Control of the Gravitational Energy by means of Sonic Waves

Fran De Aquino
Professor Emeritus of Physics, Maranhao State University, UEMA.
Titular Researcher (R) of National Institute for Space Research, INPE

It is shown here that the incidence of sonic waves on a solid can reduce its gravitational mass. This effect is more relevant in the case of the Aerogels, in which it is possible strongly reduce their gravitational masses by using sonic waves of low frequency.

Key words: Gravitational Energy Control, Gravitational Mass, Sonic Waves, Sound Pressure.

The quantization of gravity showed that the *gravitational mass* m_g and the *inertial mass* m_i are correlated by means of the following factor [1]:

$$\chi = \frac{m_g}{m_{i0}} = \left\{1 - 2\left[\sqrt{1 + \left(\frac{\Delta p}{m_{i0}c}\right)^2} - 1\right]\right\} \qquad (1)$$

where m_{i0} is the *rest* inertial mass of the particle and Δp is the variation in the particle's *kinetic momentum*; c is the speed of light.

When an electromagnetic wave strikes an atom, it interacts *electromagnetically* with the atom, *acting simultaneously on all its structure*. Unlike *a sonic wave that strikes the internal particles of the atom isolatedly*, interacting *mechanically* with them. Thus, if a lamina of *monoatomic* material, with thickness equal to ξ contains n atoms/m^3, then the number of atoms per area unit is $n\xi$. Thus, if the *sonic wave* with frequency f incides perpendicularly on an area S of the lamina it reaches $nS\xi$ atoms. Consequently, the wave strikes on $ZnS\xi$ orbital *electrons*[*] (Z is the atomic number of the atoms). Therefore, if it incides on the *total area of the lamina*, S_f, then the *total number of electrons* reached by the radiation is $N = ZnS_f\xi$.

The number of atoms per unit of volume, n, is given by

$$n = \frac{N_0 \rho}{A} \qquad (2)$$

where $N_0 = 6.02 \times 10^{26}\, atoms/kmole$ is the Avogadro's number; ρ is the matter density of the lamina (in kg/m^3) and A is the molar mass($kg/kmole$).

When the *sonic wave* incides on the lamina, it incides N_f *front electrons*, where $N_f \cong (ZnS_f)\phi_e$, ϕ_e is the "diameter" of the electron *inside an atom*[†], which is $\phi_e = 1.4 \times 10^{-13}\, m$ [2]. Thus, the sonic wave incides effectively on an area $S = N_f S_e$, where $S_e = \frac{1}{4}\pi\phi_e^2$ is the cross section area of one atom. After these collisions, it carries out $n_{collisions}$ with the other orbital electrons (See Fig.1).

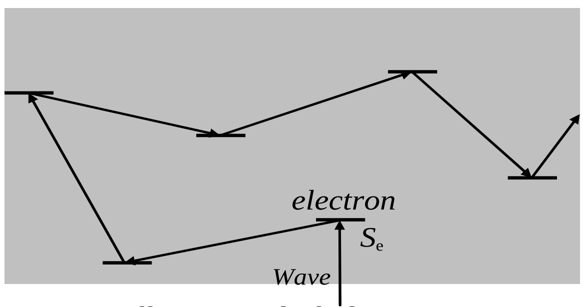

Fig. 1 – *Collisions inside the* lamina.

Thus, the total number of collisions in the volume $S\xi$ is

[*] Assuming that, all of them are reached by the sonic wave.

[†] The diameter of the electron and protons depends on the region where it is placed.

$$N_{collisions} = N_f + n_{collisions} = n_l S\phi_e + (n_l S\xi - n_e S\phi_e) = = n_l S\xi \quad (3)$$

The power density, D, of the sonic radiation on the lamina can be expressed by

$$D = \frac{P}{S} = \frac{P}{N_f S_e} \quad (4)$$

We can express the *total mean number of collisions in each orbital electron*, n_1, by means of the following equation

$$n_1 = \frac{n_{total\ \ phonons} N_{collisions}}{N} \quad (5)$$

Since in each collision a *momentum* h/λ ‡ is transferred to the atom, then the *total momentum* transferred to the lamina will be $\Delta p = (n_1 N) h/\lambda$. Therefore, in accordance with Eq. (1), we can write that

$$\frac{m_{g(l)}}{m_{i0(l)}} = \left\{1 - 2\left[\sqrt{1 + \left[(n_1 N)\frac{h}{m_{i0} c\lambda}\right]^2} - 1\right]\right\} = = \left\{1 - 2\left[\sqrt{1 + \left[n_{total\ phonons} N_{collisions} \frac{h}{m_{i0} c\lambda}\right]^2} - 1\right]\right\} \quad (6)$$

Since Eq. (3) gives $N_{collisions} = n_l S\xi$, we get

$$n_{total\ \ phonons} N_{collisions} = \left(\frac{P}{hf^2}\right)(n_l S\xi) \quad (7)$$

Substitution of Eq. (7) into Eq. (6) yields

$$\frac{m_{g(l)}}{m_{i0(l)}} = \left\{1 - 2\left[\sqrt{1 + \left[\left(\frac{P}{hf^2}\right)(n_l S\xi)\frac{h}{m_{i0} c\lambda}\right]^2} - 1\right]\right\} \quad (8)$$

‡ *Phonon* is a *quantum* of vibrational energy. The phonon energy is given by $\varepsilon = \hbar\omega = hf$, and its velocity is $v = \lambda f$ (λ is the wavelength). Thus, the *momentum* carried out by a phonon is $p = \varepsilon/v = hf/\lambda f = h/\lambda$. Thus, the expression of the *momentum* carried out by the *phonon* is similar to the expression for the *momentum* carried out by the *photon* [3].

Substitution of P given by Eq. (4) into Eq. (8) gives

$$\frac{m_{g(l)}}{m_{i0(l)}} = \left\{1 - 2\left[\sqrt{1 + \left[\left(\frac{N_f S_e D}{f^2}\right)\left(\frac{n_l S\xi}{m_{i0(l)} c}\right)\frac{1}{\lambda}\right]^2} - 1\right]\right\} \quad (9)$$

Substitution of $N_f \cong Z(n_l S_f)\phi_e$ and $S = N_f S_e$ into Eq. (9) results

$$\frac{m_{g(l)}}{m_{i0(l)}} = \left\{1 - 2\left[\sqrt{1 + \left[\left(\frac{Z^2 n_l^3 S_f^2 S_e^2 \phi_e^2 \xi D}{m_{i0(l)} c f^2}\right)\frac{1}{\lambda}\right]^2} - 1\right]\right\} \quad (10)$$

where $m_{i0(l)} = \rho_{(l)} V_{(l)}$.

The speed of the sound, v, as a function of frequency, f, and wavelength, λ, is given by $v = \lambda f$, (*phase* velocity) [4]. When the sonic wave propagates itself through the lamina its velocity is modified and becomes $v_{mod} = v/n_{r(l)} = \lambda f/n_{r(l)}$, where $n_{r(l)}$ is the *sonic refractive index* of the lamina, which can be expressed by the following equation: $n_{r(l)} = v_{air}/v_{la\min a}$. Since $v_{mod} = \lambda_{mod} f$, where λ_{mod} is the modified wavelength, then we can write that

$$\lambda_{mod} = \frac{\lambda}{n_{r(l)}} = \frac{v/f}{n_{r(l)}} \quad (11)$$

Substitution of λ by λ_{mod} into Eq. (10) yields

$$\frac{m_{g(l)}}{m_{i0(l)}} = \left\{1 - 2\left[\sqrt{1 + \left[\left(\frac{Z^2 n_l^3 S_f^2 S_e^2 \phi_e^2 \xi D}{m_{i0(l)} c f^2}\right)\frac{n_{r(l)} f}{v}\right]^2} - 1\right]\right\} \quad (12)$$

Considering that $m_{i0(l)} = \rho_{(l)} S_\alpha \xi$, we obtain

$$\chi = \frac{m_{g(l)}}{m_{i0(l)}} = \left\{1 - 2\left[\sqrt{1 + \frac{Z^2 n_{r(l)}^2 n_l^6 S_f^4 S_e^4 \phi_e^4 D^2}{\rho_{(l)}^2 S_\alpha^2 c^2 f^2 v^2}} - 1\right]\right\} \quad (13)$$

For $S_f = S_\alpha$ we obtain

$$\chi = \frac{m_{g(l)}}{m_{i0(l)}} = \left\{1 - 2\left[\sqrt{1 + \frac{Z^2 n_{r(l)}^2 n_l^6 S_\alpha^2 S_e^4 \phi_e^4 D^2}{\rho_{(l)}^2 c^2 f^2 v^2}} - 1\right]\right\} \quad (14)$$

Since

$$D = \frac{P^2}{2\rho \ v} \quad (15)$$

where P is the pressure of the sonic radiation [5], then substitution of Eq. (15) into Eq. (14) gives

$$\chi = \frac{m_{g(l)}}{m_{i0(l)}} = \left\{1 - 2\left[\sqrt{1 + \frac{Z^2 n_{r(l)}^2 n_l^6 S_\alpha^2 S_e^4 \phi_e^4 P^4}{4\rho_{(l)}^4 c^2 f^2 v^4}} - 1\right]\right\} \quad (16)$$

This equation, deduced for *phonons*, is only valid for *solids*[§], unlike the correspondent equation deduced for *photons*, which is valid for *solid*, *liquid* and *gases*.

The speed of the sound for pressure waves in solid materials is given by

$$v_{solid} = \sqrt{\frac{Y}{\rho}} \quad (17)$$

where Y is the Young's modulus.

Aerogels are solids with high porosity ($<100\,nm$), with ultra low density ($\sim 3\,Kg/m3$ or less) and with ultra low sound speed (~110m/s) [6,7,8]. We can take Eq. (16) for a *hypothetic aerogel* with the following characteristics: Debye speed of sound $v = 110 m.s^{-1}$;
$n_{r(l)} = v_{air}/v = 343/110 = 3.1$; $\rho_{(l)} = 3kg.m^{-3}$;
$n_{l(solid)} = N_0 \rho_{solid}/A_{solid} \cong 1\times 10^{29}\ atoms\ /\ m^3$
(ρ_{solid} is neither the bulk density nor the skeletal density it is the *specific mass* of the part solid) ; $S_e = \pi\phi_e^2/4 = 1.6\times 10^{-26}\, m^2$; $\phi_e = 1.4\times 10^{-13} m$; $Z \cong 10$. By substitution of these values into Eq. (16), we get

$$\chi = \frac{m_{g(l)}}{m_{i0(l)}} = \left\{1 - 2\left[\sqrt{1 + 6\times 10^{-6}\frac{S_\alpha^2 P^4}{f^2}} - 1\right]\right\} \quad (18)$$

Note that for $S_\alpha \cong 1m^2$, $f = 20Hz$ and $P = 120\,N/m^2$, (Loudest human voice at 1 inch reach $110\,N/m^2$; Jet engine at 1 m reach $632\,N/m^2$ [9].), the Eq. (18) tells us that

$$\frac{m_{g(l)}}{m_{i0(l)}} \cong -1 \quad (19)$$

This shows that under these conditions, the weight of the lamina $(m_{g(l)}g)$ will have its direction *inverted*. For $P = 600\,N/m^2$; $S_\alpha \cong 1m^2$ and $f = 20Hz$ the result is

$$\frac{m_{g(l)}}{m_{i0(l)}} \cong -85.2 \quad (20)$$

In this case, the weight of the lamina besides to be inverted, it is intensified 85.2 times.

Thus, by controlling the magnitude of the gravitational mass is then possible to control the *gravitational energy*, *gravity*, etc.

∴

[§] Since a *phonon* is a mechanical excitation that propagates itself through the crystalline network of a *solid*.

References

[1] De Aquino, F. (2010) Mathematical Foundations of *the Relativistic Theory of Quantum Gravity*, Pacific Journal of Science and Technology, **11** (1), pp. 173-232.

[2] De Aquino, F. (2012) *Superconducting State generated by Cooper Pairs bound by Intensified Gravitational Interaction*, Appendix A. Available at: http://vixra.org/abs/1207.0008

[3] Riessland, J. A. (1973). *The Physics of Phonons,* Wiley-Interscience Publication.

[4] Ference Jr, M., et al., (1956) *Analytical Experimental Physics*, The University of Chicago Press. Portuguese version, Ed. Edgard Blucher, S. Paulo, Brazil, p.5.

[5] Ference Jr, M., et al., (1956) *Analytical Experimental Physics*, The University of Chicago Press. Portuguese version, Ed. Edgard Blucher, S. Paulo, Brazil, p.38.

[6] Thapliyal, P. C and Singh, K. (2014) *Aerogels as Promising Thermal Insulating Materials: An Overview*. Journal of Materials, Volume 2014, Article ID 127049.

[7] Gurav, J.L. et al., (2010) *J. Nanomaterials*, 409310.

[8] Jing, X., et al., (2013) *Thermal conductivity of a ZnO nanowire/silica aerogel nanocomposite.* Applied Physics Letters, **102**, 193101.

[9] https://en.wikipedia.org/wiki/Sound_pressure