Regarding force exerted by gravitational radiation emitted from binary system

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Abstract: The new mathematical model allows us to calculate force exerted by gravitational radiation . It is shown that the equation for the calculation of force exerted by gravitational radiation accounts for the potential energy of the binary system emitting gravitational radiation and life time of an orbit.The above expression **F= U/ 8t**C (**F**= Force exerted by gravitational radiation ,**U**= Gravitational potential energy of the binary system emitting gravitational radiation, **t** = lifetime of an orbit ,**C**=Speed of light in vaccum) was developed based on the Newton gravitational concepts and basic concepts of gravitational waves.The force of gravitational radiation is defined as the function of rate of energy loss of binary system with respect to orbital decay. [Academia Arena, 2010;2(4):52-58] (ISSN 1553-992X).

Key words: Force of gravitational radiation ,Gravity, Speed of light ,Radius of orbit,Gravitational potential energy.

Gravitational wave is a fluctuation in the curvature of spacetime which propagates as a wave, traveling outward from the source. Predicted by Einstein's theory of general relativity, the waves transport energy known as gravitational radiationTwo objects orbiting eachother in highly elliptical orbit or circular orbit about their center of mass comprises binary system.This system losses mass by emitting gravitational wave . Gravitational waves are radiated by objects whose motion involves acceleration, provided that the motion is not perfectly spherically symmetric (like a spinning, expanding or contracting sphere) or cylindrically symmetric (like a spinning disk).

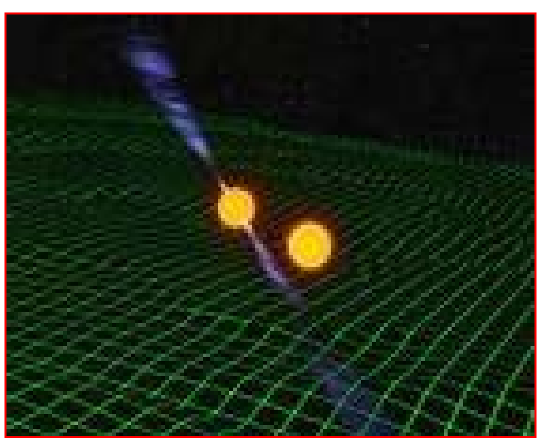

Figure -1: Emission of gravitational waves from the binary system

The rate of flow of energy from the binary system through gravitational radiation is given by

$$\mathbf{P = - dE/dt} \qquad (1)$$

Here **P**= Power of the gravitational radiation , **dE** be the energy change of the binary system with respect to time **dt** , **- ve** sign indicates rate of energy loss of binary system in the form of gravitational radiation

Power of gravitational radiation can be given by

Suppose that the two masses are $\mathbf{m_1}$ and $\mathbf{m_2}$, and they are separated by a distance **r.** The power given off (radiated) by this system is:

$$P = \frac{dE}{dt} = -\frac{32}{5}\frac{G^4}{c^5}\frac{(m_1 m_2)^2(m_1+m_2)}{r^5} \qquad (2)$$

Here **G** = universal gravitational constant , **C** = speed of light in vaccum.

Gravitational radiation robs the orbiting bodies of energy. As the energy of the orbit reduces, the distance between the bodies decreases, and they rotate more rapidly. The rate of decrease of distance between the bodies versus time is given by:

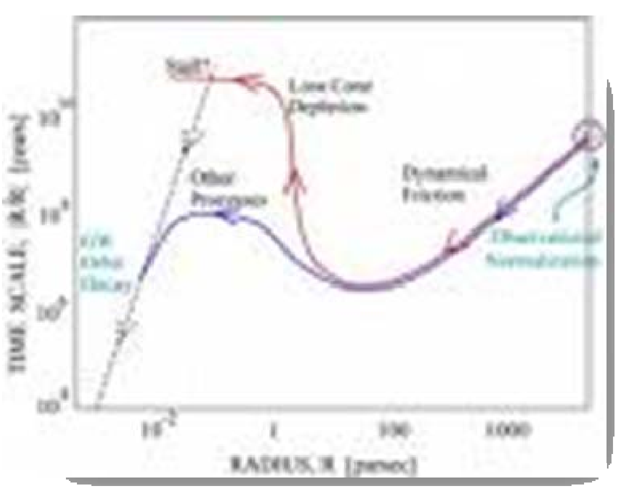

Figure -2: Orbital decay due to emission of gravitational radiation with respect to time

$$\frac{dr}{dt} = -\frac{64}{5}\frac{G^3}{c^5}\frac{(m_1 m_2)(m_1+m_2)}{r^3} \qquad (3)$$

Multiplying the equation (2) by 2 we get

$$\mathbf{2P = [-64\, G^3/C^5 *(m_1m_2)\,(m_1+m_2)\,/r^3]\, *Gm_1m_2/r^2} \qquad (4)$$

From (3) we get

$$2P = dr/dt * Gm_1m_2/r^2 \quad (5)$$

Newton's law of universal gravitation states that "Every massive particle in the universe attracts every other massive particle with a force which is directly proportional to the product of their masses and inversely proportional to the square of the distance between them ".

Gravitational force between the two objects orbiting each other in highly elliptical orbits given by

$$F_g = Gm_1 m_2 / r^2 \quad (6)$$

Here F_g = Gravitational force between two objects orbiting each other ,**G** = Universal gravitational constant , **r** = Distance between masses m_1 and m_2 respectively.

Thus (5) becomes $2P = dr/dt * F_g$ (7)

From (1) we know $P = - dE/dt$

Then the equation (7) becomes $F_g = - 2dE/dr$ (8)

dE be small change in energy of binary system with respect to small change in **dr** , **-** ve sign indicates rate of energy loss of binary system with orbital decay .

The lifetime of an orbit is given by: $t = \frac{5}{256}\frac{c^5}{G^3}\frac{r^4}{(m_1m_2)(m_1+m_2)}$ (9)

Let us multiply (9) by 4 we get

$$4t/r = 5C^5 r^3 / 64 G^3 *(m_1m_2)(m_1+m_2) \quad (10)$$

Since $- dt/dr = 5C^5 r^3 / 64 G^3 *(m_1m_2)(m_1+m_2)$

$$4t/r = - dt/dr \quad (11)$$

$$dr = - dt* r/ 4t \quad (12)$$

Thus the (8) becomes

$$F_g = - 2dE*4t /-dt *r \quad (13)$$

Here r = Distance between masses m_1 and m_2 respectively , **t** = lifetime of an orbit .

From (1) we know $dE/dt = - P$

Then (13) becomes $F_g = -8Pt / r$ (14)

$$P = - F_g\ r/8t \quad (15)$$

Here P = power of gravitational radiation **,** F_g =gravitational force between 2objects orbiting each other,

r = Distance between masses m_1 and m_2 respectively , **t** = lifetime of an orbit .

Determination of the Photon Force and Pressure
Reissig, Sergej

The 35th Meeting of the Division of Atomic, Molecular and Optical Physics, May 25-29, 2004, Tuscon, AZ. MEETING ID: DAMOP04, abstract #D1.102

In [1] the formula for the practical determination of the power of a light particle was derived: P = hf^2 (W) (1). For the praxis it is very usefully to define the forces and pressure of the electromagnetic or high temperature heat radiation. The use of the impulse equation F = fracdPdt = fracd(mc)dt (2) together with the Einstein formula for E = mc^2 leads to the following relationship: F = frac1cfracd(mc^2)dt = frac1cfracdEdt (3) In [1] was shown: -fracdEdt = P (4). With the use the eq. (1), (3), (4) the force value could be finally determinated: | F | = frachf^2 c or | F | = frachcλ ^2 = fracEλ [N]. The pressure of the photon could be calculated with using of the force value and effective area: p = fracFA [Pa]. References 1. About the calculation of the photon power. S. Reissig, APS four corners meeting, Arizona, 2003 -www.eps.org/aps/meet/4CF03/baps/abs/S150020.html

$$\mathbf{E=F\,\lambda}$$

According to Planck's theory of radiation

Energy associated with radiation can be given by

$$\mathbf{E=h}\,f$$

Thus the equation **E=F λ** becomes **F=h *f* / λ**

Then the equation (1) becomes **P=FC** (16)

Here **P**= Power of radiation, **F**= Force exerted by radiation ,**C**= speed of light in vaccum , **h** = planck'sconstant , ***f*** = frequencyof radiation , **λ** = wavelength of radiation .

According to General relativity gravitational radiation travels at speed of light. It carries energy along its motion .It possess wavelength and exerts force on other objects .

Hence the equation (16) also applies to Gravitational radiation .

Then (15) becomes $\mathbf{F= - F_g \; r/8tC}$ (17)

Gravitational potential energy of the binary system can be given by

$$\mathbf{U = - F_g \; r} \qquad (18)$$

Thus the equation (17) becomes **F= U/ 8t**C (19)

Here **F**= force exerted by gravitational radiation ,**U**= Gravitational potential energy of the binary system emitting gravitational radiation, **t** = lifetime of an orbit ,**C**=Speed of light in vaccum .

■Since power of gravitational radition is given by **P=FC**

From (17) we kn ow $\mathbf{F= - F_g \; r/8tC}$ i.e $\mathbf{P = - F_g \; r/8t}$ (20)

Power of gravitational radiation can be given by **P=h *f* ^2**

Here f = frequency of gravitational radiation .

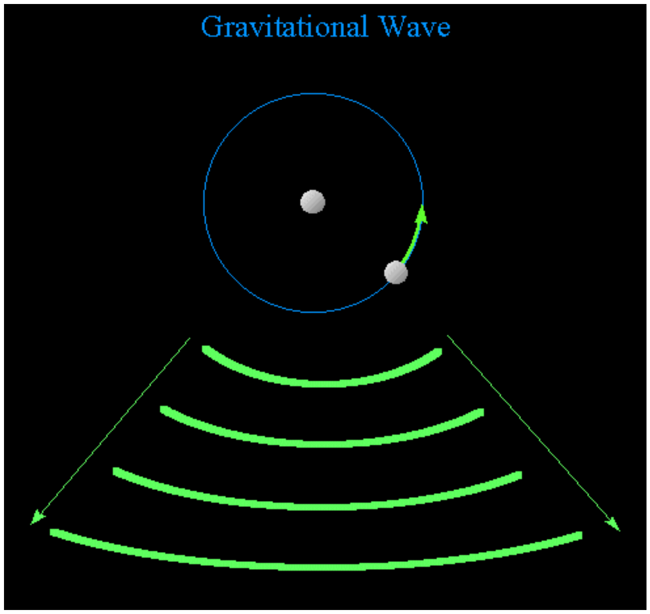

Figure-3: Loss of mass of orbiting object in the form of power radiated

Then the equation (20) becomes f^2 = **- Fg r/8ht**

f =[**- Fg r/8ht**]^1/2 (21)

From (18) we know **U = - Fg r**

Then the equation(21) becomes f =[**U / 8ht**]^1/2 . (22)

Here f = frequency of gravitational radiation , **h** =planck's constant (6.625*10^ -34JS) .

Angular frequency of gravitational wave can be given by $\omega = 2\pi f$

Thus the equation (22) becomes

$\omega = 2\pi$[**U /8ht**]^1/2 (23)

Here **ω** =Angular frequency of gravitational wave

According to Plancks law of radiation ,Energy associated withthe gravitational radiation can be given by

E=h f (24)

Multiply the equation(22) by h ,where h= planck's constant

we get **E= h[U / 8ht]^1/2**

Here **E**=Energy of gravitational radiation

Result:

1) Gravitational force between 2objects orbiting eachother is given by$F_g = -2dE/dr$
   (**dE** be small change in energy of binary system with respect to small change in **dr** , **-** ve sign indicates rate of energy loss of binary system with orbital decay) .
2) Frequency of gravitational radiation is given by $f = [-F_g r/8ht]^{1/2}$
   (f = frequency of gravitational radiation , h =planck's constant (6.625*10^ -34JS), F_g =Gravitational force between 2objects orbiting eachother, t = lifetime of an orbit).
3) Force exerted by gravitational radiation is given by $F = U/8tC$
   (F= force exerted by gravitational radiation ,U= Gravitational potential energy of the binary system emitting gravitational radiation, t = lifetime of an orbit ,C=Speed of light in vaccum).
4) The angular frequency of gravitational radition is given by $\omega = 2\pi[U/8ht]^{1/2}$.
5) The energy associated with the gravitational radition is given by $E = h[U/8ht]^{1/2}$.
   (E= Energy of gravitational radiation ,U= Gravitational potential energy of the binary system emitting gravitational radiation, t = lifetime of an orbit ,C=Speed of light in vaccum,h =planck's constant).

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Conclusion : The theory of relativity predicts that masses being accelerated should emit ``gravitational radiation" in the same way that charged particles (like electrons) emit electromagnetic radiation when they are accelerated.When two objects orbit each other,they lose mass in the form of radiation.According to the equation **$F_g = - 2dE/dr$**, gravitational force between 2orbiting objects increases with rate of energy loss of binary system with orbital decay. More energy loss from binary system leads to more orbital decay .The distance between 2 objects orbiting each other decreases then gravitational force between 2 objects orbiting each other increases(**F_g *a* 1/r**). According to equation **F= U/ 8tC** i.e **F*a* U/ t** force of gravitational radiation increases with gravitational potential energy of binary system and force of gravitational radiation decreases with the lifetime of an orbit. As frequency of emitted radition is more ,more is the loss of mass from the system in the form of gravitational radiation .The decrease in lifetime of an orbit is followed by increase in frequency of gravitational radition.

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