan Siegel, et al., (2020), "Yes, Stephen Hawking Lied To Us All About How Black Holes Decay", Forbes, https://www.forbes.com/sites/startswithabang/2020/07/09/yes-stephen-hawking-lied-to-us-all-about-how-black-holes-decay/?sh=44c1eea4e63a. Retrieved on July 9, 2020.

[6]: https://twitter.com/universetoday/status/1281351173140881408 . Retrieved on July 9, 2020.

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