Using of the Correction Schwarzschild radius Equation and Its Application of the Black Holes

Majida H. Al-kubaisy
Dept. of Physic/Collage of Science Al-Mustensiriyh /University

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Abstract

This study is a try to compare between the traditional Schwarzschild's radius and the equation of Schwarzschild's radius including the photon's wavelength that is suggested by Kanarev for black holes to correct the error in the calculation of the gravitational radius where the wavelengths of the electromagnetic radiation will be in our calculation. By using the different wavelengths; from radio waves to gamma ray for arbitrary black holes (ordinary and supermassive).

Key words: black hole, photon, wavelength, Schwarzschild's radius, mass, general.

Introduction

After a star has exhausted its nuclear fuel, it can no longer remain in equilibrium and must ultimately undergo gravitational collapse. The star will end as a white dwarf .If the mass of the collapsing core is less than the famous Chandrashekhar limit of 1.4 $M_\odot$ which represents the solar masses. It will end as a neutron star if the core has a mass greater than the Chandrashekhar limit and less than about 35 times the mass of the sun. It is often believed that a core heavier than about 5 solar masses will end, not as a white dwarf or as a neutron star, but as a black hole [1].

Photon always travels at the speed of light, but they lose energy when travelling out of a gravitational field. The stronger the gravitational field the more energy the photon lose .The extreme case is the black holes where photons from wither radius lose all energy and became invisible. In physical terms, a black hole is a region where gravity is so strong that nothing can escape. In order to make this notion precise, one must have in mind a region of space time to which one can contemplate escaping.

Black holes are perhaps the most strange and fascinating objects in the universe [2]. In principle, any object - even a rock - can be made into a black hole, by squeezing it into a tiny enough volume. Under these conditions, the object continues to collapse under its own weight, crushing itself down to zero size. However, according to Einstein's theory, the object's mass and gravity remain behind, in the form of an extreme distortion of the space and time around it. This distortion of space and time is the black hole. The resulting black hole is the darkest black in the universe: No matter how powerful a light you shine on it, no light ever bounces back, because the light is swallowed by the hole. A black hole is a true "hole" in space. Anything that crosses the edge of the hole -called the "horizon" of the hole - is swallowed forever. For this reason, black holes are considered an edge of space, a one-way exit door from our universe; nothing inside a black hole can ever communicate with our universe again, even in principle.

A black hole is, by definition a region in space-time in which the gravitational field so strong that is precludes even light from escaping to infinity. Black holes are formed when a body of mass M contracts to size less than the so called gravitational radius R_s= $2GM/C^2$ (Newton's gravitational constant) the velocity required to leave the boundary of the black holes and move away to infinity equals to the speed of light [3]. Since signal cannot escape from a black hole, while physical object and radiation can fall into it, the surface boundary the black hole in space-time is called the event horizon, which is a light surface.

In Newtonian physics, the escape velocity from a spherical mass M of radius R satisfies $V_{esc} = \sqrt{2GM/R}$, (independent of the mass of the escaping object, by equivalence of inertial and gravitational masses). V_{esc} exceeds the velocity of light if the R < R_s where The radius R_s is called the Schwarzschild's radius for the mass M [4],[5].

The New Schwarzschild's radius

It has shown that the equation of the Schwarzschild's radius for the black holes does not account the photon wavelength [6], so that first we review the ordinary Schwarzschild's radius.

In 1916, Karl Schwarzschild, the German Astronomer offered a formula for the calculation of the gravitational radius R_s of the black holes which is called also Schwarzschild's radius:

$$R_s = \frac{2G.M}{C^2} \qquad (1)$$

Where G= 6.67×10^{-11} N. m^2/kg^2 is the gravitational constant, M is the star mass and C is the velocity of light. The gravitational radius formula (1) is derived by using the mathematical relation in the law gravitation [7]:

$$F_g = G.\frac{m.M}{R^2} \quad (2)$$

Here F_g is the gravitational force, m is the photon mass and R is the distance between the center of masses of the bodies which form the gravitation. In order to find the gravitation radius R= R_s of the star , by which its gravitational field retard light it is necessary to find relationship between the gravitational force and the force F_F which moves the photon and has the formula [6]:

$$F_F = \frac{m\,c^2}{\lambda} \quad (3)$$

If we equate equation (2) with equation (3), we will have:

$$G.\frac{m.M}{R_s} = \frac{mC^2}{\lambda} \quad (4)$$

It's clear that in order to convert the equation of the forces (4) into equation of energies it is necessary to reduce the denominator of the left side part by the R_s and to reduce the denominator of the right side by λ of the photon , Actually it means that it is necessary to equate the gravitational radius to the wavelength of the photon it is possible to do it , Schwarzschild did it and his followers did not notice this error [6].

Thus Kanarev will add the photon wavelength to calculate the gravitational radius of the black hole; it is the result of the mistake that Schwarzschild made when he derived this formula. The final formula derived by Kanarev must add 2π to right side of equations (4) as shown below:

$$R_S = \frac{1}{c}\sqrt{\frac{G.M.\lambda}{2\pi}} \quad (5)$$

The density of the black holes according to equation (5) will be:

$$\rho = \frac{3M}{4\pi.R_S^3} \quad (6)$$

This the new gravitational radius or new Schwarzschild's radius which contains the wave length of the photon that corrected the error of the traditional Schwarzschild's radius formula according to Kanarev work in 2002.

The results

This work is based on a comparison between classical and new Schwarzschild's radius for many black holes by using matlap programing to the equations (1) ,(5) and (6). To show the difference between these two radius (we found some errors in the Kanarev paper's when he made his calculation for the new Schwarzschild radius of sun at infrared and gamma wavelength, we resolved them as shown in this table below).

Equations (1) &(5) are used to find the traditional and the new Schwarzschild radius as shown in table No.(1), for many arbitrary black holes [8] where their masses lie between (4-20)$M_\odot$. By using wavelength from radio to gamma in equation (5), we found that the new R_s will have less value than the traditional R_s and its value decreases when the wavelength is decreased as it is mentioned in figure (1). It's clear that the gravitational field in black hole with R_s lie between (10- 19) m (in radio spectrum) will retard the electromagnetic radiation while the smaller wavelength in the spectrum will penetrate easily.

Another application for the supermassive black holes [9] for the same equation as shown in table No. (2). The large R_s value will retard the electromagnetic while the small one will penetrate the radiation, here we can see that the black holes will have the larger gravitational field for the both traditional R_s and new R_s in the radio , infrared and visible wavelength which is obviously in the figure (2).

Conclusion

The difference in our calculation of the gravitational field of a black holes between the traditional and new Schwarzschild radius is about 10^9 times when the wavelength of the electromagnetic radiation taken into account which is close to the value found by Kanarev in 2002 which equal to 10^8 times, while for the ordinary black holes and for the supermassive black holes 10^{14} times.

This calculation will show us that by using the wavelength in the Schwarzschild radius the black holes will not be black just for the wavelength that penetrates the R_s while the other will shine in new color which refers to the wavelength that retards.

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Table No. (1) Schwarzschild radius (R_s& new R_s) for black holes in binary system for given wavelengths

Note: All the reference in the table exists in [8].

Black Holes (BH)	BH mass (Solar mass) (kg)	Traditional R_s (m)	Radio	Infrared	visible	x-ray	Gamma	Ref.
			New R_s (m)	New R_s (m)	New R_s (m)	New R_s (m)	New R_s (m)	
SS433	4.4±0.8	1.3061e+4	10.6925	1.0195	0.0204	1.0195e-4	1.0195e-5	10
GX 339-4	≥ 6.0	1.7810e+4	12.4861	1.1905	0.0238	1.1905e-4	1.1905e-5	12
GS1124-684	7±0.6	2.0779e+4	13.4866	1.2859	0.0257	1.2859e-4	1.2859e-5	14
XTE J1118+480	8.5±0.6	2.5231e+4	14.8615	1.4170	0.0283	1.4170e-4	1.4170e-5	14
A 0620-00	11±2	3.2652e+4	16.906	1.6120	0.0322	1.6120e-4	1.6120e-5	12
GRS 1915+105	14±4	4.1558e+4	19.0729	1.8185	0.0364	1.8185e-4	1.8185e-5	13
CygX-1	20±5	5.9368e+4	22.7965	2.1736	0.0435	2.1736e-4	2.1736e-5	11

Table No. (2) Schwarzschild radius (R_s & new R_s) for supermassive black holes in binary system for given wavelengths

Note: All reference in the table exists in [9] for the supermassive black holes masses.

Black Holes (BH)	BH mass (Solar mass) (kg)	Traditional R_s (m)	Radio	Infrared	visible	x-ray	Gamma	Ref.
			New R_s (m)	New R_s (m)	New R_s (m)	New R_s (m)	New R_s (m)	
Milky Way	4.1e+6	1.2170e+10	1.0322e+04	984.1205	19.6824	0.0984	0.0098	8,38,40
Circinus	1.7e+6	5.0463e+09	6.6463e+03	633.6958	12.6739	0.0634	0.0063	4,41
N1194	6.8e+7	2.0185e+11	4.2035e+04	4.0078e+03	80.1569	0.4008	0.0401	34
N1023	14.6e+7	4.3339e+11	6.1593e+04	5.8726e+03	117.4526	0.5873	0.0587	8,46
N224(N31)	1.5e+8	4.4526e+11	6.2431e+04	5.9525e+03	119.0507	0.5953	0.0595	8,44
N524	8.3e+8	2.4638e+12	1.4686e+05	1.4002e+04	280.0434	1.4002	0.1400	45
N1332	1.45e+9	4.3042e+12	1.9410e+05	1.8507e+04	370.1437	1.8507	0.1851	49
N3842	9.7e+9	2.8793e+13	5.0204e+05	4.7868e+04	957.3532	4.7868	0.4787	37

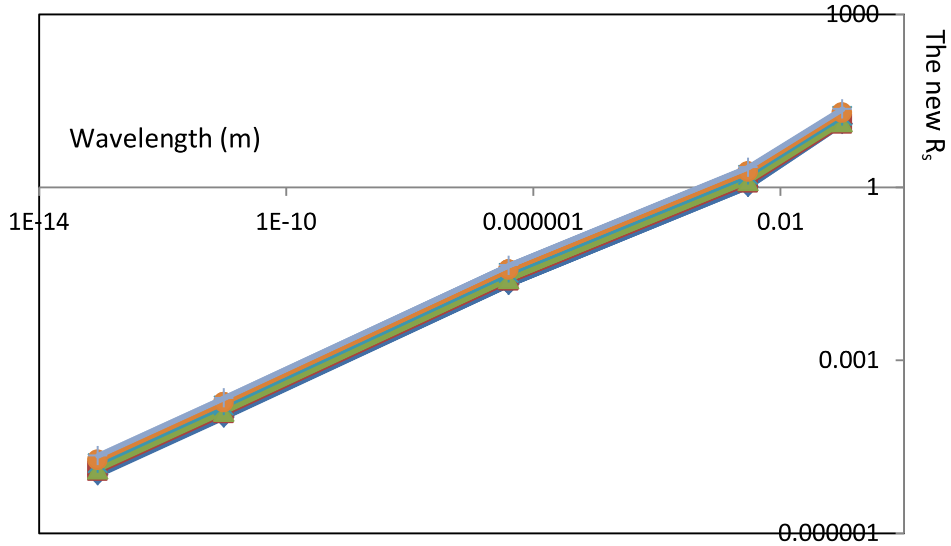

Figure No. (1) The difference for the R_s for many black holes with wavelength

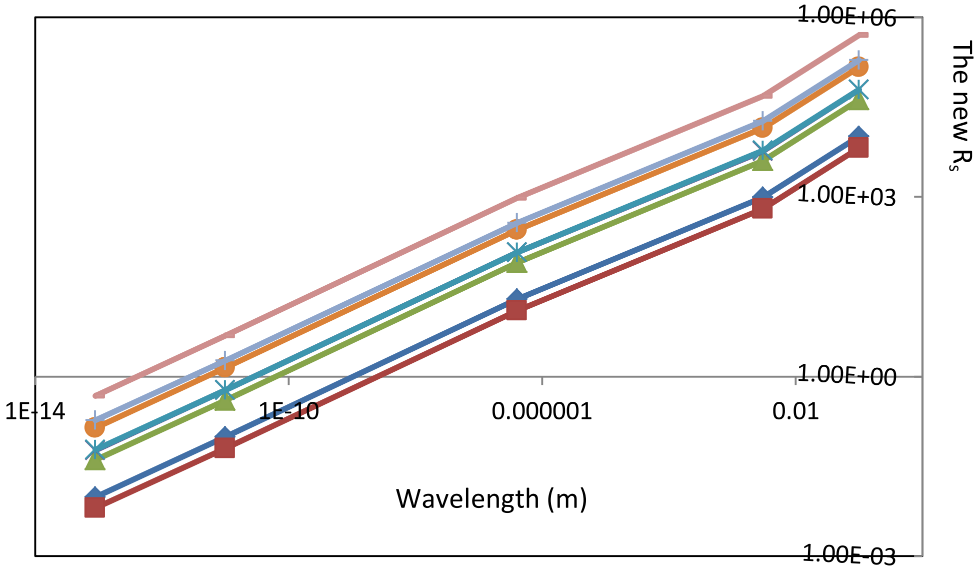

Figure No.(2) The difference for the R_s for many supermassive black holes with wavelength

باستخدام المعادلة المصححة لنصف قطر شوارزجايلد وتطبيقاتها على الثقوب السوداء

ماجدة حمدان الكبيسي
قسم الفيزياء/ كلية العلوم/ الجامعة المستنصرية

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الخلاصة

هذه الدراسة محاولة لأجراء مقارنة بين نصف قطر شوارزجايلد التقليدي ومعادلة نصف قطر شوارزجايلد التي تتضمن الطول الموجي للفوتون والمقترحة من كنيرف للثقوب السوداء وذلك لتصحيح الخطأ في الحسابات لقياس نصف قطر التجاذبي، حيث الاطوال الموجية للإشعاع الكهرومغناطيسي ستستعمل في حساباتنا. باستخدام الاطوال الموجية المختلفة من الموجات الراديوية والى اشعة كاما وتطبيقها بشكل اعتباطي للثقوب السوداء (الاعتيادية وفائقة الكتلة).

الكلمات المفتاحية: الثقب الاسود، الفوتون، نصف قطر شوارزجايلد، الكتلة، عام.