341(4): Theory of Absorption and Emission of Gravitons

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 its area and l a length. If the graviton $\hbar\omega$ is assumed for the sake of argument to travel 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 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.

As in UFT300, the uncorrected Planck

) distribution of gravitons is:

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

and the corrected Planck distribution of UFT291 is used to give

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

where

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

The uncorrected Planck distribution gives:

$$I = \frac{\hbar\omega^3}{\pi^2 c^2}\left(\frac{1}{e^x - 1}\right) \quad -(11)$$

The gravitational Beer Lambert law is:

$$\frac{I}{I_0} = \exp\left(-\alpha l\right) \quad -(12)$$

where α is the gravitational power absorption coefficient.

As in UFT300, in the limit:

$$\hbar\omega << kT \quad -(13)$$

the gravitational Evans Morris effect is obtained

$$\frac{\omega}{\omega_0} = \exp\left(-\frac{\alpha l}{2}\right) \quad -(14)$$

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

3)

$$W_{if} = B_{if}\,\rho \quad -(15)$$

where B_{if} is the gravitational B coefficient, and ρ is the energy density of states, given by eq. (8) in the uncorrected Rayleigh Jeans theory of gravitational radiation, $\rho_{10}/3$ in the corrected and multiplied by a factor of theory. Eq. (15) defines the coefficient of stimulated absorption of gravitational radiation from a quantized state i to a quantized state f of which an atom or molecule.

The coefficient of stimulated emission of gravitational radiation is

$$W_{fi} = B_{fi}\,\rho \quad -(16)$$

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

There are N_i molecules in state i and N_f in state f. 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:

$$N_f\,(A_{fi} + B_{fi}\,\rho) = N_i\,B_{if}\,\rho \quad -(17)$$

where

$$\frac{N_i}{N_f} = \exp\left(\frac{\hbar\omega}{kT}\right) \quad -(18)$$

4) at thermal equilibrium. From eq. (17):

$$\frac{B_{if}\,\rho}{A_{fi}+B_{fi}\,\rho} = \frac{N_f}{N_i} \qquad -(19)$$

and

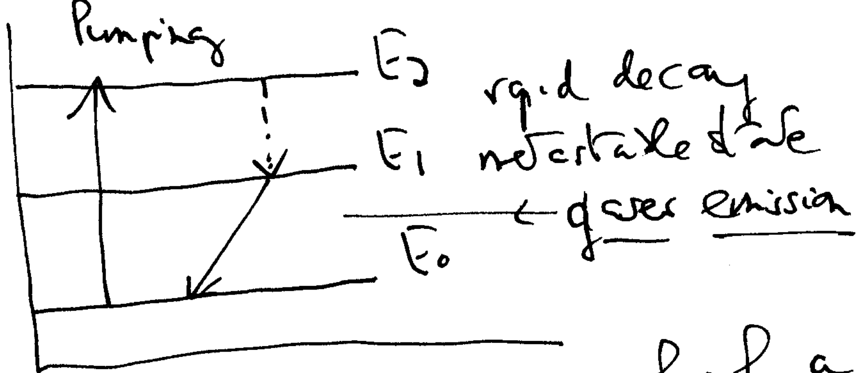
$$\frac{\text{Total rate of emission}}{\text{Total rate of absorption}} = \frac{N_f\left(\bar{W}_{fi}+A_{fi}\right)}{N_i\,\bar{W}_{if}} \qquad -(20)$$

The phenomena of gravitational amplification by stimulated emission of radiation (GASER) depend on adjusting the system so that:

$$N_f \gg N_i \qquad -(21)$$

which is known as <u>population inversion</u>. This is achieved as in Fig (1):

Fig.(1)



This is a three level mechanism in which a graviton is absorbed from level E_0 to E_2 in a process of stimulated absorption. There is rapid decay from level E_2 to level E_1, which is a metastable state, so there is a build up of N_f, which becomes greater than N_i.

5) 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. A very intense gravitational beam attracts a test mass m in the laboratory.

The laser and gaser process can be thought of as a gain in the Beer Lambert law:

$$\frac{I}{I_0} = \exp(g\ell) \quad -(22)$$

where

$$g = g_0 (N_1 - N_0) \quad -(23)$$

with population inversion:

$$N_1 \gg N_0.$$