Nuclear Fission by means of Terahertz Sonic Waves

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It is shown here that when terahertz sonic waves strike on an atomic nucleus they can produce the fission of the nucleus. This fact can be now checked in practice since recently it was developed an *acoustic* device called a SASER that is the first to emit sonic waves in the *terahertz* range.

Key words: Nuclear Fission, Terahertz Sonic waves, Sasers, Sonic Waves.

The quantization of gravity shows that the *gravitational mass* m_g and *inertial mass* m_i are not equivalents, but correlated by means of a factor χ, i.e.,

$$m_g = \chi\ m_{i0} \tag{1}$$

where m_{i0} is the *rest* inertial mass of the particle. The expression of χ can be put in the following form [1]:

$$\chi = \frac{m_g}{m_{i0}} = \left\{1 - 2\left[\sqrt{1+\left(\frac{W}{\rho\ c^2}n_r\right)^2} - 1\right]\right\} \tag{2}$$

where W is the density of electromagnetic energy on the particle $\left(J/m^3\right)$; ρ is the matter density of the particle; c is the speed of light, and n_r is its index of refraction of the particle.

Equation (2) shows that χ can be *positive* or *negative*. This fact affect fundamentally the expressions for the *momentum* $\vec{q}$ and *energy* E_g of a particle with gravitational mass m_g and velocity $\vec{v}$, which are respectively given by

$$\vec{q} = \frac{m_g \vec{v}}{\sqrt{1-v^2/c^2}} \tag{3}$$

$$E_g = \frac{m_g c^2}{\sqrt{1-v^2/c^2}} \tag{4}$$

Since $\vec{q}$ has *always the same direction of* $\vec{v}$, then the coefficient $m_g/\sqrt{1-v^2/c^2}$ cannot be negative as occurs in the case of m_g be *negative*. For this coefficient always be positive the unique way is take m_g in modulus, rewriting Eq. (3) as follows:

$$\vec{q} = \frac{|m_g|\vec{v}}{\sqrt{1-v^2/c^2}} \tag{5}$$

This is not necessary in Eq. (4) because the energy can be both positive as negative. Then substitution of m_g given by Eq.(1) into Eqs. (4) and (5) gives

$$E_g = \frac{m_g c^2}{\sqrt{1-v^2/c^2}} = \frac{\chi\ m_{i0}c^2}{\sqrt{1-v^2/c^2}} = \chi\ M_{i0}c^2 \tag{6}$$

and

$$\vec{q} = \frac{|m_g|\vec{v}}{\sqrt{1-v^2/c^2}} = \frac{|\chi| m_{i0}\vec{v}}{\sqrt{1-v^2/c^2}} = |\chi| M_{i0}\vec{v} \tag{7}$$

By substituting M_{i0} by hf/c^2 into equation (6) and (7), it is possible to transform these equations for the case of particles with *null mass* as *photons* and *phonons*, etc. The result is

$$E_g = \chi\ hf \tag{8}$$

and

$$\vec{q} = |\chi| \left(\frac{\vec{v}}{c} \right) \frac{h}{\lambda} \qquad (9)$$

In the case of *photons* $(v = c)$ the equations are the followings

$$E_g = \chi\, hf \qquad and \qquad \vec{q} = |\chi| \frac{h}{\lambda} \qquad (10)$$

Note that the *energy* and the *momentum* of the photons depend on the factor χ, which depends on *the medium where the photons propagate, and the local energy density*. Only for $\chi = 1$ is that the equations (10) are reduced to the well-known expressions of Einstein (hf) and DeBroglie $(q = h/\lambda)$.

For *phonons* ($v = v_s$ and $\lambda = \lambda_s$) Eq. (9) tells us that

$$\vec{q}_s = |\chi| \left(\frac{\vec{v}_s}{c} \right) \frac{h}{\lambda_s} = |\chi| \frac{hf}{c} \qquad (11)$$

Thus, when a sonic wave strikes on an atomic nucleus, the total *momentum* transferred for the nucleus in 1second, for example, is given by

$$\vec{q}_{s(1second)} = \vec{q}_s \left(\frac{1s}{1/f} \right) = |\chi| \frac{hf^2}{c} \qquad (12)$$

We can express $\vec{q}_{s(1second)}$, as a function of *the kinetic energy* E_k *absorbed in one second*, by means of the following equation:

$$\vec{q}_{s(1second)} = \frac{2E_k}{v_s} \qquad (13)$$

Nuclear fission can occur in a heavy nucleus when it acquires sufficient excitation energy $\left(E_k > 5Mev = 8 \times 10^{-13}\,J\right)$[2]. Thus, comparing Eq. (12) and (13), we can conclude that the frequency f of a *phonon*, necessary to produce *nuclear fission*, is given by

$$f = \sqrt{\frac{2E_k c}{|\chi| h v_s}} > \frac{8.5 \times 10^{14}}{\sqrt{|\chi| v_s}} \qquad (14)$$

For example, in order to produce nuclear fission in Uranium $\left(v_s = 3155 m.s^{-1}\right)$, in the case of $\chi \cong 1$, the frequency, f, must have the following value

$$f > \frac{8.5 \times 10^{14}}{\sqrt{|\chi| v_s}} \cong 15THz \qquad (16)$$

In the case of the Air $\left(v_s = 343{,}4 m.s^{-1}\ at\ \ 20^0\, C\right)$, the frequency, f, is given by

$$f > \frac{8.5 \times 10^{14}}{\sqrt{|\chi| v_s}} \cong 45.8THz \qquad (17)$$

In 2009, it was developed an *acoustic* device called SASER that is the first to emit sonic waves in the *terahertz* range [3]. While a laser uses packets of electromagnetic vibrations called photons, the SASER uses sonic waves composed of sonic vibrations called *phonons*.

The advent of the sasers is highly relevant mainly because it will be possible to check the theoretical predictions made here.

References

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