Further thoughts on the mass distribution in black hole interiors

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Abstract. Having defined the mass distribution in black hole interiors in an earlier paper, thought is now given to the contribution of photons to the structure, with a definite conclusion.

Introduction

Careful consideration of the destiny of infalling particles into a black hole was shown in an earlier paper[1] to result in a specific distribution of matter within the event horizon. This paper left unanswered the question of what happens when a photon approaches the event horizon of a black hole. There are at least two distinct possibilities. To a far-off observer, the photon may slow down and stop, just like a particle, forever moving toward the event horizon, but never actually reaching it because of time dilation; or the photon could cross the event horizon in a finite time, and then presumably carry on unimpeded until it reaches a singularity at the centre of the black hole. Conceivably, there could also be a combination of these two options.

Argument

Construct a reference frame close to, but outside, the event horizon and place an observer named Alice there, as part of an ambitious thought experiment. A far-off observer, Bob, observes Alice's watch running slowly. The closer Alice is to the event horizon, the slower her watch will appear to run. To Alice, an incoming photon will appear to be travelling at the speed of light, but we are concerned with how this will appear to Bob. Bob knows that Alice is measuring the incoming photons as travelling at the speed of light, but then applies a correction for Alice's slow running watch, and decides that the photons slow down as they approach the event horizon. He also knows that if Alice were arbitrarily close to the event horizon, her watch would slow to a standstill, and the photons would cease to move at all. He concludes that photons, like matter, will never cross the event horizon, but remain frozen in space close, but never touching the event horizon. A photon that has ceased moving still retains its' energy, and so contributes mass to the infalling material.

Conclusion

The internal structure of a black hole remains as predicted in the original paper[1], if any part of infalling material is in the form of photons. The photons, whilst never failing to move towards the centre, will, to a distant observer, come to a standstill close to their local event horizon, and contribute to the overall mass of the black hole.

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The result is satisfying as any different result would mean that we would have to consider the makeup (matter/radiation) of black holes to determine all of their properties. This would be contrary to the no-hair theorem for black holes.

[1] D. Proffitt, “Mass distribution in black hole interiors,” *viXra:1201.0107*, pp. 1-3.