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 \( \chi \), i.e.,

\[
m_g = \chi m_{i0}
\]

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

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

where \( W \) is the density of electromagnetic energy on the particle \( (J/m^3) \); \( \rho \) 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 \( \chi \) can be positive or negative. This fact affects fundamentally the expressions for the momentum \( \tilde{q} \) and energy \( E_g \) of a particle with gravitational mass \( m_g \) and velocity \( \tilde{v} \), which are respectively given by

\[
\tilde{q} = \frac{m_g \tilde{v}}{\sqrt{1 - v^2/c^2}}
\]

\[
E_g = \frac{m_g c^2}{\sqrt{1 - v^2/c^2}}
\]

Since \( \tilde{q} \) has always the same direction of \( \tilde{v} \), 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:

\[
\tilde{q} = \frac{|m_g| \tilde{v}}{\sqrt{1 - v^2/c^2}}
\]

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

\[
E_g = \frac{m_{i0} c^2}{\sqrt{1 - v^2/c^2}} = \frac{\chi m_{i0} c^2}{\sqrt{1 - v^2/c^2}} = \chi M_{i0} c^2
\]

and

\[
\tilde{q} = \frac{|m_g| \tilde{v}}{\sqrt{1 - v^2/c^2}} = \frac{|\chi| m_{i0} \tilde{v}}{\sqrt{1 - v^2/c^2}} = |\chi| M_{i0} \tilde{v}
\]

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

\[
E_g = \chi hf
\]

and

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\[
E_g = \chi hf
\]

and
\[ \tilde{q} = |\chi| \left( \frac{v}{c} \right) \frac{h}{\lambda} \] (9)

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

\[ E_g = \chi hf \quad \text{and} \quad \tilde{q} = |\chi| \frac{h}{\lambda} \] (10)

Note that the energy and the momentum of the photons depend on the factor \(\chi\), 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

\[ \tilde{q}_s = |\chi| \left( \frac{v_s}{c} \right) \frac{h}{\lambda_s} = |\chi| \frac{hf}{c} \] (11)

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

\[ \tilde{q}_{s(1\text{second})} = \tilde{q}_s \left( \frac{1}{1/f} \right) = |\chi| \frac{hf^2}{c} \] (12)

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

\[ \tilde{q}_{s(1\text{second})} = \frac{2E_k}{v_s} \] (13)

Nuclear fission can occur in a heavy nucleus when it acquires sufficient excitation energy \((E_k > 5\text{MeV} = 8 \times 10^{-13} J)\) [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

\[ f = \frac{2E_k c}{|\chi| hv_s^2} > \frac{8.5 \times 10^4}{\sqrt{|\chi| v_s}} \] (14)

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

\[ f > \frac{8.5 \times 10^4}{\sqrt{|\chi| v_s}} \approx 15\text{THz} \] (16)

In the case of the Air \((v_s = 343.4\text{m.s}^{-1}\text{ at } 20^\circ C)\), the frequency, \(f\), is given by

\[ f > \frac{8.5 \times 10^4}{\sqrt{|\chi| v_s}} \approx 45.8\text{THz} \] (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

