Bulletin of Pure and Applied Science
Physics, Vol.41D No.1,
January-June 2022 P.20-22
Original Research Article

Print version ISSN 0970 6569
Online version ISSN 2320 3218
DOI: 10.5958/2320-3218.2022.00004.5
Available online at www.bpasjournals.com

Comparative Relativistic Study of Change in Frequency of Hawking Radiation between XRBS and AGN

Medhatithi Chandan, Supriya Kumari, Ashok Kumar, Dipo Mahto

Author's Affiliations:

Medhatithi Chandan
Research Scholar, University Department of Physics, B.N.M.U. Madhepura, Bihar 852113, India.
Supriya Kumari
Assistant Professor, Department of Physics, SBN College Garhirampr, Munger University, Mahamda, Bihar 811211. India.
Ashok Kumar
Professor & Head, University Department of Physics, B.N.M.U. Madhepura, Bihar 852113, India.
Dipo Mahto
Associate Professor, Department of Physics, Marwari College Bhagalpur, Bihar 812007, India.

Corresponding author:

Dipo Mahto
Associate Professor, Department of Physics, Marwari College Bhagalpur, Bihar 812007, India
E-mail: dipomahto@hotmail.com

Received on 03.01.2022
Revised on 01.04.2022
Accepted on 15.04.2022

ABSTRACT

The present paper gives the comparative study of change in relativistic frequency of Hawking radiation due to XRBs and AGN categories of black holes and concludes that the relativistic change in frequency of Hawking radiation due to XRBs is greater than to that of AGN category of spinning black holes.

KEYWORDS Hawking radiation, XRBs and AGN

How to cite this article: Chandan M, Kumari S, Kumar A, Mahto D. (2022). Comparative Relativistic Study of Change in Frequency of Hawking Radiation between XRBS and AGN. *Bulletin of Pure and Applied Sciences- Physics*, 41D (1), 20-22.

INTRODUCTION

The black holes are the product of supernova explosion due to dying stars of masses greater than 5 solar masses and perfect absorbers of every things. These do not emit anything; their temperature is absolute zero. The quantum mechanical effect suggests the emission of particles from black holes like a hot body at the temperature $\kappa/2\pi$, where κ is surface gravity of black holes [1,2,3]. The thermal emission of radiation from black hole leads to show decrease in the mass of the black hole and to its eventual disappearance [2]. Mahto et al. gave a model for the frequency/wavelength of radiation emitting from the black holes and have shown that the frequency or wavelength of radiation emitted from the black holes may be treated as the characteristics of black holes [4]. Mahto and Ranjan gave a model for the frequency and wavelength of Hawking radiation in terms of the event horizon using quantum theory of radiation, energy of Hawking radiation and the radius of event horizon of the spinning

black holes which may be regarded as the characteristics of spinning black holes [5].

In the present paper, we have presented the comparative study of change in relativistic frequency of Hawking radiation due to XRBs and AGN black holes and concluded that the relativistic change in frequency of Hawking radiation due to XRBs is greater than to that of AGN category of the black holes.

THEORETICAL DISCUSSION

The virtual particles called electrons and positrons are created on the event horizon of the black holes in which virtual particles like electrons fall into the black hole and others escape from black hole as Hawking radiation. The frequency of radiated photons is given by the following equation [6].

$$\nu = \frac{c^3}{16\pi GM} \tag{1}$$

Where G be the gravitational constant and c be the velocity of light. The constants G and c have their own significances as discussed in the reference [7].

The mass of black holes will vary with velocity as proposed by Albert Einstein's special theory of relativity as [8], because the spinning black holes have their spinning velocity from 50% to 99% of the velocity of light [9]

$$M = \frac{M_0}{\sqrt{1-V^2/c^2}} \tag{2}$$

Where M_0 is the rest mass and V be the spinning velocity of black holes. Combining Eq(1) and Eq(2) with proper mathematical proper operation, we get the relativistic frequency of Hawking radiation as follows [10,11]:

$$\nu_{rel} = \frac{c^3}{16\pi GM_0}\left[1-\frac{1}{2}(V/c)^2\right] \tag{3}$$

or

$$\left|\frac{d\nu_{rel}}{dV}\right| = \frac{1}{16\pi}\left(\frac{V}{M_0}\right) = 0.19625\left(\frac{V}{M_0}\right) \tag{4}$$

The above equation is used to calculate the maximum relativistic change in the frequency of radiation in terms of mass and spinning velocity of black holes.

The model represented by the equation (8) is applied for the black holes of masses M= $5M_\odot$, $10M_\odot$, $15M_\odot$ and $20M_\odot$ belonging to XRBs and for the black holes of masses M= $10^6 M_\odot$, $10^7 M_\odot$, $10^8 M_\odot$ and $10^9 M_\odot$ belonging to AGN [12] and compared relativistic change in the frequency of radiation of Hawking radiation in terms of mass and spinning velocity.

RESULT AND DISCUSSION

The present work gives the comparative study the relativistic change in the frequency of Hawking radiation due to both categories of black holes. The final expression for the proposed model is in terms of mass and spinning velocity of black holes, which means that the relativistic change in the frequency of Hawking radiation is dependent on the mass and spinning velocity. From the final expression, it is is clear that the relativistic change in the frequency is a function of mass and spinning speed of black holes. This model is applied for the black holes of masses M= $5M_\odot$, $10M_\odot$, $15M_\odot$ and $20M_\odot$ belonging to XRBs and for the black holes of masses M= $10^6 M_\odot$, $10^7 M_\odot$, $10^8 M_\odot$ and $10^9 M_\odot$ belonging to AGN. This shows that for the constant values of mass of black holes, the magnitude of the relativistic change in frequency increases with increase in velocity of black holes while increasing the mass of black holes, this change decreases. In both categories of black holes, the relativistic change in frequency of Hawking radiation w.r.t. spinning velocity for different masses of black holes existing in XRBs as well as in AGN have uniform variations and showing a definite relation between the rate of change in the frequency of Hawking radiation of black holes w.r.t. spinning velocity with corresponding values of spinning velocity of black holes, but the inclination of variations differ. The inclination of variations of XRBs is greater than AGN. It is clear that for the higher mass, the rate of variation of relativistic change in frequency of black holes with velocity is lower and vice – versa in both cases of black holes either XRBs or AGN.

From the theoretical discussions of our work, we finally conclude that the relativistic change

in frequency of Hawking radiation due to XRBs is greater than to that of AGN category of spinning black holes.

CONCLUSIONS

The following conclusions are drawn during the present research.

1. The relativistic change in frequency of Hawking radiation of black holes w.r.t. spinning velocity due to XRBs is greater than the relativistic change in frequency of Hawking radiation of black holes w.r.t. spinning velocity due to AGN
2. The non-spinning black holes of both categories of black holes give maximum change in the relativistic change in frequency of Hawking radiation of black holes than spinning black holes of both categories.
3. The relativistic change in the frequency of Hawking radiation is a function of the mass and spinning velocity.

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