Journal of High Energy Physics, Gravitation and Cosmology, 2017, 3, 558-563
http://www.scirp.org/journal/jhepgc
ISSN Online: 2380-4335
ISSN Print: 2380-4327

Variation in Gravity Due to Laser Inducing an Explosion—Comparison with the Spinning Barbell Driven by Lasers

Andrew Beckwith

Department of Physics, Chongqing University, Chongqing, China
Email: abeckwith@uh.edu, rwill9955b@gmail.com

How to cite this paper: Beckwith, A. (2017) Variation in Gravity Due to Laser Inducing an Explosion—Comparison with the Spinning Barbell Driven by Lasers. *Journal of High Energy Physics, Gravitation and Cosmology*, **3**, 558-563.
https://doi.org/10.4236/jhepgc.2017.34042

Received: May 12, 2017
Accepted: August 26, 2017
Published: August 29, 2017

Abstract

We review by dimensional analysis what is necessary for a variation in gravity as to the change in gravitons due to an explosion of a matter sample created by a laser. This is the template as to a graviton induced variation experiment. This is complimentary to work done with Dr. Baker as far as modeling a spinning barbell experiment impacted by Laser pulses which was accepted as a presentation in STAIF II, in April 2015. This document is in terms of an implosion of a pellet of matter leading to a subsequent explosion instead of a spinning barbell.

Keywords

Gravity, Explosion, Lasers

1. Introduction

We first supply a dimensional analysis of what the necessary ingredients are to obtaining the flux of gravitons from a laser hitting a target, with a given power. The idea is an adaptation of a problem in a book written by [1] which invokes dimensional analysis. We will merely cite the end results of the dimensional analysis, and make recommendations as to its applications. Equation (1) below, with its graviton flux, as given by Equation (2), is effectively a creation or fluctuation of gravity, due to the sudden creation of gravitons.

2. Summary of GW Variation, as Flux of Gravitons

Lightman *et al.* [1] have a problem as to the number of gravitons created by an explosion, of arbitrary energy, E, which will result in a definite number of gravitons being produced. We estimate that we have a laser firing for 10 to the minus 5 seconds, so then that for a certain laser power, we have a finite probability of an energy being released by an arbitrary explosion which presumably will release gravitons. The trick is to obtain a sufficiently large energy value, *E*, in the explosion, as well as pay attention to laser power issues. The formula is so simple, that the reader is advised to go to [1], page 509, for confirmation. We presume a 1-meter squared Graviton detector, and a 2-meter distant from the target laser which fires on a target for about 10^{-3} seconds.

3. Actual Formula for the Number of Gravitons Created by a General Explosion

Lightman *et al.*, [1] delineate the end result as

$$N_{\text{gravitons}} \approx \left(E_{\text{energy-explosion}} / 10^{16}\,\text{ergs}\right)^2 \tag{1}$$

It should be understood that the relevant parameter is, that the energy be sufficiently strong so that there would be a way that the gravitons would be detectable. The issue is of flux, and that is over a surface area. The flux would be definable in the following manner. The number N defined above, to first approximation would be in a circular sphere, with a surface area of $4\pi r_{\text{radius}}^2$.

If the radius were say of 2 meters, then the relevant division of presumed gravitons in a detector screen of one meter, squared, would be of the order of

$$N_{\text{graviton}} / 16\pi \sim \#\text{ of gravitons in detector} \tag{2}$$

Equation (2) is, if we assume a 1-meter, squared graviton detector screen, the simplest view, FLUX. *i.e.* this is graviton flux, per square meter, and from that we go to the issue of what the energy $E_{\text{energy-explosion}}$ is.

4. How to Calculate $E_{\text{energy-explosion}}$

According to [1], page 509, there would be a power *P* (for internal energy flow) which would be bundled into a gravitational wave power, via, if the time τ for the duration of a process

$$\begin{gathered} P_{GW} \sim \frac{P^2}{3\times 10^{59}\,\text{erg/sec}} \sim \left(E/\tau\right)^1 \\ \Leftrightarrow E_{\text{energy-explosion}} \sim \tau \cdot P^2 / 3\times 10^{59}\,\text{erg/sec} \end{gathered} \tag{3}$$

It is in our interest to make the power, *P*, as large as possible, presuming τ is of the order of 10^{-5} seconds in duration. *i.e.* almost a delta function spike of power, being supplied, hitting a sample, with a laser.

Doing this, requires, then that re revisit Equation (1) and Equation (2).

5. Summing up

If Equation (1) and Equation (2) are legitimate, with an effective presuming τ is of the order of 10^{-5} seconds, with the *P*, being very large, then what we are looking at is, if time τ for the duration of a process

$$N_{\text{gravitons}} \approx \left(E_{\text{energy-explosion}} / 10^{16}\,\text{ergs}\right)^2 \sim \left(\tau \cdot P^2 \cdot \text{sec} / 3 \times 10^{59}\,\text{erg} \cdot 10^{16}\,\text{ergs}\right)^2 \quad (4)$$

It really depends upon the effective power, *P*, delivered, presumably to initiate an explosion, at a site, plus the duration of the laser beam with a target, given by τ

Presumably, if the cross sectional area, of the detector is smaller, then Equation (4) would have a smaller value. This though, is the clearest derivation of all the relevant physics, via dimensional analysis, needed to initiate an inquiry as to this problem. We assume that Equation (1) and Equation (2) are effectively local variation of gravity, assuming gravitons are commensurate with GW and gravity itself. We will then, after looking at Equation (4) get to the matter of variation in gravity next.

6. Brief Review of Graviton Production for Massless Gravitons, Using Weinberg Black Body Analogy

From the book written by [2], for frequencies, between ω and $\omega + \mathrm{d}\omega$: the number of gravitons is given by Weinberg [3], page 287 Formula 10.89 as

$$n(\omega)\mathrm{d}\omega = \frac{\omega^2}{\left[\pi^2 \cdot \left(\exp\left[\frac{\hbar \cdot \omega}{k_B T}\right] - 1\right)\right]} \cdot \mathrm{d}\omega \quad (5)$$

Integrate this, between two band widths of frequency for the graviton, or for a very narrow graviton frequency width $\bar{\omega}$, the following approximation is acceptable

$$n(\bar{\bar{\omega}}) \approx \frac{\bar{\omega}^2}{\left[\pi^2 \cdot \left(\exp\left[\frac{\hbar \cdot \bar{\omega}}{k_B T}\right] - 1\right)\right]} \quad (6)$$

Note that k_B above is for the Boltzmann constant, and that T can be set by ANYTHING one wants to have it set by, and the upshot, is that for frequencies approximately as $\bar{\omega}$ approximately of about 10^9 Hz, that if there is a boost in temperature, call it T increased that there will be a corresponding boost in the magnitude of Equation (6) above. To do this, we reference what Dr. Baker has suggested to the author, as far as variation in gravity [3], in the next equation

$$\Delta g\big|_{\text{gravity-variance}} \approx \tilde{L} \cdot \omega^2_{\text{graviton}} \quad (7)$$

Our job is to determine the quantity, $\tilde{L}$, and it will be to mesh our prediction of Equation (7) with Equation (6) and that with the information given in Equation (4), times 16π, so we have a generalized relationship as to the power of a laser, hitting a target involved.

Note that our first approximation is to set up how to come up with a base line calculation for what we call $\tilde{L}_0$ in the below formula. This assumes that the quantity ΔT is huge, which is due to a temperature boost due to a laser.

$$\tilde{L} \propto \tilde{L}_0 \cdot \frac{1}{\left[\pi^2 \cdot \left(\exp\left[\frac{\hbar \cdot \omega_{\text{graviton}}}{k_B \cdot \Delta T}\right] - 1\right)\right]} \approx \frac{\tilde{L}_0}{\pi^2} \cdot \left[\left(\frac{\hbar \cdot \omega_{\text{graviton}}}{k_B \cdot \Delta T}\right)^{-1} - \frac{1}{2}\right] \tag{8}$$

First, we look at $\tilde{L}_0$ in the context of ΔT being enormous, in the above Equation (8), which then will be compared with Equation (4) above.

We should note what happens if the power, *P*, as given above in Equation (4) is given by the expression given by Dr. Baker [4], as

$$P = 10.1 \times 10^{24}\,\text{W} = 10.1 \times 10^{30}\,\text{erg/sec} \sim 10^{31}\,\text{erg/sec} \tag{9}$$

Then we are looking at, if we have 2.95 times 10 to the 13th Hertz for graviton frequency,

$$N_{\text{gravitons}} \sim \left(\tau.\text{sec} \cdot 10^{62}\,(\text{erg/sec})^2 \big/ 3 \times 10^{59}\,\text{erg} \cdot 10^{16}\,\text{ergs}\right)^2 \propto \left(\frac{\tau}{3 \cdot \text{sec}} \cdot \frac{10^{62}}{10^{75}}\right)^2 \tag{10}$$

This is TINY. It is necessary, then to get more experimentally useful results via applying a power expression for Equation (11) which is substantially larger, *i.e.*

$$P \sim 10^{41}\,\text{erg/sec} \tag{11}$$

Then,

$$N_{\text{gravitons}} \sim \left(\frac{\tau}{3 \cdot \text{sec}} \cdot \frac{10^{82}}{10^{75}}\right)^2 \tag{12}$$

Assume then that the process is going on for about $\tau \sim 10^{-3}\,\text{sec}$, then

$$N_{\text{gravitons}} \propto \left(\frac{\tau}{3 \cdot \text{sec}} \cdot \frac{10^{62}}{10^{75}}\right)^2 \approx 10^7/\text{sec} \tag{13}$$

Divide by 16π when looking at the situation given by Equation (2) where we are considering number of gravitons entering a 1 meter, squared screen, of a GW detector 2 meters away from an implosion pellet, to get a value 1/50 the size, so then one is getting, then

$$N_{\text{gravitons}}\Big|_{\text{1 meter squared detector}} \approx \frac{10^7}{50}\Big/\text{sec} \approx 2 \times 10^5\,\text{gravitons/sec} \tag{14}$$

If one has a value of power, say

$$\begin{aligned} &P \sim 10^{40}\,\text{erg/sec} \\ &\tau \sim 10^{-3}\,\text{sec} \end{aligned} \tag{15}$$

then one will have, instead,

$$N_{\text{gravitons}}\Big|_{\text{1 meter squared detector}} \approx \frac{10^5}{50}\Big/\text{sec} \approx 2 \times 10^3\,\text{gravitons/sec} \tag{16}$$

We are assuming, for the purpose of our analysis, that we are working with Equation (14) in a 10 to the minus 3 interaction, with the result that one is looking at a temperature increase, due to power, as given above, in Equation (11) of the order of, if using forms similar to Equation (8) so one obtains

$$\Delta T \sim 10^2 / \log_e(1.0000005066) \approx 4\times 10^9 \,\text{Kelvin} \tag{17}$$

if we use an applied power given by Equation (11), so then that in 10 to the -3rd seconds we get Equation (18) below.

Then, we have that if there are 2 times 10 to the 5th gravitons entering a 1-meter squared surface area,

$$\tilde{L} \propto \tilde{L}_0 \cdot \frac{1}{\left[\pi^2 \cdot \left(\exp\left[\dfrac{\hbar\cdot\omega_{\text{graviton}}}{k_B\cdot\Delta T}\right]-1\right)\right]} \approx \tilde{L}_0 \cdot \left|4\times 10^9\right| \tag{18}$$

Then the assumption is, if we have a brief increase of gravity, due to 10 to the 7th gravitons being produced, radially, is that there would be the following value of gravity increase, *i.e.* 10 to the 1st power increase in local gravity due to increase of local gravitons given by, if we assume a frequency for the gravitons averaged to about 10 to the 13th Hertz

$$\tilde{L}_0 \approx \frac{98\cdot \text{meters}/\text{sec}^2}{4\times 10^9 \cdot \left(2.95\times 10^{13}\,\text{Hz}\right)^2} \tag{19}$$

Then to first approximation one could write:

$$\tilde{L} \approx \frac{98\cdot \text{meters}/\text{sec}^2}{4\times 10^9 \cdot \left(2.95\times 10^{13}\,\text{Hz}\right)^2} \cdot \frac{1}{\left[\pi^2 \cdot \left(\exp\left[\dfrac{\hbar\cdot\omega_{\text{graviton}}}{k_B\cdot\Delta T}\right]-1\right)\right]} \tag{20}$$

7. Conclusions—Comparison with the Rotating Bar, Hit with Laser Pulses Offered

Equation (20) put in with Equation (7) will, if there is a 10 to the −3rd second interval where there are approximately 10 to the 5th gravitons entering a 1-meter squared detector, 2 meters from a pellet, resulting due to a temperature increase of the order of Equation (17) above. This value of a length, given by Equation (20) with 2.95 times 10 to the 13th frequencies associated with the graviton cold, is detectable. The 100,000 or so gravitons, if detected, lead to new ways to model gravitons, as opposed to our present very crude models. The author, with Dr. Baker looks forward to the implementation of such an experiment, in the coming year. The variation in local gravity expected would be approximately 10 times the average surface gravity value of 9.8 meters per second, squared.

As can be related, this analysis is meant to be complimentary to work which the author did with Dr. Baker, in modeling a laser driven torque of a barbell, *i.e.* the author finds that the barbell will, as a spinning rod [5] by a semi classical treatment generate, perhaps over a period of seconds a steadier output of gravitons than what is admittedly an extension of the laser pellet explosion idea of [1] which assumes in essence a takeoff of the laser implosion of a pellet of matter as has been attempted in Lawrence Livermore labs, in their controlled fusion experiments.

The disadvantage of the method brought up in this document is that there may be in a period of micro seconds up to 100,000 or so gravitons generated, *i.e.* this would put a premium upon ultrafast electronics and signal processing, *i.e.* could a detector be able to process graviton flux that fast?

It is an open question.

The rotating dumb bell, while it could go on up to seconds of operation may have problems of stochastic noise, and this has been brought up by Dr. Li with Dr. Beckwith, as of November 2015. Needless to say, the author has had extensive discussions with laser theorists whom informed him that the TIMING of laser pulses up to 10^{-5} seconds separation between tapping the ends of a rotating rad, can be technically performed, and that with extensive R and D that there is no question as of the ability of laser technicians to perform the tapping of the ends of the dumb bell visualized in [5]. The issue of stochastic GW generation though is a problem. But the feasibility of the synchronization of the tapping of the ends of a rotating rod by lasers has been confirmed as doable.

IMO, the disadvantage of the implosion/explosion of the target hit by the laser would be in evaluation of a flux of 100,000 or so gravitons in an extraordinarily short period of time.

The disadvantage of the rotating dumb bell may be in stochastic noise, *i.e.* making a noisy signal, *i.e.* both methods are feasible and would put a premium though upon R and D for extremely precise engineering.

References

[1] Lightman, A., Press, W., Price, R. and Teukolsky, S. (1975) Problem Book in Relativity and Gravitation. Princeton University Press, Princeton, New Jersey.

[2] Weinberg, S. (1972) Gravitation and Cosmology, Principles and Applications of the General Theory of Relativity. John Wiley & Sons, Inc., New York.

[3] Dr. Robert Baker: Private Communication with the Author, March 12, 2014.

[4] Baker Jr., R.M.L. (2006) Novel Formulation of the Quadrupole Equation for Potential Stellar Gravitational-Wave Power Estimation. *Astronomische Nachrichten/Astronomical Notes*, **327**, 710-713.
http://www.drrobertbaker.com/docs/Astron.%20Notes%20GW%20Article.pdf
https://doi.org/10.1002/asna.200510617

[5] Beckwith, A. and Baker, R. The Generation of Gravitational Waves by Lasers. *Proceedings of the Space Technology & Applications International Forum* (*STAIF II* 2015), Albuquerque, New Mexico, 16-18 April 2015, 1-12.