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Change in Entropy of Fermionic Field of BHs of Spin a* =+5/2 & -5/2 in XRBs

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ABSTRACT

The research paper discusses the change in entropy of black holes w. r. t. the change in mass as given by $\delta S/\delta M = 8\pi M(1-2\Omega Ma^{*}+a^{*2}/2-M\Omega a^{*3})$ for spin parameters a* =+5/2 & -5/2 and is used to calculate the possible values of different masses of BHs which concludes that this change in entropy decreases due to co-rotation and increases due to counter rotation.

KEYWORDS

Fermionic fields, Spin Parameters and XRBs

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INTRODUCTION

The radiation emitting from black holes is not explained by the classical theory, while the quantum theory explains the emission of radiation from a black body**(1975).**The basis for the formulation of laws of black holes has been discussed**(Bardeen et al.1973)**. There are so many discussions have been done regarding the entropy of black holes by Strominger & Vafa **(1996)**, Transchen **(2000)**, Dabholkar **(2005)**, Narayan**(2005)**,Bekenstein**(2008),**Carlips,**(2009)**, Mahto et al., (**2012, 2013)**.Mahto &Kumari**(2018)**., Mahto et al.**(2020)**.

The present paper discusses the change in entropy of fermionic fields of BHs w. r.t. the change in mass of spin a* =+5/2 & -5/2 and calculates their values in XRBs.

THEORETICAL ASPECTS OF THE WORK

For the present purpose of this work, the concerned model for the change in entropy is used given as**(Mahto and Kumari 2018).**

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

The equation (1) is applied for a*= +5/2 and -5/2**(Tayal 2009, Yash 2022)**, then we have

$$\left(\frac{\delta S}{\delta M}\right)_{+5/2} = -\pi M(165M - 33) \quad (2)$$

$$\left(\frac{\delta S}{\delta M}\right)_{-5/2} = \pi M(165M + 33) \quad (3)$$

The maximum or minimum values of mass can be obtained under the following condition.

$$\left(\frac{\delta S}{\delta M}\right)_{\pm 3/2} = 0 \quad (4)$$

When the equation (1) is applied on the equations (2) and (3), we get..

$$M(165M - 33) = 0 \quad (5)$$

$$M(165M + 33) = 0 \quad (6)$$

The solutions of the above both equations are given below.

M=0 or M=33/165 (7)

M=0 or M=-33/165 (8)

The solutions for the masses are 0, 33/165 and -33/165. This shows the zero, positive and negative masses respectively. The positive mass explains the gravity. The negative mass provides the naked singularity &dark matter. The zero mass has also existence as explained by the general relativity and quantum theory. Now by the use of proper data, change in entropy w.r.t. the mass for XRBs is listed in the table 1.

Table 1: The change in entropy for a* = +5/2 and -5/2 .

S.N.	**Mass in ($M_\odot$)**	$\left(\frac{\delta S}{\delta M}\right)_{+5/2} = -\pi M(165M - 33)$ [Joule/Kelvin/kg] × 10^{64}	$\left(\frac{\delta S}{\delta M}\right)_{-5/2} = \pi M(165M + 33)$ [Joule/Kelvin/kg] × 10^{64}
1	5$M_\odot$	-5 . 1810	5 . 1810
2	6 $M_\odot$	-7 . 4610	7 . 4610
3	7 $M_\odot$	-10 . 1500	10 . 1500
4	8 $M_\odot$	-13 . 2600	13 . 2600
5	9 $M_\odot$	-16 . 7900	16 . 7900
6	10 $M_\odot$	-20 . 7200	20 . 7200
7	11 $M_\odot$	-25 . 0600	25 . 0600
8	12 $M_\odot$	-29 . 8400	29 . 8400
9	13 $M_\odot$	-35 . 0200	35 . 0200
10	14 $M_\odot$	-40 . 6200	40 . 6200
11	15 $M_\odot$	-46 . 6300	46 . 6300
12	16 $M_\odot$	-53 . 0500	53 . 0500
13	17 $M_\odot$	-59 . 8900	59 . 8900
14	18 $M_\odot$	-67 . 1500	67 . 1500
15	19 $M_\odot$	-74 . 8100	74 . 8100
16	20 $M_\odot$	-82 . 900	82 . 900

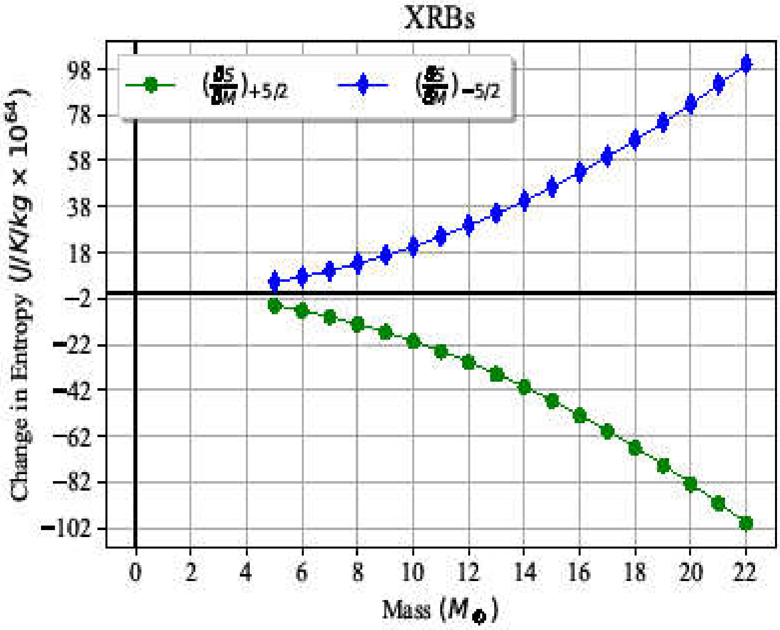

Figure 1: The variation of entropy change of BHs a* = +5/2 and -5/2.

RESULT AND DISCUSSION

The present work starts with consideration of the model for change in entropy given as:

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

The observation of above equation indicates that the change in entropy depends on mainly three parameters like angular velocity, spin and mass. The above equation is used for two spins like a*= +5/2 & -5/2, two equations(2) & (3) are obtained for discussions and their values listed in the table concludes that change in entropy decreases the entropy for a*= +5/2, while increases the entropy change for a*= -5/2 .

For clear conception, the graph is plotted betn the mass of BHs and corresponding change in entropy with change in mass for XRBs with the help of equations (2) & (3). This is shown in the Figs.1. We observe that the variation is symmetrical for either types of spin parameters for co-rotation and counter rotations.

CONCLUSION

The entropy changefor a*= +5/2 showsthe decrease in entropy change, while increases the entropy change fora*= -5/2.The present model also gives the naked singularity as well as dark matter.

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