GRAVITATIONAL AMPLIFICATION BY STIMULATED EMISSION OF RADIATION (GASER)

by

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ABSTRACT

The outline theory of the gaser is developed from the field equations of gravitation in ECE2 theory, whose structure is the same as the field equations of electromagnetism. Therefore there is a gravitational Rayleigh Jeans density of states, and a Planck distribution of gravitons, In ECE2 the latter are bosons. There is also a gravitational Steffan Boltzmann law, so the energy density of gravitational radiation is proportional to the fourth power of temperature. It is reasonable, arguing by analogy, that gravitons are absorbed and emitted by atoms and molecules. The theory of the gaser follows in precise analogy to that of the laser. It may become possible to amplify gravitational radiation to the point where it becomes observable in the laboratory using a gaser beam to attract a test mass.

Keywords: ECE2 theory, gaser theory, laws of gravitational radiation.

UFT 341

1. INTRODUCTION

The field equations of ECE2 unified field theory {1 - 12} have the same structure for electromagnetism and gravitation, so can be solved and developed for gravitation using all the highly developed methods of electromagnetism, bearing in mind that gravitation is about twenty orders of magnitude weaker than electromagnetism in the laboratory. It follows immediately that the graviton in ECE2 theory is a wave / particle and a boson. There is a Rayleigh Jeans density of states of gravitational radiation on the classical level. This law must be corrected as in UFT291 on www.aias.us for an error by Rayleigh. When incorporated in the Planck theory, there follows that there exists a Planck distribution of gravitons, giving a Stefan Boltzmann law of gravitational radiation: the energy density of gravitational radiation is proportional to the fourth power of temperature. The field equations of gravitation can be solved in precise analogy to the field equations of electromagnetism, so there exist plane waves of gravitation for example, and the gravitational B(3) field {1 - 12}. It can be inferred that gravitons can be absorbed and emitted by atoms and molecules, so there exist Einstein B and A coefficients for gravitons, and a set of selection rules.

The most useful outcome of this analogous thinking is that there exists gravitational amplification by stimulated emission of radiation (gaser). A gaser beam can be constructed using principles that are precisely analogous to those of the well known laser beam (light amplification by stimulated emission of radiation). The outcome is that a gaser beam can be constructed in theory which is many orders of magnitude more intense than diffuse gravitational radiation from a laboratory source. As a result it is expected that the gaser beam will attract a test mass in an experimentally measurable way, proving the existence of ECE2 gravitational radiation. ECE2 allows for the existence of counter gravitation, so in theory a counter gravitational gaser beam could be constructed, with obvious aerospace engineering applications. The source of gravitational waves is the same as the source of electromagnetic waves: oscillating mass instead of oscillating charge.

This paper is a concise synopsis of detailed calculations found in the notes accompanying UFT341 on www.aias.us. Note 341(1) gives complete details of the field and potential equations of electromagnetism and gravitation in ECE2 theory and considers the special case of gravitational plane waves, an idealized solution of the field equations hypothetically free of mass / current density. This theory predicts the gravitational B(3) field and the gravitational inverse Faraday effect. The note gives a simple demonstration of why gravitation is s much weaker than electromagnetism in the laboratory. Note 341(2) gives the gravitational Rayleigh Jeans density of states in a theory which is precisely analogous to that of UFT291 on www.aias.us, in which an important correction was made to Rayleigh's original calculation. This correction also applies to the gravitational density of states. In analogy with UFT291 the d'Alembert equation used by Rayleigh is replaced by the gravitational Proca equation, incorporating the graviton with mass, analogous with the massive photon. The Proca equation is derived from the ECE wave equation of UFT2, based on the tetrad postulate of Cartan geometry. In analogy with Planck's inference of photons, the Planck distribution of gravitons is defined, giving the Stefan Boltzman law of gravitational radiation. In Note 341(3), details are given of the integral calculus needed to correct the error made by Rayleigh, which was to incorrectly omit higher order infinitesimals. The correction requires a method of integrating the square root and in general 1 / n root of an infinitesimal, where n is an integer. The integration is carefully defined by adopting the Riemann method, described in every textbook. Finally Note 314(4) introduces the theory of absorption and emission of gravitons, and gives a simple three level gaser theory. Section 2 is based on Note 314(4).

2. THEORY OF THE GASER

In close analogy with UFT300 consider a gravitational beam of energy density U / V in joules per cubic metre. Its energy flux density is defined as:

$$\Phi = c\frac{U}{V} \quad -(1)$$

in watts per square metre. The volume of gravitational radiation is:

$$V = Al \quad -(2)$$

where A is the area and l a length. The graviton is the quantum of radiation $\hbar\omega$ where $\hbar$ is the reduced Planck constant and ω the angular frequency of the radiation. If for the sake of argument the graviton is assumed to propagate at c, the vacuum speed of light, then in an interval Δt :

$$l = c\Delta t. \quad -(3)$$

The total gravitational energy is:

$$U = \left(\frac{U}{V}\right)V = \frac{U}{V}Al. \quad -(4)$$

The infinitesimal of gravitational flux density in the range ω to $\omega + d\omega$ is:

$$d\Phi = c\rho\, d\omega = I(\omega)\, d\omega \quad -(5)$$

where the energy density of gravitational states is:

$$\rho(\omega) = \frac{1}{V}\frac{dU}{d\omega}. \quad -(6)$$

The intensity of polychromatic gravitational radiation is:

$$I(\omega) = \frac{c}{V}\frac{dU}{d\omega} \quad -(7)$$

in watts per square metre.

Exactly as in UFT300 the uncorrected Planck distribution of gravitons (see background notes) is:

$$\rho = \frac{1}{V}\frac{dU}{d\omega} = \frac{\hbar\omega^3}{\pi^2 c^3}\left(\exp\left(\frac{\hbar\omega}{kT}\right)-1\right)^{-1} \quad -(8)$$

where k is Boltzmann's constant and T the temperature. The corrected Planck distribution of UFT291 is:

$$I = \frac{10}{3}\frac{\hbar\omega^3}{\pi^2 c^2}\left(e^{x}-1\right)^{-1} \quad -(9)$$

where:

$$x = \frac{\hbar\omega}{kT}. \quad -(10)$$

The gravitational Beer Lambert law is:

$$I = I_0 \exp(-\alpha l) \quad -(11)$$

where α is the gravitational power absorption coefficient. In the limit:

$$\hbar\omega \ll kT \quad -(12)$$

the gravitational Evans Morris effect is defined:

$$\omega = \omega_0 \exp\left(-\frac{\alpha l}{2}\right). \quad -(13)$$

The rate at which a graviton is absorbed by an atom or molecule is:

$$W_{if} = B_{if}\,\rho \quad -(14)$$

where B_{if} is the gravitational B coefficient, analogous to the Einstein B coefficient for the absorption of electromagnetic radiation, and ρ is the energy density of gravitational states defined already. Eq. (14) defines the coefficient of stimulated absorption of gravitational radiation from a quantum state i to a quantum state f within an atom or molecule.

The coefficient of stimulated emission of gravitational radiation is A_{fi}.

There are N_i molecules in state i and N_f in state f, so the total rate of absorption of gravitational radiation is $N_i W_{if}$ and the total rate of emission of gravitational radiation is $N_f (W_{fi} + A_{fi})$. At thermal equilibrium:

$$N_f \left(A_{fi} + \rho B_{fi} \right) = N_i \rho B_{if} \quad -(15)$$

where:

$$\frac{N_i}{N_f} = \exp\left(\frac{\hbar\omega}{kT} \right). \quad -(16)$$

Therefore:

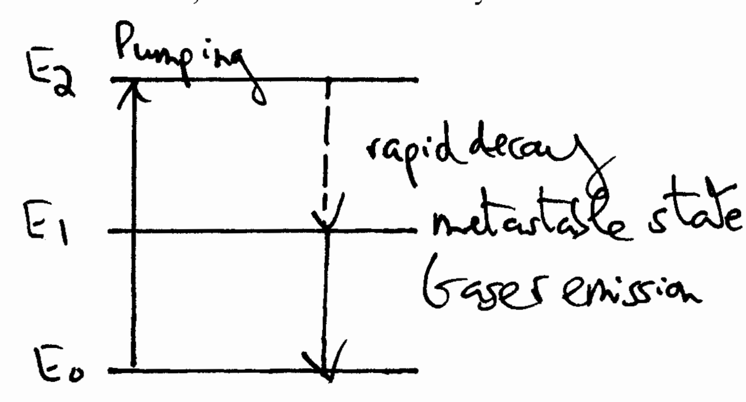
$$\frac{\text{Total emission rate}}{\text{Total absorption rate}} = \left(\frac{N_f}{N_i} \right) \left(\frac{W_{fi} + A_{fi}}{W_{if}} \right). \quad -(17)$$

The phenomenon of gravitational amplification by stimulated emission of of radiation (gaser) depends on adjusting the system so that:

$$N_f \gg N_i \quad -(18)$$

This is known as population inversion, and in a three level system is achieved as in Fig (1).

Fig (1)



A graviton is absorbed from level E_0 to level E_2 by stimulated absorption. There is a rapid decay to level E_1, which is a metastable state, so there is a build up of N_f, which becomes much greater than N_i.

The gaser action is emission of gravitational radiation from state E_1 to E_0. Exactly as in the laser, the emitted beam can become very intense. For example one of the most powerful lasers yet built is the Hercules laser at Ann Arbor, with a power of 10^{22} watts per square metre achieved using a very small area. This is equivalent to a gravitational beam of about a watt per square metre. In general, the force between two masses m_1 and m_2 is:

$$\underline{F} = m_1 \underline{g} = -\frac{m_1 m_2 G}{r^2} \underline{e}_r \quad -(19)$$

where the gravitational potential energy, denoted U, is:

$$U = -\frac{m_2 G}{r}. \quad -(20)$$

For two masses of a kilogram each separated by a metre, the gravitational potential energy is of the order of 10^{-11} Joules. The gravitational power per unit area is:

$$\underline{\Phi} = c\frac{U}{V} \quad -(21)$$

in watts m^{-2}. The gaser maximizes U / V, so for a given volume of radiation V the energy is maximized, giving a much greater force of attraction and acceleration due to the attraction of the test mass m_1 and the gaser beam

$$\underline{F} = m_1 \underline{g} = m_1 \frac{U}{r} \underline{e}_r \quad -(22)$$

For a test mass m_1 of one kilogram separated from a mass m_2 of one kilogram by one metre, the acceleration is about 10^{-11} m s^{-2}. The acceleration due to gravity is 9.807 m s^{-2} due to the earth's mass and radius. So to observe an acceleration due to gravity the gaser has to produce an energy of 9.807 joules.

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