Spacetime Curvature And The Extra Dimension

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Abstract— *With the advent of the space age, we have come across exotic objects like black holes, neutron stars etc. These objects have led us to understand space and its curvature around high gravitating objects. In this paper, I am trying to address that how black hole's can be the source for us to see beyond the three physical dimensions of our universe and might give us a glimpse of another dimension. Any object in vacuum space which has physical mass has gravitating effects some objects have less gravitating effect while some have more, this gravitation can be understood in terms of space time curvature ,more the space time curvature more the gravitational attraction. If the space is not dominant by strong gravitating objects (means where the curvature is less) the time with respect to earth remains almost invariant but where the curvature is too high time dilates pretty quickly. So time is nothing but the property of space so one should look space and time as not different entities but the same i.e. space-time. Black holes have presumably the highest space time curvature and at the very centre of the black hole it is thought that space and time lose their meaning as we know it. In this paper we will see how the center which defies the laws of our universe might give us an outlook towards a different dimension*

Index Terms— *kerr metric, schwarschild radius ,black hole, extra dimension*

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1 INTRODUCTION

Black holes are objects in which anything falls and nothing can come out not even light. It's like a doomsday machine which destroys anything that comes in its way. They were first thought by the predictions of general relativity of Einstein since then understanding this exotic object and finding it has become one of the crucial work of the astrophysics department throughout the world. They became the objects of interest because they supposedly were objects from which light the ultimate speed also cannot escape. These black holes were first thought from the predictions of Einstein's general relativity. The solutions of the Einstein's general relativity were found by Roy Kerr. The Kerr metric is an exact solution of Einstein field equation of general relativity; these equations are highly non linear, which makes exact solutions very hard to find. The Kerr metric is a generalization of Schwarzschild metric, which was discovered by Karl Schwarzschild in 1916.Black holes did came from the theory ,but the problem was to see if there are really any. For this job general relativity gave way to astrophysics and space technology. The primary tools were not just optical telescopes, but also x-ray detectors, radio telescopes and spectrographs. The first object to be generally recognized as a black hole is the x-ray binary star Cygnus X 1, It belongs to a high mass x-ray binary system about 6100 light years away from the sun that includes a blue supergiant variable star designated HDE 226868 which it orbits at 0.2 AU, or 20 % of the distance from the Earth to the Sun.

Every object with considerable amount of gravity bends spacetime around itself. Black holes have presumably the strongest gravitational field. The most famous analogy is the rubber sheet with a sphere ball , take a rubber sheet and place a sphere ball to represent a star, now ripples in space time has been created around the sphere ball on the rubber sheet due to the depression created by the sphere ball. For a particular value of mass that sphere ball the depression created will be such that it will lead to the formation of a pit. That is when the black hole is formed. Now consider another analogy consider a sheet of paper now the paper is 2-d consider that there are 2-D beings on that sheet of paper, so the eyes of all the beings on the sheet of paper are restricted to 2-D only. Now if somehow a hole is created on that sheet of paper from the 3-D the beings on the sheet of paper will never come to know what is beyond the hole, they will only be able to experience and witness the ripples created by the hole but not what is beyond the hole because the eyes of the beings are restricted to 2-D ONLY. Similarly our eyes are restricted to 3-D only so at a black hole's center space –time loses its meaning as the very center is at some another dimension which we fail to realize due to our restriction of the 3 Dimensional universe. The center of the black hole is like the hole created on the sheet whose only ripples can be realized but the being of 3-Dimension will never realise what is at the very center.

2 HOW DOES BLACK HOLE HELP US SEEING THE WORLD BEYOND THE REALMS OF OUR UNIVERSE?
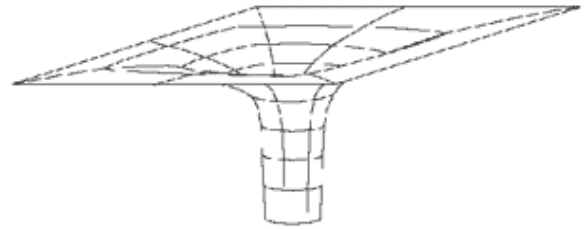
3. EQUATIONS

$$d\tau^2 = (1 - \frac{r_s}{r})t^2 - \frac{r^2}{(1 - \frac{r_s}{r})c^2} - r^2 d\Omega^2$$

Equation(1)

Where

$$r_s = \frac{2MG}{c^2} \quad and \quad d\Omega^2 = d\varphi^2 + \sin^2\varphi d\theta^2$$
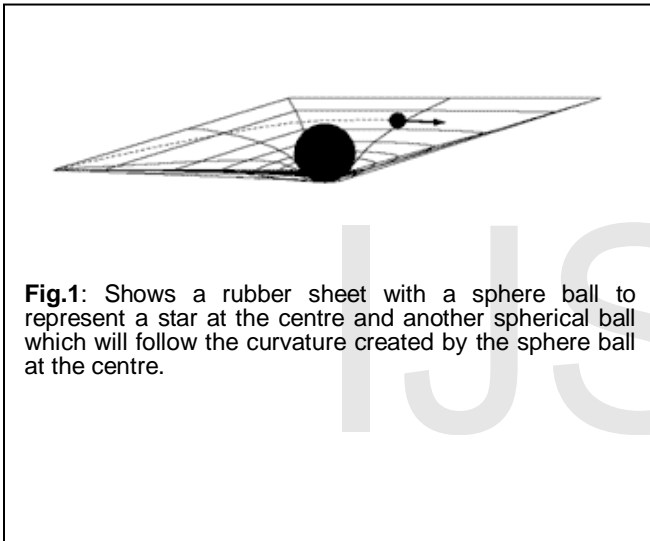
4 Figures

Fig.1: Shows a rubber sheet with a sphere ball to represent a star at the centre and another spherical ball which will follow the curvature created by the sphere ball at the centre.

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, **Fig.2**: Shows the depression created by a very heavy mass which eventually will lead to the formation of the pit.

MATHEMATICAL ANALYSIS

Equation (1) represents Schwarzschild metric which represents the simplest of black hole which is not rotating nor it has any charge at r=0 meaning at the singularity the center of the black hole the t^2 term becomes infinity and the r^2 term becomes zero meaning the space term in the metric becomes zero and the time goes to infinity which means for an observer it is clear that time has stopped and the space dimension has also tended to zero. Meaning the math that we understand for our dimensions becomes funny at the center giving rise to the possibility of another dimension at the center which incorporates this funny looking mathematical structure where space and time is losing their meaning. But what will be the size of that dimension or will it be a space like dimension or not is beyond recognition.

5 CONCLUSION

There can be a dimension beyond our three dimensional universe and that cannot be realized or seen by the naked eye, but its presence can be indirectly inferred from the existence of an exotic object known as Black hole. Black hole's heart has been an enigma since the days of its theoretical discovery. Its known that at the center of an black hole space-time ceases to exist as we know it, all the laws of the universe breaks down at that very point and this has started a quest on unraveling the mystery of a black hole's center in order to fully understand the laws of nature, but this very point can make us see a whole new dimension beyond the existing dimensions of our universe and to realize us that the universe is not only limited to us but is open to many endless possibilities. Similarly we can take any metric like kerr metric or Einstein rosen quasi charged metric and describe the same mystery at the very center.

6 ACKNOWLEDGMENT

NOMENCLATURE

- Escape velocity $= \sqrt{\dfrac{2GM}{R}}$. $= v_e$
- c- velocity of light
- G-gravitational constant
- r_s -is the Schwarzschild radius
- r, θ, ϕ are standard spherical coordinate system

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