A mechanism that prevents information from entering the event horizon

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Abstract

For a very long time Black hole information paradox has troubled us. Once the information falls into the event horizon, we don't know how it can be released back out. Which violates the principle that the state of a system at one point in time should determine its value at any other time, thus causing paradoxes. This article describes a novel model of the black hole which fundamentally prevents information from falling into the event horizon. Here we show how the gravitational length contractions and dilation can make every point in space neared a strong gravitational field remain a bijection relationship between any two observations as the gravitational field varies. Consequently making all the information located on these points never fall into the event horizon. The observer also can never enter the event horizon.

Let's first consider a simple Schwarzschild black hole which the mass of that black hole are evenly and spherically located around center. For it is the easiest for us to study the length contraction and dilation near a gravitational field.

To minimize the length change caused by material strain and focus on the effects caused by gravitational field solely, we assume that all objects appeared in this article are rigid.

If we put a scaled tape directly toward the center of black hole, and fix the tip of the tape on a distant rock that is still to reference frame of the black hole, then there will be a length contraction in the reference frame of a distant stationary observer. Using Schwarzschild coordinates, we have:

$$dl = \frac{1}{\sqrt{1-\frac{r_g}{r}}} dr \qquad \Delta l = \int_{r2}^{r1} \frac{1}{\sqrt{1-\frac{r_g}{r}}} dr$$

Δl is the proper length of a part of that tape. r_g is the Schwarzschild radius of black hole.

This also reflects the time dilation on the tape. If we have a ray of light traveling a radius distance of dr it would cost us $t = dl/c$.

Because the mass of the black hole is spherically symmetric around the center, the gravitational length contraction rate and time dilation rate on a surface of sphere that centered the center of black hole should be identical. For example if an observer located him self on one of that surface, and throw a clock at any point on the same surface, later, pull it back, two clocks will show the same time.

Thus if an observer is trying to climb down the tape, he should not only found that the event horizon is retreating before him, but if he stay still and observe, the Schwarzschild radius of black hole decreasing spherically before him, because the time dilation rate around the same sphere surface are the same.

If the tape is long enough, then as he approaches the center, the Schwarzschild radius would approaches to zero before him.

If the observer placed a mark near the "black hole point" and used a rigid rod to fix the mark to the rigid tape, and climbs up, what would he see?

For a distant stationary observer we can apply to any of the surface a factor γ, which is similar to the Lorentz factor, to describe the radio length contraction rate $\frac{dl}{dr}$ and also the time dilation rate of all points on that surface.

$$\gamma=\frac{1}{\sqrt{1-\frac{r_g}{r}}}=\frac{1}{\sqrt{1-\frac{2GM}{c^2 r}}}$$

Beware that both r_g and r are measured by a distant stationary observer. So that γ of every point would only reflect the properties of that point, not the observer.

For a distant stationary observer A, the length contraction on that tape would be:

$$dr=dl\cdot\sqrt{1-\frac{r_g}{r}}=\frac{dl}{\gamma}$$

But for an observer B that is rather close to the black hole, B it self has a contraction of radial length, so to B it would be:

$$\gamma_B=\frac{1}{\sqrt{1-\frac{r_g}{r_B}}} \qquad d\,r_B=dr\cdot\gamma_B=dl\cdot\frac{\gamma_B}{\gamma} \qquad \Delta r_B=\int_{l2}^{l1}\frac{\gamma_B}{\gamma}dl=\int_{l2}^{l1}\frac{\sqrt{1-\frac{r_g}{r}}}{\sqrt{1-\frac{r_g}{r_B}}}dl$$

Δr_B is the length measured by B, r_B is the radius length between B and the center.

To that observer C who climbed up: γ_C decreased, making the total length of the tape measured by C decrease. Thus C would observe that the mark on the tape retreating away from the center. The Schwarzschild radius of the black hole would enlarge, but not larger than the mark no matter how low the mark would be.

Because we need an infinitely long tape to reach the Schwarzschild radius:

Assume that we have a meter stick with two mirrors attached at both ends, and a ray of light bouncing back and forth between the mirrors. Every time when the light hits the mirror, it would give out a single. The proper time duration between two singles are measured as $1/c$.

Then, if the meter stick is rigid, no matter where it is, because that the speed of light in vacuum is the same for all observers, the time duration received by the observer are always $1/c$.

For a stationary distant observer, if he shoots a ray of light toward the event horizon, the light would need infinite amount of time before it reaches the horizon. Means that if we put meter sticks along the light ray, it would took infinite amount of meter sticks to reach the event horizon, which is infinitely long.

In real life measuring direction of light rays might be distorted in a gravitational field, making it hard to measure lengths for a distant observer. If we are trying to measure the Δr for a specific Δl we may fix two light sources at both ends of that Δl . By knowing the frequency of the light source and the mass of the black hole, we can calculate the radial length r of both light sources.

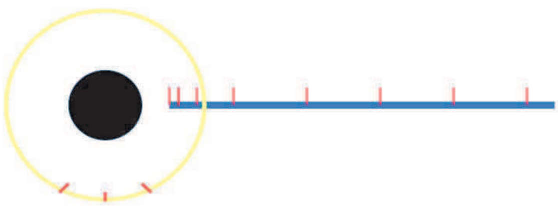
What happens if the mass of that black hole had increased? Let’s assume that the mass had increased evenly and spherically around the center.

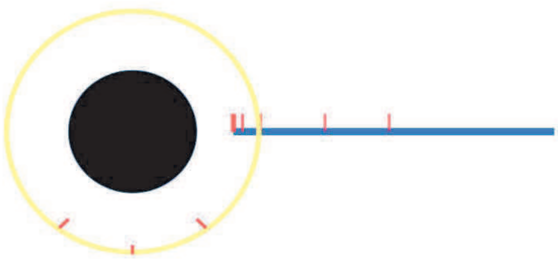
For a Schwarzschild black hole, we have $r_g = \frac{2GM}{c^2}$. So for every point, γ will increase. That tape would also retreat back up from the event horizon and thus never touching it.

Interestingly, when the mass increases, if the observer drops a tape toward the center of the black hole, from his perspective, length contraction would first effect on the farthest part from the black hole, pulling rest of the tape outward, then those near parts. The space it self will contract the same way accordingly, from far to near the horizon, leaving a “hole” in the center(which is of course the black hole it self)

Let’s assume that there is a scaled Dyson ring or hula hoop around the black hole. A stationary circle. And there are multiple tapes attaching the circle from different directions. As the Schwarzschild radius increases, all of the tapes are retreating away from the center.

Thus from the perspective of a distant stationary observer, the radius of the circle will increase, leading to an increased perimeter of the circle. Thus there is not a contraction of length on the tangential directions, but a dilation. There is no material deformation, the effects are formed merely by the distortion of space. These effects are rather similar to the tidal force caused by the spherical shape of the black hole. So the time that light takes to travel along the circle from one index mark to another remains constant.





Let’s assume that a short stick is located at a radius of R, and turned parallel to the tangential direction.

We say that in the tangential direction, the stick's proper length divided by the observed length equals a factor E . then E would also be the observed radius of a circle in flat space-time (or centering a zero-mass black hole) divided by the observed radius of that same circle centered a black hole that has a Schwarzschild radius of r_s .

Then we have:

$$E=1-\frac{\int_{R}^{+\infty}(1-\frac{r_s}{r})^{-\frac{1}{2}}dr-dr}{R}$$

This formula describes the length dilation near the black hole in the tangential direction.

Thus we have a novel metric of a Schwarzschild black hole:

$$g_D=-c^2 d\tau^2=-(1-\frac{r_s}{r})c^2 dt^2+(1-\frac{r_s}{r})^{-1} dr^2+r^2 E^2(d\theta^2+\sin^2\theta\, d\varphi^2)$$

Factor E is to describe the length dilation on tangential direction.

According to the metric if we put a micro black hole(A few micrometers large) into a block of rigid glass(A few kilometers large), then inject many paint point into that glass, thus as the black hole enlarges, the paint points would in the radial directions retreating away from the black hole.

Interestingly, if we compare the locations of these points before and after the enlargement, we would find that every point that is near to the micro black hole would corresponds to a point that is above the event horizon, vice versa. (because if a tape is located at one of these point, then the position of that tape would be identical to the position of the point, as the tape retreats, the point will too retreat.)

The total number of these points would be constant, which can be thought as a bijection between points.

If an observer would digs through the glass and approaches the center of an enlarged black hole, the observer would of course find that as if the black hole had returned to micro, and the points around had returned to original location. If the observer then sticks a long rigid selfie stick towards the out side, the photo will be him with every atom on his body located at corresponding points that are slightly above the event horizon. We can easily prove that no matter how close he is to the center, the observer can only be located at points that corresponds to the points above the black hole, meaning that an observer cannot enter the event horizon. Thus the observer can infinitely approach the event horizon, he can observe that the distance between him self and the center of the black hole are closer than the proper Schwarzschild radius(which is observed from a distant stationary reference frame), but he will always be located on these points that corresponds to the points that are above the horizon. All the conclusions remains valid in all the accelerating reference frames, because incidents observed from an accelerating reference frame is identical to the observation from a stationary reference frame.

If the observer leaves a book near the micro black hole, digs back up, he can still observe that the book appearing at the locations that corresponds to the original location, which is a little above the event horizon. There are going to be some shape change according to the metric above, but the total amount of the atoms that be can observe remains the same, the observer can always dig down to recover all the mass and information from it, because it would took us infinite amount of time before seeing that book actually touches the event horizon.

This mechanism of space time will fundamentally prevent any information from falling into the event horizon

We can anticipate that the majority of the mass of a black hole should be appressed to event horizon, though the event horizon it self is “hairless”, but information can be stored in that layer of mass. This can more or less explain the Black hole information paradox.