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The Heat of the Sun

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Abstract
The way heat affects the masses and gravitational properties of celestial bodies. The general law of gravity is not valid in space and should be supplemented for space conditions. Determination of frequency of radiated heat temperature. The effect of solar heat on the earth. The orbital characteristics of the Earth have no effect on the mass of the sun. Determination of the amount of heat contained in the sun and the age of the sun. Heavenly bodies need to be corrected

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I. INTRODUCTION

Conventionally, astrophysics does not consider heat energy when solving problems related to the motion of celestial bodies although heat has been mentioned in the Bible as the main force behind celestial mechanics/movements. The latter belief can be attributed to the unreasonable but persistent convictions that arose in the years before thermodynamics was yet to be discovered (in the times of Copernicus, Kepler, and Newton, in the 16^{th} and 17^{th} centuries). Heat was known only as an imaginary substance and lacked the corresponding proof that is typically borne out by or results from observations of natural phenomena. Nicolas Léonard Sadi Carnot (1796–1832) and William Thomson (later known as Lord Kelvin of Larges (1824–1907) founded thermodynamics as recently as in the 19th century, to produce a new branch *Heat Science*. If Einstein's knowledge is added (20th century) that energy has mass and therefore thermal energy, thermomechanics has joined astrophysics as a new branch of science in this field. The introduction of thermodynamics into astrophysics can solve many unknowns that kinematics and dynamics cannot solve on their own.

To determine the mass of energy Einstein set the equation:

$$m_E = \frac{E}{c^2} = \frac{kcal \times 4.186,84}{c^2} = \frac{W \times 3.600}{c^2} \quad (\mathrm{kg}), \qquad 1)$$

where m_E denotes the mass (kg), E refers to the mechanical equivalent of heat energy (kg m^2 s^{-2} ; W_s), and c is the speed of light (m s^{-1}).

Thus, the field of astrophysics was completely revolutionized with this new knowledge, which could be applied to the causes of celestial movements, their masses, and gravitational properties.

If, according to Einstein, energy has mass, and if such energy is contained in a solid material body in the form of heat and forms part of the total body mass, then the heat energy mass increases the gravitational properties of that body. The heat energy contained in the material body does not have density, viscosity, and volume because these properties are linked to the solid mass and cannot exist independently. Therefore, two questions remain: where in material bodies is this heat mass located and in what form? The answer can only be that heat increases the mass of atoms of the base matter and its volume, and therefore, it also increases the volume of the molecules; the volume of the body increases due to the addition of heat to it. The greater the amount of heat transferred into the material body, the greater its volume and vice versa. Should a material body completely lose its heat (i.e., T = 0 K), the volume decreases to the volume of its atoms and it becomes an absolute black body also called a “black hole” in the universe. Moreover, the gravitational force is reduced by the amount of heat mass that was comprised part of the mass of that body.

II. THE EFFECTS OF HED IN CELESTIAL SPACE

In space conditions, that is, in vacuum, the heat of a body is not transferred to the surrounding space by convection because there is no atmosphere. Rather, it is transferred to another body by radiation only, which means that the energy of radiated heat must also possess mass, and therefore, atoms. That the mass of the radiated energy does indeed have atoms was established by Max Planck (1858–1947) based on a photo-chemical reaction, which produces heat and light. Planck named such atoms quanta and he developed the quantum theory based on light because he considered that light is comprised of atoms or quanta of light (i.e., photons). Science accepted Max Planck's theory of light quanta, according to which only light would possess atoms (i.e., mass). However, this is not correct because it implies that the energy of the radiated heat at lower/invisible temperatures does not have any mass. In fact, the radiated heat energy has mass at lower temperatures even though it does not give off light. Light is just the product of heat and not vice versa, and it should remain an imaginary creation with a visible heat effect. Such atoms should be called **thermotoms** because they have thermodynamic characteristics with regard to mass, velocity, and temperature (i.e., the frequency of radiated heat energy). How such atoms are created in the radiated heat energy is not known!

The most important law pertaining to thermodynamics in astronomy is the Stefan–Boltzmann law (1884) because it describes the radiation of heat from a body, and therefore, from space bodies. It determines the heat power (heat flow) that a body radiates into space per unit surface area depending on its temperature at the surface compared to an absolute black body. The mass of the heat radiated from the spherical body propagates in circular waves in the same manner as electromagnetic waves, at the speed of light, and the frequency is determined by the temperature at the surface of the body and is inversely proportional to the square of the distance. The temperature remains the same as that of the surface of the body radiating the heat. The radiated heat travels without losses only through vacuum and thin gaseous substances, including air, and partially through transparent solid substances (glass), where the temperature (i.e., frequency) decreases unlike the electromagnetic waves, which encounter no obstacles except in exceptional cases (e.g., a metal cage). The frequencies of the temperatures of the bodies that radiate heat towards each other differ and do not mix, but a low-temperature body, through its radiation, reduces the temperature of the high-energy body, and thereby also reduces the frequency until the temperatures equalize. When the temperatures of the two bodies equalize, their frequencies oppose each other, as is the case for electromagnetic waves.

The frequency of the radiated heat can be calculated using the equation derived in the text, provided the temperature is known. The logic of the equation stems from the following. If a body (e.g. one made of steel) is heated to 1.073 K (800°C), that is, to red color, then the wavelength of the radiated heat is $\lambda = 0{,}7 \times 10^{-6}$ m (as in Newton's ring apparatus) and the frequency is $f = c/\lambda$, where c is the speed of light and is equal to 3×10^{8} m s^{-1}. In this case, the frequency is $f = c/\lambda = 3\times 10^{8}/0{,}7 \times 10^{-6} = 4{,}28 \times 10^{14}$ s^{-1}. If the body is heated to 1.273 K (1.000°C), that is, to orange color, the wavelength is $\lambda = 0.589 \times 10^{-6}$ m and the frequency is $f = 5{,}09 \times 10^{14}$ s^{-1}. If the body is further heated to 1.473 K (1.200°C), that is, to yellow color, the wavelength will be $\lambda = 0{,}51 \times 10^{-6}$ m and the frequency will be $f = 5{,}88 \times 10^{14}$ s^{-1}. By heating the body further, the wavelength will decrease and the frequency will increase. In other words, by reducing the temperature, the wavelength will increase and the frequency will decrease. If the wavelength is multiplied with the appropriate temperature from the above examples, the result is always the same, that is, 751×10^{-6}. From the above, we can conclude that the product of wavelength and temperature always remains constant. Thus,

$$\lambda \times T = 751 \times 10^{-6} \quad \left(\text{m}, {}^{0}\text{K} \right) = \text{constant } k_{T,}$$

where λ denotes the wavelength (m), T denotes the temperature (K), and k_T is a constant (m K). Therefore, the frequency f (s^{-1}) of radiated heat is

$$f = \frac{c}{\lambda} = \frac{c}{k_T / T} = \frac{c}{751 \times 10^{-6} / T} = \frac{c \times T \times 10^{6}}{751} \quad (s^{-1}), \qquad 2)$$

When the temperature $T = 0$ K, wavelength $\lambda = \infty$ and frequency $f = 0$.

Unlike the heat energy mass contained in a material body, the radiated heat energy mass also has density δ , and if necessary, it can be determined with the following equation:

$$\delta = \frac{\Phi}{c^{3}} \quad (\text{kg/m}^{3}), \qquad 3)$$

where Φ denotes heat power (heat flow; W m^{-2} = kg m^{2} s^{-3} m^{-2}). If the speed of light c is expressed in m s^{-1}, then the density of radiated heat is expressed in kg m^{-3}.

III. EFFECT OF RADIATED HEAT ON GRAVITY

If one body, with mass m_1, and constantly higher temperature at the surface radiated its heat towards a second body with mass m_2 with the same surface area and the same radiation coefficient (emission) but with a lower temperature at the surface, the temperature of the body with mass m_2 will increase but a repulsive force will also appear. The repulsive force will act in a direction opposite to that of gravitational force and will gradually decrease as the temperature of the body with mass m_2 increases, if this body does not lose its heat. When the temperatures on the surfaces of the bodies become equalized, both bodies would radiate heat at the same temperature toward each other, and the attractive (gravitational) force will be equal to the value defined by the law of universal gravitation because the repulsive force is no longer present. The repulsive force that appears in this case is a consequence of radiated heat whose mass collides with the mass m_2 of the body at the speed of light and at the frequency of the associated temperature of the radiated heat. It is proportional to the heat mass m_T, speed of light c, and temperature frequency *f*, and accordingly, impulse = momentum (Impulse of force = Amount of motion). Thus,

$$F_T \times t = m_T \times c \quad \rightarrow F_T = \frac{m_T \times c}{t} = \frac{m_T \times c}{1/f_T} = m_T \times c \times f_T \quad (\mathrm{kgm/s^2;\ N}) \qquad 4),$$

If the heat mass, speed of light, and frequency are expressed in kg, m s^{-1}, and s^{-1}, then the force of the radiated heat is expressed in kg m s^{-2} (N).

The body of mass m_2 also radiates its heat towards the body of mass m_1, and it will continue to do so until the temperature equalizes. The total radiated heat force present between the two bodies is

$$F_{Tu} = F_{Tm1} - F_{Tm2}, \qquad 5)$$

where F_{Tm1} and F_{Tm2} refer to the heat force of the body of mass m_1 and mass m_2, respectively. The bodies of masses m_1 and m_2 radiate thermal power (flow) according to Stefan–Boltzmann's law expressed below.

$$\Phi = \varepsilon \times \sigma \times \left(\frac{T}{100}\right)^4 \times A \quad (\mathrm{W}), \qquad 6)$$

where ε is the emission coefficient of radiation of the grey body, σ is the radiation constant of an absolute black body (W m^{-2} K^4), and *A* is the area of the radiating surface (m^2). Therefore, the heat mass is expressed to equation 1):

$$m_T = \frac{\Phi_T \times 3600\ s}{c^2} = \frac{W \times 3600\ s}{c^2} = \frac{kgm^2 \times 3600\ s}{s^3 \times c^2} \quad (\mathrm{kg}),$$

where Φ_T is the heat flow or power (W). The realization that the gravitational force of radiant heat acts on gravity must be supplemented and expressed by Newton's law of gravitation under space conditions:

$$F_u = F_g - F_{Tu} = \frac{G \times m_1 \times m_2}{L^2} - F_{Tu} = \frac{G \times m_1 \times m_2 - L^2 \times F_{Tu}}{L^2} \qquad 7)$$

Here, *Fg* refers to the force of gravity (kg m s^{-2}), G is the gravitational constant (m^3 kg^{-1} s^2), L refers to the distance of the body (m), and F_{Tu} is the total force of heat (kg m s^{-2}), which is valid for sphere-shaped bodies only.

Accordingly, it follows that the force of gravity is proportional to the mass of the body and gravitational acceleration $F_g = m_{body} \times g_{body}$, and the repulsive force is proportional to the heat mass and heat acceleration $F_T = m_T \times a_T$, which acts from the surface of the body. Heat mass amounts to $m_T = E_T/c^2$, and acceleration of the top-line force is proportional to the speed of light and temperature frequency $a_T = c \times f_T$. The greater the surface area of the body, the greater the repulsive force of heat independent of the mass of the body. If the force of the radiated heat is equal to the gravitational force, no more forces act between the bodies.

Thus, this knowledge, namely that heat energy plays a very significant part in celestial mechanics, sheds new light in the field. As this aspect is not considered in astronomy studies, it is necessary to make corrections to the orbital and physical properties of space bodies, wherever possible.

IV. EXAMPLE

According to conventional astronomy, the mass of the Sun has been determined such that the gravitational force of the Sun (according to the general law of gravitation) is equal to the centrifugal force of Earth's circular motion, which is expressed by an equation using which the mass of Sun is calculated.

$$\frac{G \times m_S \times m_Z}{L_Z^2} = \frac{m_Z \times v_Z^2}{L_Z} \qquad 8)$$

where G is the gravitational constant ($m^3\ kg^{-1}\ s^{-2}$), m_S refers to the mass of the Sun (kg), m_Z is the mass of Earth (kg), L_Z is the average distance between Earth and the Sun (m), and v_Z refers to the average circular velocity of Earth ($m\ s^{-1}$). If the median distance between Earth and the Sun is $L_Z = 149.5 \times 10^9$ m, the average circular velocity of Earth is $v_Z = 29.76 \times 10^3\ m\ s^{-1}$. Then, according to this equation 8), the mass of the Sun shall be

$$m_S = \frac{v_Z^2 \times L_Z}{G} = \frac{\left(29{,}76 \times 10^3\right)^2 \times 149{,}5 \times 10^9}{66{,}74 \times 10^{-12}} \approx 2 \times 10^{30} \quad (kg)$$

This equation is satisfactory only if we disregard the heat of the Sun and the heat effect of heat radiation. To determine the total mass of the Sun, including the heat mass it contains, it is necessary to include the heat radiation forces from the Sun to Earth and from Earth to the Sun, and input them into the equation of the forces of radiated heat. They act in the direction opposite to the gravitational force of the Sun. Thus,

$$\frac{G \times m_S \times m_Z}{L_Z^2} = \frac{m_Z \times v_Z^2}{L_Z} + F_{Tu} . \qquad 9)$$

The actual mass of the Sun can be determined as

$$m_S = \frac{m_Z \times v_Z^2 \times L_Z + F_{Tu} \times L_Z^2}{G \times m_Z}$$

F_{Tu} – total repulsive force of radiated heat = $F_{Tm1} - F_{Tm2}$. where F_{Tu} is the total repulsive force of radiated heat ($F_{Tm1} - F_{Tm2}$) ccording to equation 5) .

The total repulsive force of the heat radiated by the Sun can be calculated in the following manner. Poulliet (1838) established that at a high altitude, the Sun radiates 1140 kcal $h^{-1}\ m^{-2}$ on average on a perpendicular area of 1 m^2 of Earth. Subsequently, a more detailed measurement provided a value of 1.174 kcal $h^{-1}\ m^{-2}$ (i.e. 1.366 W m^{-2}), which is the mechanical equivalent of heat and represents the "sun constant.". Therefore, with an area of 1 m^2, the Sun radiates heat in space:

$$\Phi_S = \frac{\Phi_Z \times L_Z^2}{r_S^2} = \frac{1.366 \times \left(149{,}5 \times 10^9\right)^2}{\left(697{,}5 \times 10^6\right)^2} = 62{,}75 \times 10^6 \quad (W / m^2)$$

$$\text{or } 62{,}75 \times 0{,}86 = 54 \times 10^6 \quad (kcal / h, m^2)$$

where r_s is the diameter of the Sun.

According to Stefan–Boltzmann's law of heat radiation and assuming that the Sun is an absolute black body, the temperature of the Sun according to equation 6) is

$$\Phi_S = \sigma \times \left(\frac{T_S}{100}\right)^4 \times A = 5{,}67 \times \left(\frac{T_S}{100}\right)^4 \times 1 = 62{,}75 \times 10^6 \rightarrow$$

$$T_S = 100 \times \sqrt[4]{\frac{62{,}75 \times 10^6}{5{,}67 \times 1}} = 5.768 \quad K$$

The frequency of this temperature according to equation 2) is

$$f = \frac{c}{\lambda} = \frac{c}{k_T / T_S} = \frac{c \times T_S}{k_T} = \frac{3 \times 10^8 \times 5.768}{751 \times 10^{-6}} = 23 \times 10^{14} \quad (s^{-1}) .$$

If we multiply the projected area of the Earth with the Sun constant, the Sun radiates to Earth a heat power or heat flow of

$$\Phi_{S \to Z} = 1.366 \times d_Z^2 \times \pi / 4 = 1.366 \times (12{,}736 \times 10^6)^2 \times \pi / 4 = 174 \times 10^{15} \quad (W ; kgm^2/s^3) \quad ,$$

where d_z is the diameter of Earth.

The mass of radiated heat of the equation 1) is:

$$m_{TS \to Z} = \frac{\Phi_{S \to Z} \times t}{c^2} = \frac{174 \times 10^{15} \times 3600}{(3 \times 10^8)^2} = 69{,}6 \times 10^2 \quad (kg) .$$

This mass of radiated heat collides with Earth at the speed of light and creates a repulsive force on the projection of Earth in accordance with the following equation: impulse = momentum:

$$F_{TS} \times t = m \times v \quad \to \quad F_{TS} = \frac{m \times v}{t} = \frac{m \times v}{1/f} = m \times v \times f \qquad 10)$$

Thus, the median repulsive force of the radiated heat of the Sun amounts to

$$F_{TS \to Z} = m_{TS \to Z} \times c \times f_S = 69{,}6 \times 10^2 \times 3 \times 10^8 \times 23 \times 10^{14} = 4{,}8 \times 10^{27} \quad (kgm/s^2 ; N) ,$$

where $m_{TS\text{-}Z}$ is the heat mass (kg) and f_S is the frequency of the temperature of the Sun (s^{-1}).

Earth also radiates the heat received from the Sun from its entire surface area into the surrounding space, and also towards the Sun. With its repulsive heat force, it reduces the radiated heat force of the Sun. The repulsive force of the radiant heat of Earth is too small and can be neglected.

According to the calculations, it follows that the repulsive heat forces are much greater than the centrifugal force created by the circular motion of Earth around the Sun and from which the mass of the Sun was calculated to be 2×10^{30} kg.

If we insert the value of the total repulsive force of the radiated heat of the Sun into the equation 9) we can easily calculate the total and *actual* mass of the Sun. Thus,

$$\frac{G \times m_S \times m_Z}{L_Z^2} = \frac{m_Z \times v_Z^2}{L_Z} + F_{Tu} \quad \to \quad G \times m_S \times m_Z = m_Z \times v_Z^2 \times L_Z + F_{Tu} \times L_Z^2 ,$$

according to which the actual mass of the Sun is

$$m_S = \frac{m_Z \times v_Z^2 \times L_Z + F_{Tu} \times L_Z^2}{G \times m_Z} =$$

$$= \frac{6 \times 10^{24} \times (29{,}76 \times 10^3)^2 \times 149{,}5 \times 10^9 + 4{,}8 \times 10^{27} \times (149{,}5 \times 10^9)^2}{66{,}74 \times 10^{-12} \times 6 \times 10^{24}} = .$$

$$= \frac{0{,}794 \times 10^{45} + 107{,}28 \times 10^{48}}{400{,}44 \times 10^{12}} \approx 26{,}7 \times 10^{34} \quad (kg)$$

which is significantly more than 2×10^{30} kg

According to the total mass of the Sun, gravitational acceleration of the Sun is:

$$\frac{G \times m_S \times m_Z}{L_S^2} = \frac{m_Z \times g_S \times r_S^2}{L_S^2} \quad \to$$

$$g_S = \frac{G \times m_S}{r_S^2} = \frac{66{,}74 \times 10^{-12} \times 26{,}77 \times 10^{34}}{(697{,}5 \times 10^6)^2} = 367 \times 10^5 \quad (m / s^2)$$

G – gravitational constant ($m^3/kg\ s^2$); m_S – mass of the Sun *(kg)*; r_S – diameter of the Sun (*m*)

From this we can conclude that the centrifugal force caused by the circular motion of the Earth has a negligible influence to determining the total mass of the Sun and only amounts to:

$$F_{cf} = \frac{m_z \times v_z^2}{L_z} = \frac{6\times10^{24}\times\left(29,76\times10^3\right)^2}{149,5\times10^9} = 35,54\times10^{21}\quad (kgm\ /\ s^2; N)$$

The Sun's gravity $367\times10^5\ m\ /\ s^2$ is more realistic, because the gravitational force of the Sun of only $274\ m\ /\ s^2$ has almost no effect on the far planets and especially not on the planet Neptune, because it only amounts to

$$\frac{g_S \times r^2{}_S}{L^2{}_N} = \frac{274\times(697,5\times10^6)^2}{(4,5\times10^{12})^2} = 6,58\times10^{-6}\quad (m\ /\ s^2)$$

r_S – diameter of the Sun *(m)*; L_M – distance between the Neptune and the Sun *(m)*

The calculated total mass of the Sun consists from solid mass and heat mass. Considering that the solid mass of the Sun is very small because it predominantly consists of a gaseous matter, it is negligibly small. The total mass of the Sun is therefore the total heat mass $m_S = m_{TS}$ from which we can determine the amount of heat energy which the Sun contains according to equation 1):

$$E_{TS} = m_{TS}\times c^2 =$$

$$E_{TS} = 26,77\times10^{34}\times(3\times10^8)^2 = 241\times10^{50}\ (Ws)\times0,239 = 57,6\times10^{50}\quad (kcal)$$

$$1\ Ws = 0,239\ kcal$$

This is a very large amount of heat which the Sun presently contains and from that we can calculate the total amount of heat which the Sun loses in one hour and the time it will take for the Sun to lose all of its heat.

If the Sun, on an area of 1m^2 loses heat by radiation in the amount of $54\times10^6\ kcal\ /\ m^2, h$, and from its entire surface it loses $(1.395\times10^6)^2\times\pi\times54\times10^6 = 330\times10^{24}\ kcal\ /\ h$,

this means that the Sun will lose all heat after approximately
:

$$\frac{Tatal\ current\ quantity\ of\ heat\ of\ the\ Sun}{(Sun's\ heat\ loss\ per\ haur)\times number\ of\ hours\ a\ year} =$$

$$\frac{57,6\times10^{50}}{330\times10^{24}\times8,766} \approx 2\times10^{21}\ years$$

with an average annual loss of:

$$\frac{330\times10^{24}\times365,25\ days\ /\ year\times24\ hours}{57,6\times10^{50}\times100} = 0,5\times10^{-23}\ \%\ /\ year$$

According to the present amount of heat which the Sun contains and the annual heat loss, it is possible to calculate when the Sun started to lose its heat i.e. when the Sun was created in the Universe. The Sun started to lose its heat before only

$$\frac{57,6\times10^{50}\times100}{0,5\times10^{-23}\ \%\ /\ year} \approx 11,5\times10^{76}\ years$$

and at the beginning it contained the following amount of heat:

$$\frac{57,6\times 10^{50}\times 11,5\times 10^{76}\times 0,5\times 10^{-23}}{100}\approx 3,316\times 10^{103}\ (kcal)$$

meaning that the sun is currently at $\approx$ 1/4 of its life.

The calculated value for the number of years is only an approximate value because the temperature on the surface of the Sun will get lower as the Sun loses heat, so the annual heat loss will decrease and the time of heat loss will increase. Therefore, the Sun will completely lose its heat after the approximately calculated number of years. When the Sun completely loses its heat, its volume will shrink to the volume of a mass of solid matter atom and completely lose colour i.e. visibility because it will blend with the colour of its environment (black hole?) and the gravitational acceleration will be reduced to a value which corresponds only to the solid mass of the Sun, i.e. to 273 m/s^2.

V. CONCLUSION

The introduction of thermodynamics into astrophysics changes the approach taken so far to solve celestial mechanics and creates the basis for a new celestial mechanics based on another science that can more objectively present the causes of motion of celestial bodies and their masses

This paper showed that heat energy plays a very significant part in celestial mechanics, an aspect that has been ignored so far. This paper presented an example of how the mass of the Sun can be corrected if the rules of thermodynamics are applied to the concerned equations. Future work will focus on more detailed and diverse mathematical expressions of the causes of celestial body motion using thermodynamics. In particular, future studies will investigate how the application of heat to celestial mechanics may alter known values of the speed of the Sun in the universe, the movement of Earth in space, the mass of the moon, the masses of planets, and their velocities, and why Kepler's laws are no longer valid.

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