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Entropy Change of Black Holes of Quarter Spin in XRBs & AGN

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ABSTRACT

This paper is concerned with the study of change in entropy of black holes of spin parameters a* = +1/4 & -1/4 for unit angular velocity (Ω) for XRBs and AGN. This result that the black holes of co-rotation as well as counter rotation decreases and increases the entropy respectively and the emission of energy from BHs is predicted due to loss of mass as Hawking radiation on the basis of quantum mechanical fields.

KEYWORDS

Quarter Spin, XRBs and AGN.

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INTRODUCTION

The classical theory is not able to explain the emission of radiation from BHs. The present theory explains only capturing of radiation or any information near the event horizon. The quantum theory gives the explanation of emission of radiation a black body radiation. In this case the temperature and surface gravity are proportionality related **[1]**. Many works similar to this work have been done **[2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13].** Rakesh et al. discussed the change in entropy of Bosonic Field of Black Holes of spin a* = +3 & -3 in XRBs and AGN **[14]**, whereas, Mahto et al also discussed the same for spin parameters a* = +2 & -2 **[15]**,

The work deals a model about the change in entropy of spinning black holes w.r.t. the mass of spin parameters a* = +1/4 & -1/4 for unit angular velocity (Ω) in X R Bs and A G N.

THEORETICAL DISCUSSION

The entropy change with respect to the mass is given by the following equation **[8].**

$$\delta S / \delta M = 8\pi M(1 - 2\Omega M a^* + a^{*2}/2 - M\Omega a^{*3}) \quad (1)$$

Let us apply this model for a*=+1/4 and a*=-1/4 **[16]** and unit angular velocity (Ω =1), the equation (1) becomes

$$\left(\frac{\delta S}{\delta M}\right)_{+1/4} = -\frac{33\pi M}{8}(M-2) \quad (2)$$

$$\left(\frac{\delta S}{\delta M}\right)_{-1/4} = \frac{33\pi M}{8}(M+2) \quad (3)$$

The condition for max./min. is given as.

$$\left(\frac{\delta S}{\delta M}\right)_{\pm 1/4} = 0 \quad (4)$$

Using the above equations on (2) and (3), we have

$$M(M-2) = 0 \quad (5)$$

$$M(M+2) = 0 \quad (6)$$

When the equations(5) and (6) are solved to give

M=0 or M=2 (7)

M=0 or M=-2 (8)

Now the models represented by the equations (2) and (3) are applied for the different masses of black holes in XRBs and AGN and also tabulated in the tables

Table 1: Entropy change of BHs of spin +1/4 and -1/4 in XRBs.

S. N.	**Mass in (M⊙)**	$\left(\frac{\delta S}{\delta M}\right)_{+1/4} = -\frac{33\pi M}{8}(M-2)$ [Joule/Kelvin/kg] × 10^{63}	$\left(\frac{\delta S}{\delta M}\right)_{-1/4} = \frac{33\pi M}{8}(M+2)$ [Joule/Kelvin/kg] × 10^{63}
1	5M⊙	-1 . 29525	+1 . 29525
2	6 M⊙	-1 . 86516	+ 1 . 86516
3	7 M⊙	-2 . 53859	+ 2 . 53859
4	8 M⊙	- 3 . 31584	+ 3 . 31584
5	9 M⊙	- 4 . 19661	+ 4 . 19661
6	10 M⊙	- 5 . 18100	+ 5 . 18100
7	11 M⊙	- 6 . 26901	+ 6 . 26901
8	12 M⊙	- 7 . 46064	+ 7 . 46064
9	13 M⊙	- 8 . 75589	+ 8 . 75589
10	14 M⊙	- 10 . 1548	+ 10 . 1548
11	15 M⊙	- 11 . 6573	+ 11 . 6573
12	16 M⊙	- 13 . 2634	+ 13 . 2634
13	17 M⊙	- 14 . 9731	+ 14 . 9731
14	18 M⊙	- 16 . 7864	+ 16 . 7864
15	19 M⊙	- 18 . 7034	+ 18 . 7034
16	20 M⊙	- 20 . 7240	+ 20 . 7240

Table 2: The change in entropy of BHs of spin +1/4 and -1/4 in AGN.

S. N.	Mass in M⊙	Mass in 10^7M⊙	$\left(\frac{\delta S}{\delta M}\right)_{+1/4} = -\frac{33\pi M}{8}(M-2)$ [Joule/Kelvin/kg]× 10^{77}	$\left(\frac{\delta S}{\delta M}\right)_{-1/4} = \frac{33\pi M}{8}(M+2)$ [Joule/Kelvin/kg]× 10^{77}
1	1 x 10^6M⊙	0 .1	-0.0005181	+ 0.0005181
2	2 x 10^6M⊙	0 .2	-0.0020724	+ 0.0020724
3	3 x 10^6M⊙	0 . 3	-0.0046629	+ 0.0046629
4	4 x 10^6M⊙	0 .4	-0.0082896	+ 0.0082896
5	5 x 10^6M⊙	0 .5	-0.0129525	+ 0.0129525
6	6 x 10^6 M⊙	0 .6	-0.0186516	+ 0.0186516
7	7 x 10^6M⊙	0 .7	-0.0253869	+ 0.0253869
8	8 x 10^6M⊙	0 .8	-0.0331584	+ 0.0331584
9	9 x 10^6M⊙	0 .9	-0.0419661	+ 0.0419661
10	1 x 10^7M⊙	1 . 0	-0.0518100	+ 0.0518100
11	2 x 10^7M⊙	2 . 0	-0.2072400	+ 0.2072400
12	3 x 10^7M⊙	3 . 0	-0.4662900	+ 0.4662900
13	4 x 10^7M⊙	4 . 0	-0.8289600	+ 0.8289600
14	5 x 10^7M⊙	5 . 0	-1.2952500	+ 1.295250
15	6 x 10^7 M⊙	6 . 0	-1.8651600	+ 1.865160
16	7 x 10^7M⊙	7 . 0	-2.538690	+ 2.538690
17	8x 10^7 M⊙	8 . 0	-3.315840	+ 3.315840
18	9 x 10^7M⊙	9 . 0	-4.19661	+ 4.19661
19	1 x 10^8M⊙	10 . 0	-5.181	+ 5.1810
20	2 x 10^8M⊙	20 . 0	-20.724	+ 20.724
21	3 x 10^8M⊙	30 . 0	-46.629	+ 46.629
22	4 x 10^8M⊙	40 . 0	-82.896	+ 82.896
23	5 x 10^8M⊙	50 . 0	-129.525	+ 129.525
24	6 x 10^8M⊙	60 . 0	-186.516	+ 186.516
25	7 x 10^8M⊙	70 . 0	-253.869	+ 253.869
26	8 x 10^8M⊙	80 . 0	-331.584	+ 331.584
27	9 x 10^8M⊙	90 . 0	-419.661	+ 419.661
28	1 x 10^9M⊙	100 . 0	-518.10	+ 518.100

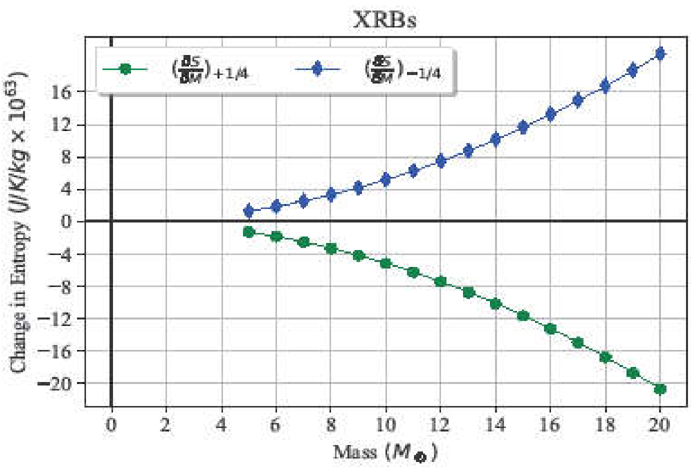

Figure 1: Entropy change of BHs of spin parameter +1/4 and -1/4 in XRBs.

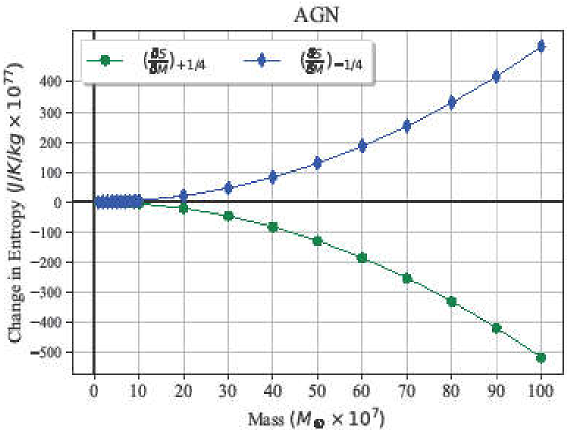

Figure 2: Change in entropy of BHs of spin +1/4 and -1/4 in AGN.

RESULT & DISCUSSIONS

The work starts to consider a model represented by the equation

$$\delta S / \delta M = 8\pi M(1 - 2\Omega M a^* + a^{*2}/2 - M\Omega a^{*3})$$

. The model is applied for spin a* = +1/4 and -1/4 to give two specific models represented by the equations (2) & (3). These two equations will provide us two specific relations for quarter spin of black holes. To get the maximum/minimum values, the equations (2) and (3) are conditioned to the equation (4) to give equations (5) &(6) respectively and then solved to get M = 0, +2 and -2. Now these models are used for the test masses of BHs in XRBs and AGN and also tabulated in the tables 1 & 2. The graphs are also plotted for the different masses of black holes using equations (2) and (3) represented by figures 1for XRBs and 2 for AGN.

The observations from the tables and graphs show that the variation for change in entropy w.r.t. mass are the same and gets symmetrical form for both rotations for each category.

From the observations of our data calculated in the present work, we also see that that there are three types of masses in which one is zero and other two values are positive (+) and negative (-). The significances of these signs (+)and (-) have the basic importance. The zero mass of photon is justified from our work. The sign (+) gives the classical concept regarding the mass. The negative sign (-) explains naked singularity and also dark matter.

CONCLUSIONS

The black holes of quarter spin for both rotations the prediction the emission of Hawking radiation due to reduction of mass on the basis of quantum mechanical fields along with naked singularity of black and dark matter.

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