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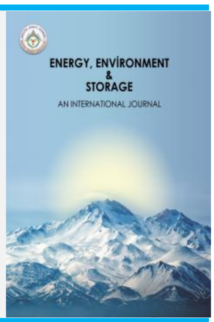

A Proposed Algorithm for Detecting Invisible Celestial Objects by Generalizing the Planck's Blackbody Radiation Law

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ABSTRACT. Blackbody radiation was proposed by Planck to measure the temperature of a body by observing its electromagnetic waves spectrum. However, when it comes to massive objects such as stars, other factors can affect the emitted wavelength of the light from the body, such as gravitational field and doppler effect, which are caused not only by the star but also by the observer (i.e., Earth). Hence, predicting the surface temperature of a star by using only its radiation might not be accurate especially for massive stars. To solve the problem, and to give more accuracy to the measurement, this paper proposes an algorithm and a modification of the Plank's blackbody radiation theory by considering the impact of relativistic Doppler effect and the gravitational field of both, the emitter (i.e., star), and the receiver (i.e., Earth). For validation purposes, the proposed modification theory is compared to the original one proposed by Planck using four different case studies, (a) sun is considered as an emitter and the earth as the receiver; (b) a massive star is considered as an emitter and the earth as a receiver; (c) the earth is considered as an emitter and a massive star as a receiver; finally (d) two identical stars are considered as emitter and receiver, respectively. Results show that our proposed method works perfectly and gives more accurate results compared to the traditional Plank's theory since the impact of gravitational field and Doppler effect on the spectrum are considered.

Keywords:Blackbody radiation, General theory of relativity, Doppler Effect, Planck hypothesis, electromagnetic spectrum, gravitational field, Wien's displacement law.

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1. INTRODUCTION

In physics, blackbody radiation is a type of electromagnetic radiation within or surrounding a body in thermodynamic equilibrium with its environment or emitted by a blackbody (an opaque and non-reflective body) held at constant and uniform temperature. The radiation has a specific spectrum and intensity that depends only on the temperature of the body [1-2].A perfectly insulated enclosure that is in thermal equilibrium internally contains the body, will emit radiation through a hole made in its wall, providing the hole is small enough to have negligible effect upon the equilibrium [3-4].A blackbody at room temperature appears black, as most of the energy it radiates is infra-red and cannot be perceived by the human eye. At higher temperatures, blackbodies glow with increasing intensity and colors that range from dull red to blindingly brilliant blue-white as the temperature increases [5-8].Although planets and stars are neither in thermal equilibrium with their surroundings nor perfect blackbodies, blackbody radiation is used as a first approximation for the energy they emit. Black holes are near-perfect blackbodies, and it is believed that they emit blackbody radiation (called Hawking radiation), with a temperature that depends on their mass [9-12].The term *black body* was introduced by Gustav Kirchhoff in 1860 [3]. When used as a compound adjective, the term is typically written as hyphenated, for example, black-body radiation, but sometimes also as one word, as in blackbody radiation. Blackbody radiation is also called complete radiation or temperature radiation or thermal radiation.

On the other hand, Doppler Effect affects the wavelength of the electromagnetic wave which is demonstrated by Doppler. In addition, gravitational fields also affect the wavelength of the electromagnetic wave which was proved by the general theory of relativity [13-15]. Hence, it can be deduced that the electromagnetic spectrum emitted by a blackbody is affected by both, Doppler effect and the gravitational field, which are not considered in the original theory proposed by Planck. In fact, the blackbody theory works perfectly for small gravitational field and for small velocities of the object. It might not give accurate results when it comes to massive objects such as massive stars moving at high speed. It is important to mention that blackbody theory is applied to a

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wide range of objects such as galaxies, black holes, stars, planets, human, molecules, and even atoms [16-27].

To fill the gap in the literature and to increase the accuracy of the measurement, this paper generalizes the blackbody radiation theory and Wien's displacement law by considering the impact of the Doppler effect and the gravitational field on the electromagnetic spectrum emitted by the blackbody. In addition, the proposed theory can be implemented in other fields of physics as in [28-35].

This paper is organized as follows: The second section presents backgrounds on the blackbody radiation law and Planck's hypothesis, the general Doppler effect, and the gravitational field. In section 3, the author proposes a general theory of the blackbody radiation.In the fourth section, results are presented. Finally,a conclusion is shown in section five.

2. BACKGROUND OF EXISTING THEORIES

2.1. Blackbody Radiation and Planck's Hypothesis

According to the blackbody radiation theory, any object at any temperature emits electromagnetic waves in the form of thermal radiation from its surface.The characteristics of this radiation depend on the temperature and properties of the object's surface. Studies showed that the radiation consists of a continuous distribution of wavelengths from all portions of the electromagnetic spectrum. If the object is at room temperature, the wavelengths of thermal radiation are mainly in the infrared region; hence, the radiation is not detected by the human eyes. For this reason, infrared cameras are widely deployed in dark to detect movements and to see objects, animals and humans. As the surface temperature of the object increases, the object eventually begins to glow visibly red. At sufficiently high temperatures, the glowing object appears white; at very high temperature it appears blue and so on. A blackbody is an ideal system that absorbs all radiation incidents on it, and emits electromagnetic radiation on a large spectrum, which is called blackbody radiation. **Fig. 1** and **Fig. 2**show how the intensity of blackbody radiation varies as a function of the temperature and wavelength based on classical and the Planck's theories, respectively, [3]. As an example, for a temperature of 5000K, the spectral radiance using classical theory does not converge for small wavelengths as it appears in **Fig. 1**. However, Plank corrected the equation in which the spectral radiance converges for any temperature as in **Fig. 2**.

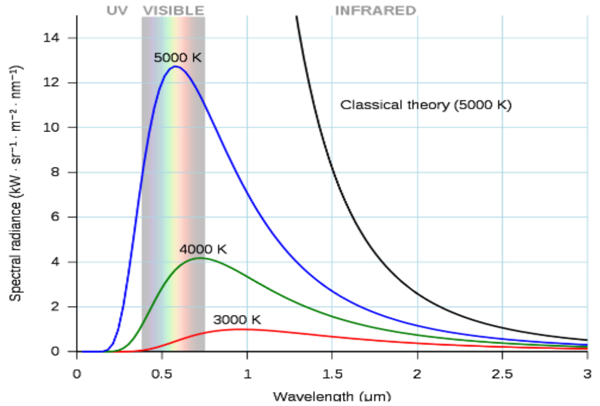

Fig. 1. Intensity as a function of the wavelength and temperature of a blackbody using classical theory.

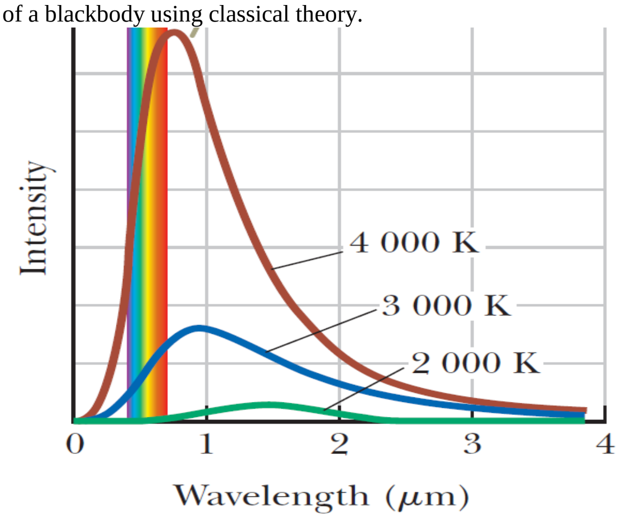

Fig. 2. Intensity as a function of the wavelength and temperature of a blackbody using Plank's theory. Visible light spectrum is between 0.4 and 0.8μm [3].

According to the classical theory, the total power of the emitted radiation increases with temperature and known as Stefan's law. This behavior is expressed in Eq. (1), [3]. Where, P is the power of electromagnetic waves radiated from the surface of the object, [W].$\sigma$is the Stefan–Boltzmann constant equal to $5.6696 \cdot 10^{-8} W/m^2K^4$.$A$ is the surface area of the object, [m^2].T is the surface temperature in Kelvin.e is the emissivity; it is equal to $e = 1$for a blackbody.

$$P = \sigma AeT^4 \quad (1)$$

The peak of the wavelength distribution shifts to shorter wavelengths as the temperature increases. This behavior is described by Eq. (2) and called Wien's displacement law [3]. Where λ_{max} is the wavelength at which the curve peaks.T is the absolute temperature of the object's surface emitting the radiation.

$$\lambda_{max} T = 2.898 \cdot 10^{-3} m \cdot K \quad (2)$$

The classical theory could not explain the radiation at very high temperature as in Figure 1. Therefore, Planck improved the theory by introducing Eq. (3), [3]. This mathematical expression for the wavelength distribution agrees remarkably well with the experimental results as presented in Figure 2. It includes the parameter h, which Planck adjusted so that his curve matched the experimental data at all wavelengths. The value of this parameter is found to be independent of the material of which the blackbody is made and independent of the temperature. It is a fundamental constant of nature, and it is equal to $h = 6.626 \cdot 10^{-34} J \cdot s. k_B$is theBoltzmann's constant, $k_B = 1.38064852 \cdot 10^{-23} m^2 \cdot kg \cdot s^{-2} K^{-1}$.

$$I(\lambda, T) = \frac{2\pi hc^2}{\lambda^5 \left(e^{\frac{hc}{\lambda k_B T}} - 1\right)} \tag{3}$$

In fact, the Planck's hypothesis is a very good approach to explain the radiation from a blackbody. It can work perfectly for bodies with weak gravitational fieldand moving at a very low speed. However, for massive bodies such as supper massive stars and quasars, the gravitational field is very strong and can affect the length of the electromagnetic wave. As an example, the emitted light from a massive blackbody is shifted to a lower frequency when it goes out the body,then it is shifted to a higher frequency when it is approaching an observer with a strong gravitational field. The same for the Doppler Effect, when the blackbody and the observer are approaching to each other, the electromagnetic wave is shifted to a higher frequency; when they are running away from each other, the electromagnetic wave is shifted to a lower frequency. From this place, it is necessary to also define the Doppler effect and the gravitational field in the next subsections.

2.2. Relativistic Doppler effect in two-dimensional space

The doppler effect is used to measure the speed of an object in space. In case the source approaches the observer, the measured frequency is increased, and the wavelength is reduced. In case the source is moving away from the observer, the frequency is reduced, and the wavelength is increased. The general doppler effect in a two-dimensional space is described by Eq. (4), [3].Where, f_R is the frequency received by the receiver (observer).V_w is the velocity of the wave, in our case, the wave is an electromagnetic radiation, and the velocity is equal to the velocity of the light $V_w = c$.V_R is the velocity of the receiver (observer).θ_R is the angle formed between the vector velocity of the receiver and the axis source-receiver (SR).V_S is the velocity of the source, in our case, it is the Blackbody.θ_S is the angle formed between the vector velocity of the source and the axis source-receiver (SR).f_S is the frequency emitted by the source (blackbody).**Fig. 3** presents the vectors of the source and the observer (receiver).

$$f_R = \left(\frac{V_w + V_R\cos(\theta_R)}{V_w - V_S\cos(\theta_S)}\right) f_S \tag{4}$$

The relativistic frequency f_R according to the special relativity of Einstein can be written as in Eq. (5).

$$f_R = f_S \left(\frac{V_w + V_R\cos(\theta_R)}{V_w - V_S\cos(\theta_S)}\right) \sqrt{\frac{1 - \left(\frac{V_S}{V_w}\right)^2}{1 - \left(\frac{V_R}{V_w}\right)^2}} \tag{5}$$

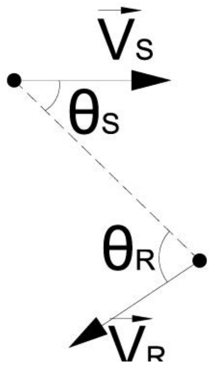

Fig. 3. Relationship between two vectors $\overrightarrow{V_S}(|V_S|, \theta_S)$ and $\overrightarrow{V_R}(|V_R|, \theta_R)$in a 2D space.

However, in this paper, we are interested in finding a relationship between the wavelengths of the receiver and the source instead of the frequency. To do so, Eq. (6) is used which presents the relationship between the frequency and the wavelength of the light. Then, by substituting it in Eq. (4), Eq. (7) is obtained. λ_R is relativistic wavelength measured by the receiver, and λ_S is the real relativistic wavelength emitted by the source. In case the receiver and the source are approaching to each other, then $\lambda_R \le \lambda_S$, if they are moving away, then $\lambda_R \ge \lambda_S$.

$$f = \frac{c}{\lambda} \tag{6}$$

$$\lambda_R = \lambda_s \left(\frac{c - V_S\cos(\theta_S)}{c + V_R\cos(\theta_R)}\right) \sqrt{\frac{1 - \left(\frac{V_R}{c}\right)^2}{1 - \left(\frac{V_S}{c}\right)^2}} \tag{7}$$

2.3. Gravitational redshift

According to the general theory of relativity [7], light is affected by the gravitational field of an object (such as a star). Hence, if the light is leaving the star, its wavelength becomes larger, and it is redshifted as depicted in **Fig. 4**. This phenomenon is called gravitational redshift and expressed as in Eq. (8). Where, f_S and f_R are the frequencies of the light at the source and receiver; G is the Newton's gravitational constant ($G = 6.6738 \cdot 10^{-11} Nm^2/kg^2$); M_S is the mass of the source; R_S is the radius of the source (in case of a spherical shape); c is the velocity of the light in a vacuum ($c = 299792458 m/s$). When an electromagnetic wave exits from a massive body, there is a reduction in its energy. Its frequency is also reduced due to the electromagnetic radiation propagating in opposition to the gravitational gradient. There also exists a corresponding blueshift when electromagnetic radiation propagates from an area of a weaker gravitational field to an area of a stronger gravitational field.

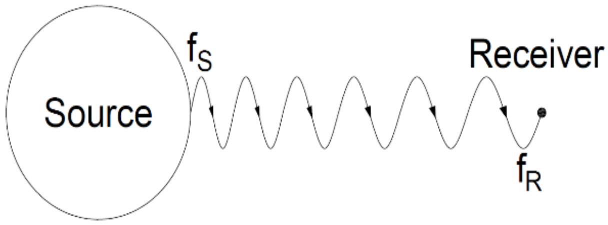

Fig. 4. Example of a gravitational redshift when an electromagnetic signal is emitted by the source toward the received, where $f_s > f_R$.

$$\frac{f_S - f_R}{f_S} = \frac{GM_S}{R_S c^2} \tag{8}$$

Since we are interested in calculating the wavelength, Eq. (6) is substituted in Eq. (8). Hence, the wavelength relationship between the source and the receiver is presented in Eq. (9).

$$\lambda_R = \frac{\lambda_S}{\left(1 - \frac{GM_S}{R_S c^2}\right)} \tag{9}$$

On the other hand, if the light is approaching to a massive receiver, the photon gains energy and increases its frequency; hence, its wavelength is reduced as described in Eq. (10) and depicted in **Fig. 5**. Where, M_R is the mass of the receiver and R_R is the radius of the receiver.

$$\lambda_R = \lambda_S \left(1 - \frac{GM_R}{R_R c^2}\right) \tag{10}$$

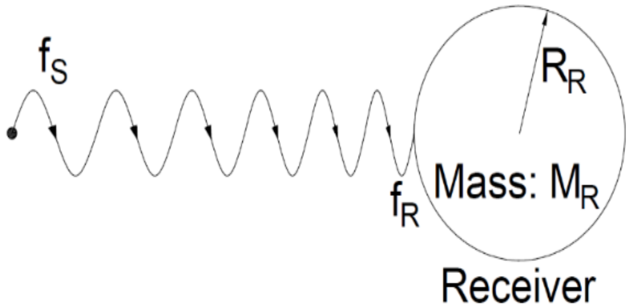

Fig. 5. Example of a gravitational redshift when an electromagnetic signal is emitted by the source toward the received, where $f_S < f_R$.

3. PROPOSED ALGORITHM FOR DETECTING INVISIBLE CELESTIAL OBJECTS

3.1. Proposed General Blackbody Radiation Theory

In this paper, the blackbody radiation theory is generalized, in which the impact of relativistic doppler effect and the gravitational redshift on the wavelength are considered. **Fig. 6** presents the variation of the wavelength passing from the source to the receiver considering the movement of both objects, their speed, mass, and radius. Planck postulated that "*The radiation has a specific spectrum and intensity that depends only on the temperature of the body*". However, since the relativistic doppler effect and gravitational redshift phenomena affect the wavelength of light received by the receiver, the postulate should be corrected as it will appear later in this paper.

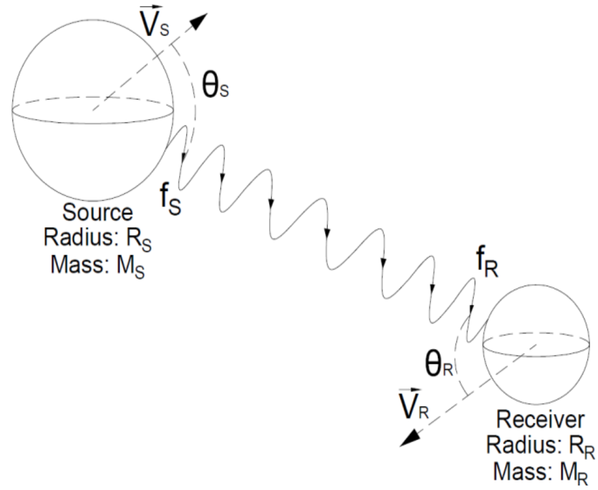

Fig. 6. Variation of the wavelength considering relativistic doppler effect and gravitational redshift.

Eq. (11) presents the relationship between the wavelength emmitted by the source and received by the receiver, which takes into account the gravitational redshift and the relativistic doppler effect.This relationship is important in studyingthe blackbodies and theirwavelength spectrum since it gives more accurate results especially for massive objects compared to the equation proposed by Planck. Equations (12) and (13) present the intensity of the electromagnetic spectrum of the blackbody at the source ($I_S(\lambda_S, T)$) and receiver ($I_R(\lambda_R, T)$) levels, respectively. Once the intensity at the receiver level is measured, it becomes easier to calculate the intensity at the source level. Hence, it is possible to calculate the missing information of the blackbody such as its speed, moving direction, surface's temperature, mass, and distance between the source and the receiver.

$$\lambda_R = \lambda_S \frac{\left(1 - \frac{GM_R}{R_R c^2}\right)}{\left(1 - \frac{GM_S}{R_S c^2}\right)} \left(\frac{c - V_S \cos(\theta_S)}{c + V_R \cos(\theta_R)}\right) \sqrt{\frac{1 - \left(\frac{V_R}{c}\right)^2}{1 - \left(\frac{V_S}{c}\right)^2}} \tag{11}$$

$$I_S(\lambda_S, T) = \frac{2\pi hc^2}{\lambda_S^5 \left(e^{\frac{hc}{\lambda_S k_B T}} - 1\right)} \tag{12}$$

$$I_R(\lambda_R, T) = \frac{2\pi hc^2 \left[\frac{\lambda_R}{\left(\frac{\left(1 - \frac{GM_R}{R_R c^2}\right)}{\left(1 - \frac{GM_S}{R_S c^2}\right)} \left(\frac{c - V_S \cos(\theta_S)}{c + V_R \cos(\theta_R)}\right) \sqrt{\frac{1 - \left(\frac{V_R}{c}\right)^2}{1 - \left(\frac{V_S}{c}\right)^2}}\right)}\right]^{-5}}{\left(\exp\left(\frac{hc \left(\frac{\left(1 - \frac{GM_R}{R_R c^2}\right)}{\left(1 - \frac{GM_S}{R_S c^2}\right)} \left(\frac{c - V_S \cos(\theta_S)}{c + V_R \cos(\theta_R)}\right) \sqrt{\frac{1 - \left(\frac{V_R}{c}\right)^2}{1 - \left(\frac{V_S}{c}\right)^2}}\right)}{\lambda_R k_B T}\right) - 1\right)} \tag{13}$$

The same procedure can be applied to the Wien's displacement law that determines the wavelength for the maximum intensity, as in Eq. (14). The electromagnetic wave with the highest intensity measured by the source and the receiver are defined in Equations (15) and (16), respectively. Where, $\varepsilon = 2.898 \cdot 10^{-3} m \cdot K$.

$$\lambda_{max} T = \varepsilon \quad (14)$$

$$\lambda_S^{Max} = \frac{\varepsilon}{T} \quad (15)$$

$$\lambda_R^{Max} = \frac{\varepsilon}{T} \frac{\left(1 - \frac{GM_R}{R_R c^2}\right)}{\left(1 - \frac{GM_S}{R_S c^2}\right)} \left(\frac{c - V_S \cos(\theta_S)}{c + V_R \cos(\theta_R)}\right) \sqrt{\frac{1 - \left(\frac{V_R}{c}\right)^2}{1 - \left(\frac{V_S}{c}\right)^2}} \quad (16)$$

Whenever λ_R^{Max} and I_R^{Max} are measured, it becomes easier to calculate λ_S^{Max} and I_S^{Max}, in which Eq. (17) represents the λ_S^{Max} as a function of $I_R^{Max}(\lambda_R^{Max}, T)$ and λ_R^{Max}, and Eq. (18) represents $I_S^{Max}(\lambda_S^{Max}, T)$ as a function of $I_R^{Max}(\lambda_R^{Max}, T)$ and λ_R^{Max}.

$$\lambda_S^{Max} = \left(\frac{I_R^{Max}(\lambda_R^{Max}, T) \cdot \left(e^{\frac{hc}{\varepsilon k_B}} - 1\right)}{2\pi h c^2} \right)^{-\frac{1}{5}} \quad (17)$$

$$I_S^{Max}(\lambda_S, T) = I_R^{Max}(\lambda_R^{Max}, T) \quad (18)$$

3.2. Proposed algorithm to detect invisible celestial objects

Invisible objects in the universe are also considered as blackbodies that emit a spectrum of light in which the wavelength of the maximum intensity is not located within the visible spectrum.The visible spectrum or optical spectrum is the portion of the electromagnetic spectrum that is visible to the human eye. Electromagnetic radiation in this range of wavelengths is called visible light or simply light. A typical human eye will respond to wavelengths from about 380 to about 750 nanometers [30]. In terms of frequency, this corresponds to a band in the vicinity of 400–790 THz. These boundaries are not sharply defined and may vary per individual. Under optimal conditions these limits of human perception can extend to 310 nm (UV) and 1100 nm (NIR) [31]. Therefore, it is not easy to notice the celestial objects and to know more about their characteristics such as mass, volume, radius, density, etc. In this section, an algorithm is proposed to detect invisible celestial objects especially stars from a distant by detecting their maximum wavelength (λ_R^{Max}) and the corresponding maximum spectrum intensity ($I_R^{Max}(\lambda_R^{Max}, T)$).

In this section, it is important to focus on the measurable parameters that can be detected by instruments from the receiver's viewpoint such as the telescope. First, it is important to mention what are the parameters that can be determined before starting the calculation.

Table 1 presents the constants and variables of the equations from (11) to (18). Some of them are known, others are to be measured, determined, or calculated.

Eq. (19) is deduced from Eq. (11), in which M_S/R_s is written as a function of other known parameters. M_S can be known since it is possible to measure the impact of the celestial object on its environment. Therefore, R_S can be calculated as in Eq. (20), and it is also possible to determine the density of the celestial object as per the Eq. (21). It can be noted that the density of the celestial object is not constant and might change based on its velocity, and the velocity of the observer.

Table 1. Data set needed.

Parameter	Status	Value
c	Constant	$299792458 m/s$
ε	Constant	$2.898 \cdot 10^{-3} m \cdot K$
G	Constant	$6.6738 \cdot 10^{-11} Nm^2/Kg^2$
h	Constant	$6.626 \cdot 10^{-34} J \cdot s$
k_B	Constant	$1.38064852 \cdot 10^{-23} J \cdot K^{-1}$
λ_R^{Max}	Detected	Only after measurement
I_R^{Max}	Detected	Only after measurement
M_R	Measured	Only after measurement
R_R	Measured	Only after measurement
V_R	Measured	Only after measurement
θ_R	Measured	Only after measurement
V_S	Measured	Only after measurement
θ_S	Measured	Only after measurement
λ_S^{Max}	Calculated	Eq. (17)
I_S^{Max}	Calculated	Eq. (18)
T	Calculated	$T = \varepsilon/\lambda_S^{Max}$
M_S	Unknown	To be calculated
R_S	Unknown	To be calculated

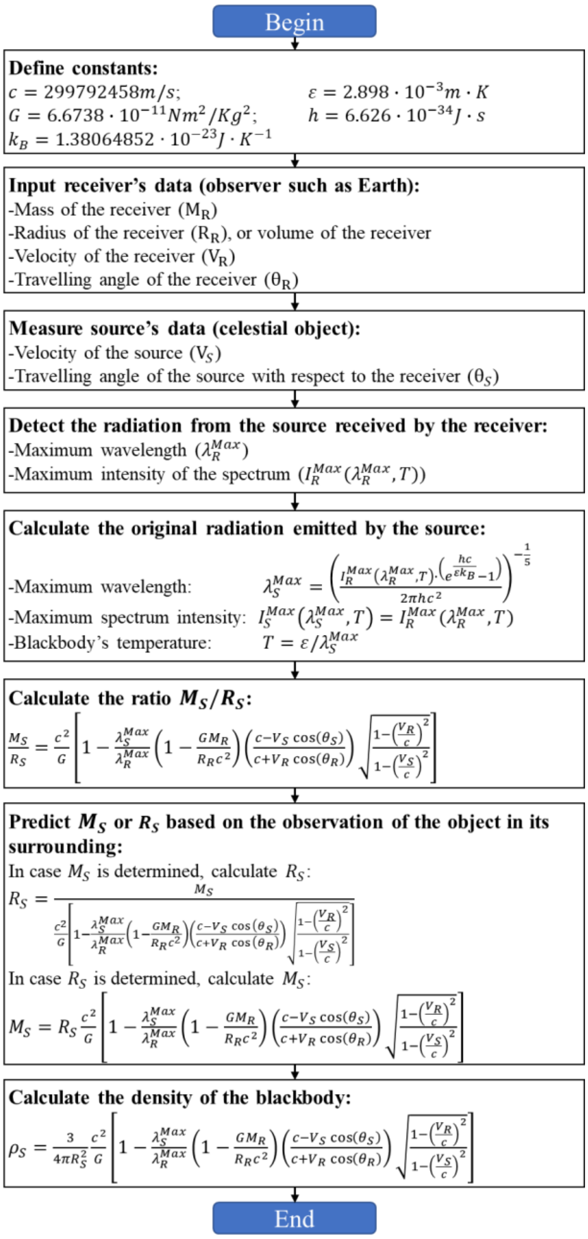

Fig. 7. Proposed algorithm fordetecting invisible celestial objects and calculating all their necessary data.

$$\frac{M_S}{R_S} = \frac{c^2}{G}\left[1 - \frac{\lambda_S^{Max}}{\lambda_R^{Max}}\left(1-\frac{GM_R}{R_R c^2}\right)\left(\frac{c-V_S\cos(\theta_S)}{c+V_R\cos(\theta_R)}\right)\sqrt{\frac{1-\left(\frac{V_R}{c}\right)^2}{1-\left(\frac{V_S}{c}\right)^2}}\right] \quad (19)$$

$$R_S = \frac{M_S}{\frac{c^2}{G}\left[1 - \frac{\lambda_S^{Max}}{\lambda_R^{Max}}\left(1-\frac{GM_R}{R_R c^2}\right)\left(\frac{c-V_S\cos(\theta_S)}{c+V_R\cos(\theta_R)}\right)\sqrt{\frac{1-\left(\frac{V_R}{c}\right)^2}{1-\left(\frac{V_S}{c}\right)^2}}\right]} \quad (20)$$

$$\rho_S = \frac{3}{4\pi R_S^2}\frac{c^2}{G}\left[1 - \frac{\lambda_S^{Max}}{\lambda_R^{Max}}\left(1-\frac{GM_R}{R_R c^2}\right)\left(\frac{c-V_S\cos(\theta_S)}{c+V_R\cos(\theta_R)}\right)\sqrt{\frac{1-\left(\frac{V_R}{c}\right)^2}{1-\left(\frac{V_S}{c}\right)^2}}\right] \quad (21)$$

Fig. 7 Presents the algorithm used to detect the invisible celestial object and calculate all its necessary information.

3.3. Programming in MATLAB

The proposed algorithm and the general blackbody radiation are programmed in MATLAB for simulation purposes. The code is written hereafter, in which it asks the user to put the needed parameters and calculates the Wien's displacement law for both the source and the receiver. In addition, it plots the "spectral radiance of the blackbody" with respect to the receiver and the source.

4. RESULTS AND DISCUSSIONS

4.1 Assumptions

In order to show the significance of this study, the proposed general blackbody radiation is compared to the original one by Planck for four different case scenarios.

- Case 1: the sun is considered as a source (blackbody) and the earth as a receiver. The following data are given:
  - Mass of the sun $M_S = 1.989 \cdot 10^{30} kg$
  - Radius of the sun $R_S = 6.963 \cdot 10^8 m$
  - Velocity of the sun$V_S = 0 m/s$
  - Angle of movement: $\theta_S = 0^0$
  - Mass of the earth $M_R = 5.9736 \cdot 10^{24} kg$
  - Radius of the earth $R_R = 6.371 \cdot 10\text{^}6 m$
  - Velocity of the earth $V_R = 29.78 \cdot 10^3 m/s$
  - Angle of movement: $\theta_R = 90^0$
- Case 2: A star is considered as a source and the earth as a receiver.The following data are given:
  - Mass of the star $M_S = 2 \cdot 10^{35} kg$
  - Radius of the star $R_S = 2.97 \cdot 10^8 m$
  - Velocity of the star$V_S = 0 m/s$
  - Angle of movement: $\theta_S = 0^0$
  - Mass of the earth $M_R = 5.9736 \cdot 10^{24} kg$
  - Radius of the earth $R_R = 6.371 \cdot 10\text{^}6 m$
  - Velocity of the earth $V_R = 0 m/s$
  - Angle of movement: $\theta_R = 0^0$

```
clc;clear;closeall; %Clear all previous data on MATLAB
for section=1:1%Physical Constants
    h=6.626e-34;%Planck's constant
    c=299792458;%velocity of the light
    KB=1.3806488e-23;%Boltzmann constant
    G=6.6738e-11;%Newton's gravitational constant
    T=5000;%Temperature of the blackbody in Kelvin
end
for section=1:1%Input data
fprintf('-----General Blackbody Radiation-----\n');
fprintf('-------------------------------------\n');
    repeat='y';
while repeat=='y'
for section1=1:1%Input Data from the user
Ms_Input='Mass of the Blackbody: Ms=';
Ms=input(Ms_Input);
Rs_Input='Radius of the Blackbody: Rs=';
    Rs=input(Rs_Input);
Vs_Input='Velocity of the Blackbody: Vs=';
    Vs=input(Vs_Input);
As_Input='Movement angle of the Blackbody: As=';
    As=input(As_Input);
Mr_Input='Mass of the Receiver: Mr=';
Mr=input(Mr_Input);
Rr_Input='Radius of the Receiver: Rr=';
    Rr=input(Rr_Input);
Vr_Input='Velocity of the Receiver: Vr=';
Vr=input(Vr_Input);
Ar_Input='Movement angle of the Receiver: Ar=';
Ar=input(Ar_Input);
end
for section1=1:1%Calculation
    a1=1-G*Mr/(Rr*c^2);
    a2=1-G*Ms/(Rs*c^2);
    a3=(c-Vs*cos(As*pi/180))/(c+Vr*cos(Ar*pi/180));
gamma=sqrt((1-(Vr/c)^2)/(1-(Vs/c)^2));
a4=a1/a2*a3*gamma;
Ratio_LambdaR_to_LambdaS=a4
Ratio_Wavelength_R_to_Wavelength_S=a4
Wavelength_S=2.898e-3./T
Wavelength_R=2.898e-3./T.*a4
    x=0:0.5e-7:4e-6;
    Is=(2*pi*h*c^2)./(x.^5.*(exp((h*c)./(x.*KB.*T))-1));
Ir=(2*pi*h*c^2)./((x./a4).^5.*(exp((h*c)./...
       ((x./a4).*KB.*T))-1));
end
for section1=1:1%Visible Spectrum
%Minimum visible light
y1=0;y2=5e13;x1=380e-9;x2=381e-9;
b1=(y2-y1)/(x2-x1); b2=y1-b1*x1;
y_red=b1*x+b2;
%Maximum visible light
y1=0;y2=5e13;x1=700e-9;x2=701e-9;
b1=(y2-y1)/(x2-x1); b2=y1-b1*x1;
y_blue=b1*x+b2;
end
for section1=1:1%Plot Data
    figure('name','Intensity of the blackbody')
xmin=0;xmax=max(x);ymin=0;ymax=max(Ir).*1.05;
FontSize=14;
    plot(x,Ir,'-*','Color',[1,0.5,0],'LineWidth',1);
    hold on;
    plot(x,Is,'-D','Color',[0,.5,1],'LineWidth',1);
    hold on;
    plot(x,y_red,'-','Color',[1,0,0],'LineWidth',2);
    hold on;
    plot(x,y_blue,'-','Color',[0,0,1],'LineWidth',2);
    hold on;
    legend('Ir','Is','Minimum visible light',...
'Maximum visible light',...
'Location','southeast','Orientation','vertical');
axis([xminxmaxyminymax])
xlabel('Wavelength [\mum]');
ylabel('Spectral Radiance');
    title('Spectral Radiance of the blackbody');
ax = gca; ax.FontSize = FontSize;
grid on;
end
for section1=1:1%Ask for repetition
fprintf('Do you want to repeat ?\nPress y for ''Yes'' or
           any key for ''No''\n');
    repeat=input('Y/N=','s'); %string input
clc; close all;
end
end%End while
end
```

- Case 3: the earth is emitting radiation to a star. In this case, the earth is considered as a blackbody and the star as a receiver.The following data are given:
  - Mass of the earth $M_S = 5.9736 \cdot 10^{24} kg$
  - Radius of the earth $R_S = 6.371 \cdot 10\text{^}6m$
  - Velocity of the earth $V_R = 0m/s$
  - Angle of movement: $\theta_R = 0^0$
  - Mass of the star $M_R = 3 \cdot 10^{35} kg$
  - Radius of the star $R_R = 2.97 \cdot 10^8 m$
  - Velocity of the star$V_R = 0m/s$
  - Angle of movement: $\theta_R = 0^0$

- Case 4: Binary massive stars are considered with the following data:
  - Mass of the star 1:$M_S = 3 \cdot 10^{35} kg$
  - Radius of the star 1:$R_S = 2.97 \cdot 10^8 m$
  - Velocity of the star 1:$V_S = 10^6 m/s$
  - Angle of movement of star 1: $\theta_S = 0^0$
  - Mass of the star 2:$M_R = 3 \cdot 10^{35} kg$
  - Radius of the star 2:$R_R = 2.97 \cdot 10^8 m$
  - Velocity of the star 2:$V_R = 10^6 m/s$
  - Angle of movement of star 2: $\theta_R = 180^0$

- Physical constants
  - Newton's gravitational constant$G = 6.6738 \cdot 10^{-11} Nm^2/kg^2$
  - Speed of light in a vacuum: $c = 299792458m/s$
  - Planck constant: $h = 6.626 \cdot 10^{-34} J \cdot s$
  - Boltzmann constant:$k_B = 5.6696 \cdot 10^{-8} W/m^2K^4$
- Other parameters: $T = 5000K$

In the following subsections, the Wien's displacement lawand the Spectral Radiance of the blackbody are calculated from the viewpoint of the receiver (using the Planck's blackbody radiation theory) and the source (using the proposed general blackbody radiation theory in this paper).

4.2. Case 1

In this case, the sun is considered as a source and the earth as a receiver. Real data are provided in **Table 2** in order to show the difference between the proposed model in this paper and the one proposed by Planck. Planck's theory measures the blackbody radiation as it is received by the observer (such as the earth in this case) neglecting other factors, such as, the mass, radius, velocity, and the angle of movement of both the source and the receiver. Fig. 8 presents a comparison between the spectral radiance of the blackbody from the perspective of the receiver (Planck's theory) and the source (proposed theory in this paper) for the case 1. It can be remarked that both spectrums are almost identical since the masses of the sun and the earth do not highly deform the wavelength of the light. Therefore, both methods give almost the same results.

Table 2. Summary data for case 1.

Data	Source	Receiver
Mass	1.989e30	5.9736e24
Radius	6.963e8	6.371e6
Velocity	0	2.978e4
Angle of movement	0	90

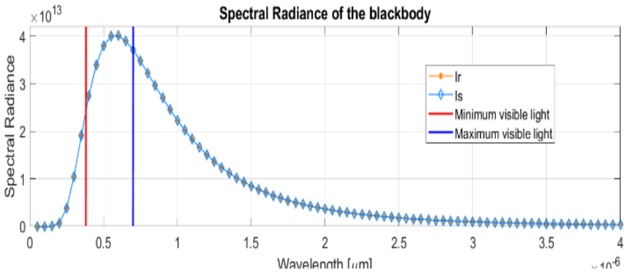

Fig. 8. Comparison between the spectral radiance of the blackbody from the perspective of the receiver (Planck's theory) and the source (proposed theory in this paper) for the case 1.

4.3. Case 2

In this case, a massive star is considered (100,553 times massive than the sun) as a source and the earth as a receiver. Data are provided in **Table 3** in order to show the difference between the proposed model in this paper and the one proposed by Planck. Fig. **9** presents a comparison between the spectral radiance of the blackbody from the perspective of the receiver (Planck's theory) and the source (proposed theory in this paper) for the case 2. It can be remarked that there is a difference between both spectrums, in which the one measured at the source level (sun) is visible, while it is not from the earth since thespectrum is shifted to the right side.

Table 3. Summary data for case 2.

Data	Source	Receiver
Mass	2e35	5.9736e24
Radius	2.97e8	6.371e6
Velocity	0	0
Angle of movement	0	0

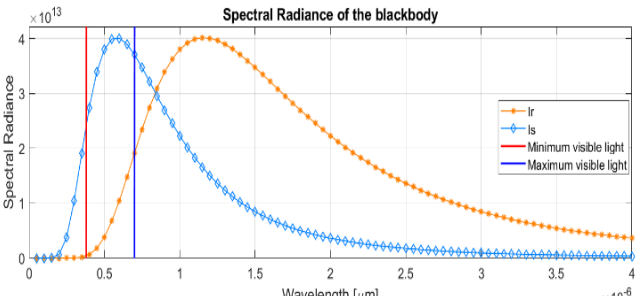

Fig. 9. Comparison between the spectral radiance of the blackbody from the perspective of the receiver (Planck's theory) and the source (proposed theory in this paper) for the case 2.

4.4. Case 3

In this case, the inverse scenario of case 2 is studied in which the earth is considered as a source and it emits light which is received by a massive star (150,829 times massive than the sun). Data are provided in **Table 4** in order to show the difference between the proposed model in this paper and the one proposed by Planck. **Fig. 10**presents a comparison between the spectral radiance of the blackbody from the perspective of the receiver (Planck's theory) and the source (proposed theory in this paper) for the case 3. It can be remarked that there is a difference between both spectrums, in which the one measured at the source level (earth) is visible, while it is not from the receiver since thespectrum is shifted to the left side.

Table 4. Summary data for case 3.

Data	Source	Receiver
Mass	5.9736e24	3e35
Radius	6.371e6	2.97e8
Velocity	0	0
Angle of movement	0	0

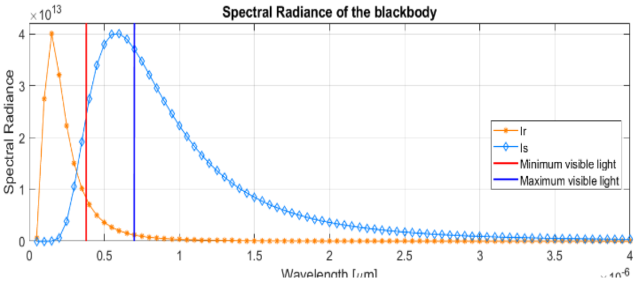

Fig. 10. Comparison between the spectral radiance of the blackbody from the perspective of the receiver (Planck's theory) and the source (proposed theory in this paper) for the case 3.

4.5. Case 4

In this case, two identical stars with the same mass, radius, velocity, and direction are examined. The star 1 has an angle equal to zero which means that it is approaching the second star. However, the angle of the second star is 180 degrees which means that it is going away from the first star. In another meaning, the distance between the two stars do not change. Data are provided in **Table 5** in order to show the difference between the proposed model in this paper and the one proposed by Planck. **Fig. 11**presents a comparison between the spectral radiance of the blackbody from the perspective of the receiver (Planck's theory) and the source (proposed theory in this paper) for the case 4. It can be remarked that there both spectrums are identical even if they are massive stars. The reason is that when the light is emitted by star 1, it becomes redshifted, and its wavelength is increased. However, when the light approaches star 2, since it has the same characteristics of star 1, the light is shifted to the left side of the spectrum (blue-shifted). Hence, the aggregated difference in the wavelength becomes equal to "0". Hence, both methods give same results and spectrums. In another meaning, if we want to see any distant massive object in the space even a black hole, we should have the same characteristics. Hence, the question that arises, can we see all black holes in the universe if we live in a black hole?

Table 5. Summary data for case 4.

Data	Source	Receiver
Mass	3e35	3e35
Radius	2.97e8	2.97e8
Velocity	1e6	1e6
Angle of movement	0	180

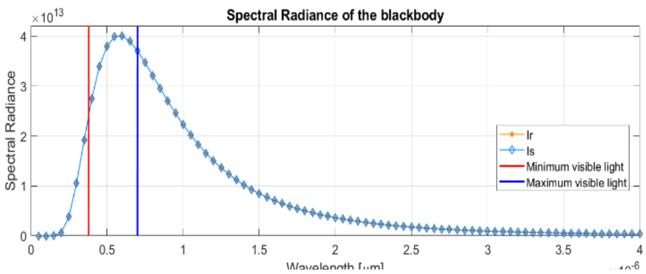

Fig. 11. Comparison between the spectral radiance of the blackbody from the perspective of the receiver (Planck's theory) and the source (proposed theory in this paper) for the case 4.

In conclusion, the proposed method could explain why we are not able to see black holes, which are massive objects in space (and maybe with tiny diameters), but they are not visible since the emitted light could be highly shifted and may not be easy to be detect. These massive objects exert huge gravitational field to their surrounding and could explain why the stars on the boarder of the galaxy do not obey Kepler's laws. In fact, Kepler's law mentioned that "based on the distribution of matter in the galaxy, the speed of an object in the outer part of the galaxy would be smaller than that for objects closer to the center, just like for the planets of the solar system."That is notwhat is observed in reality; scientists showed that for objects outside the central core of the galaxy, the curve of speed versus distance from the center of the galaxy is approximately flat rather than decreasing at larger distances. Therefore, these objects (including our own Solar System in the Milky Way) are rotating faster than can be accounted for by gravity due to the visible galaxy. This surprising result means that there must be additional mass in a more extended distribution, causing these objects to orbit so fast, and has led scientists to propose the existence of dark matter.

5. CONCLUSION

This paper generalizes the "blackbody radiation law" and the "Wien's displacement law" in which it considers many factors such as the mass, radius, velocity, angle of movement, and the surface temperature of both the source and the receiver. All these factors can affect the wavelength of the blackbody and may give inaccurate results if they are not considered. The proposed theory could explain why it is not easy to observe some massive objects in the space even if they emit radiations, such as black holes and dark matters. For validation purposes, the proposed theory is compared to the one suggested by Max Planck in 1901. Results show that both methods give almost the same results for objects with low gravitational fields in space running at low velocity. However, the predicted electromagnetic wavelength using both theories become different for objects with high gravitational fields and travelling at high speed in space. Planck postulated that "***The radiation has a specific spectrum and intensity that depends only on the temperature of the body***". However, as it has been demonstrated in this paper, other factors affect also the intensity of the spectrum including the movement of both objects with respect to each other and their gravitational fields. Hence, the modified postulate the is proposed in this paper will be as follows: "***The radiation has a specific spectrum and intensity that depends on the temperature of the blackbody, density, velocity and movement direction of both the blackbody and the receiver***".

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