Gravitational Ejection of Earth's Clouds

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It is shown that, under certain circumstances, the sunlight incident on Earth, or on a planet in similar conditions, can become negative the gravitational mass of water droplet clouds. Then, by means of gravitational repulsion, the clouds are ejected from the atmosphere of the planet, stopping the hydrologic cycle. Thus, the water evaporated from the planet will be progressively ejected to outerspace together with the air contained in the clouds. If the phenomenon to persist during a long time, then the water of rivers, lakes and oceans will disappear totally from the planet, and also its atmosphere will become rarefied.

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1. Introduction

A cloud, in Earth's atmosphere, is made up of liquid water droplets, if it is very cold, they turn into ice crystals [1]. The droplets are so small and light that they can float in the air.

Here we show that, under certain circumstances, the sunlight incident on the planet can become *negative* the gravitational mass of water droplet clouds. According to Newton's gravitation law, the force between the Earth and a particle with *negative gravitational mass* is *repulsive*. Then, by means of gravitational repulsion, the clouds are ejected from the atmosphere of the planet, stopping the hydrologic cycle. Thus, the water evaporated from the planet is progressively ejected to outerspace together with the air contained in the clouds. Consequently, if the phenomenon to persist during a long time, then the water of rivers, lakes and oceans will disappear totally from the planet, and also its atmosphere will become rarefied.

2. Theory

The quantization of gravity shown that the *gravitational mass* m_g and *inertial mass* m_i are correlated by means of the following factor [2]:

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

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 Δp is produced by the absorption of a photon with wavelength λ, it is expressed by $\Delta p = h/\lambda$. In this case, Eq. (1) becomes

$$\frac{m_g}{m_{i0}} = \left\{1 - 2\left[\sqrt{1+\left(\frac{h/m_{i0}c}{\lambda}\right)^2} - 1\right]\right\} = \left\{1 - 2\left[\sqrt{1+\left(\frac{\lambda_0}{\lambda}\right)^2} - 1\right]\right\} \qquad (2)$$

where $\lambda_0 = h/m_{i0}c$ is the *De Broglie wavelength* for the particle with *rest* inertial mass m_{i0}.

From Electrodynamics we know that when an electromagnetic wave with frequency f and velocity c incides on a material with relative permittivity ε_r, relative magnetic permeability μ_r and electrical conductivity σ, its *velocity is reduced* to $v = c/n_r$ where n_r is the index of refraction of the material, given by [3]

$$n_r = \frac{c}{v} = \sqrt{\frac{\varepsilon_r \mu_r}{2}\left(\sqrt{1+(\sigma/\omega\varepsilon)^2} + 1\right)} \qquad (3)$$

If $\sigma >> \omega\varepsilon$, $\omega = 2\pi f$, Eq. (3) reduces to

$$n_r = \sqrt{\frac{\mu_r \sigma}{4\pi\varepsilon_0 f}} \qquad (4)$$

Thus, the wavelength of the incident radiation (See Fig . 1) becomes

$$\lambda_{mod} = \frac{v}{f} = \frac{c/f}{n_r} = \frac{\lambda}{n_r} = \sqrt{\frac{4\pi}{\mu f \sigma}} \qquad (5)$$

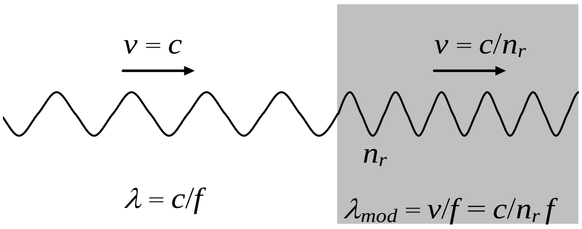

Fig. 1 – *Modified Electromagnetic Wave*. The wavelength of the electromagnetic wave can be strongly reduced, but its frequency remains the same.

If a *water droplet* with thickness equal to ξ contains n molecules/m^3, then the number of molecules per area unit is $n\xi$. Thus, if the electromagnetic radiation with frequency f incides on an area S of the water droplet it reaches $nS\xi$ molecules. If it incides on the total area of the water droplet, S_f, then the total number of molecules reached by the radiation is $N = nS_f\xi$. The number of molecules per unit of volume, n_d, is given by

$$n_d = \frac{N_0\rho}{A} \qquad (7)$$

where $N_0 = 6.02\times10^{26}\,molecules/kmole$ is the Avogadro's number; ρ is the matter density of the water droplet (in kg/m^3) and A is the molar mass. In the case of *water droplet* $\left(\rho = 1000kg/m^3, A = 18kg.kmole^{-1}\right)$ the result is

$$n_d = 3.3\times10^{28}\,molecules/m^3 \qquad (8)$$

The *total number of photons* inciding on the water droplet is $n_{total\ photons} = P/hf^2$, where P is the power of the radiation flux incident on the water droplet.

When an electromagnetic wave incides on a water droplet, it strikes on N_f front water molecules, where $N_f \cong (n_d S_f)\phi_m$, ϕ_m is the "diameter" of the water molecule. Thus, the electromagnetic wave incides effectively on an area $S = N_f S_m$, where $S_m = \frac{1}{4}\pi\phi_m^2$ is the cross section area of one water molecule. After these collisions, it carries out $n_{collisions}$ with the other molecules (See Fig.3).

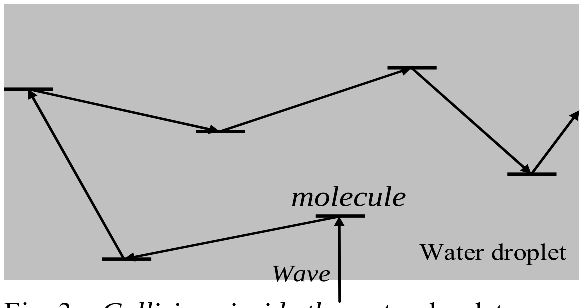

Fig. 3 – *Collisions inside the* water droplet.

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

$$N_{collisions} = N_f + n_{collisions} = n_d S\phi_m + \left(n_d S\xi - n_d S\phi_m\right) =$$
$$= n_d S\xi \qquad (9)$$

The power density, D, of the radiation on the water droplet can be expressed by

$$D = \frac{P}{S} = \frac{P}{N_f S_m} \qquad (10)$$

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

$$n_1 = \frac{n_{total\ photons} N_{collisions}}{N} \qquad (11)$$

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

$$\frac{m_{g(d)}}{m_{i0(d)}} = \left\{1 - 2\left[\sqrt{1 + \left[(n_1 N)\frac{\lambda_0}{\lambda}\right]^2} - 1\right]\right\} =$$
$$= \left\{1 - 2\left[\sqrt{1 + \left[n_{total\ photons} N_{collisions}\frac{\lambda_0}{\lambda}\right]^2} - 1\right]\right\} \qquad (12)$$

Since Eq. (9) gives $N_{collisions} = n_d S\xi$, we get

$$n_{total\ photons} N_{collisions} = \left(\frac{P}{hf^2}\right)\left(n_d S\xi\right) \qquad (13)$$

Substitution of Eq. (13) into Eq. (12) yields

$$\frac{m_{g(d)}}{m_{i0(d)}}=\left\{1-2\left[\sqrt{1+\left[\left(\frac{P}{hf^2}\right)(n_d S\xi)\frac{\lambda_0}{\lambda}\right]^2}-1\right]\right\} \quad (14)$$

Substitution of P given by Eq. (10) into Eq. (14) gives

$$\frac{m_{g(d)}}{m_{i0(d)}}=\left\{1-2\left[\sqrt{1+\left[\left(\frac{N_f S_m D}{f^2}\right)\left(\frac{n_d S\xi}{m_{i0(d)}c}\right)\frac{1}{\lambda}\right]^2}-1\right]\right\} \quad (15)$$

Substitution of $N_f \cong (n_d S_f)\phi_m$ and $S = N_f S_m$ into Eq. (15) results

$$\frac{m_{g(d)}}{m_{i0(d)}}=\left\{1-2\left[\sqrt{1+\left[\left(\frac{n_d^3 S_f^2 S_m^2 \phi_m^2 \xi D}{m_{i0(d)}cf^2}\right)\frac{1}{\lambda}\right]^2}-1\right]\right\} \quad (16)$$

where $m_{i0(d)} = \rho_d V_d = \rho_d S_d \xi$. Thus, Eq. (16) reduces to

$$\frac{m_{g(d)}}{m_{i0(di)}}=\left\{1-2\left[\sqrt{1+\left[\left(\frac{n_d^3 S_f^2 S_m^2 \phi_m^2 D}{\rho_d S_d cf^2}\right)\frac{1}{\lambda}\right]^2}-1\right]\right\} \quad (17)$$

Making $\lambda = \lambda_{\text{mod}}$, where λ_{mod} is given by Eq. (5), we get

$$\chi_d = \frac{m_{g(d)}}{m_{i0(d)}}=\left\{1-2\left[\sqrt{1+\frac{n_d^6 S_f^4 S_m^4 \phi_m^4 (\mu_d \sigma_d) D^2}{4\pi\rho_d^2 S_d^2 c^2 f^3}}-1\right]\right\} \quad (18)$$

The area S_f is the *total surface area* of the *water droplets*, which can be obtained by multiplying the *specific surface area* (SSA) *of the water droplet* (which is given by $SSA = A_d/\rho_d V_d = 3/\rho_d r_d = 300 m^2/kg$) *by the total mass* of the water droplets ($m_{i0(Td)} = \rho_d V_d N_d$); $N_d \cong 1\times10^8\, droplets/m^3$ [4]. Assuming that the *water droplet cloud is composed* of monodisperse particles with $10\mu m$ radius $\left(r_d = 1\times10^{-5} m; V_p = \frac{4}{3}\pi r_p^3 = 4.1\times10^{-15} m^3\right)$, we get

$$S_f = (SSA)\rho_d V_d = 4\pi r_d^2 N_d \cong 0.13 m^2 \quad (18)$$

The area S_d is the surface area of one water droplet, which is given by

$$S_d = 4\pi r_d^2 = 1.2\times10^{-9} m^2 \quad (20)$$

The "diameter" of a water molecule is $\phi_m \cong 2\times10^{-10} m$. Thus, we get $S_m = \frac{1}{4}\pi\phi_m^2 \cong 3\times10^{-20} m$.

An important electrical characteristic of clouds is that the electrical conductivity of *the air inside them* must be less than in the free atmosphere, *due to the capture of ions by the water droplets*. This means that, the ions concentration in the water droplets is much greater than in the fresh water. In this way, *the electrical conductivity of the water in the droplets, is also is much greater than conductivity of the fresh water*, which is approximately $0.01 S.m^{-1}$. The sea water also has an ions concentration much greater than that of the fresh water. The conductivity of sea water is approximately $5 S.m^{-1}$. Obviously the ions concentration in the water droplets of the clouds is less than the ions concentration in the sea water. Based on these facts, we can conclude that the electrical conductivity of the water in the droplets should be close of $1 S.m^{-1}$. Thus, in first approximation, we can assume that $\sigma_d \cong 1 S.m^{-1}$. By substitution of the obtained values into Eq. (18), we get

$$\chi_d = \left\{1-2\left[\sqrt{1+4\times10^{38}\frac{D^2}{f^3}}-1\right]\right\} \quad (19)$$

Since $m_{g(d)} = \chi_d m_{i(d)}$, we can conclude, according to Eq. (19), that the gravitational mass of the droplet becomes *negative* when $4\times10^{38} D^2/f^3 > 1.25$, i.e., when

$$D > 5\times10^{-20} f^{\frac{3}{2}} \quad (20)$$

In the case of Earth, the actual *average* valor of D due to the sunlight, is $D_0 = 495 W.m^{-2}$ [5]*.

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* The solar constant is equal to approximately 1,368 W/m² at a distance of one astronomical unit (AU) from the Sun (that is, on or near Earth) [6]. Sunlight on the surface of Earth is attenuated by the Earth's atmosphere so that the power that arrives at the surface is closer to 1,000 W/m² in clear conditions when the Sun is near the zenith [7]. However, the *average* value is $D_0 = 495\ W.m^{-2}$ [5].

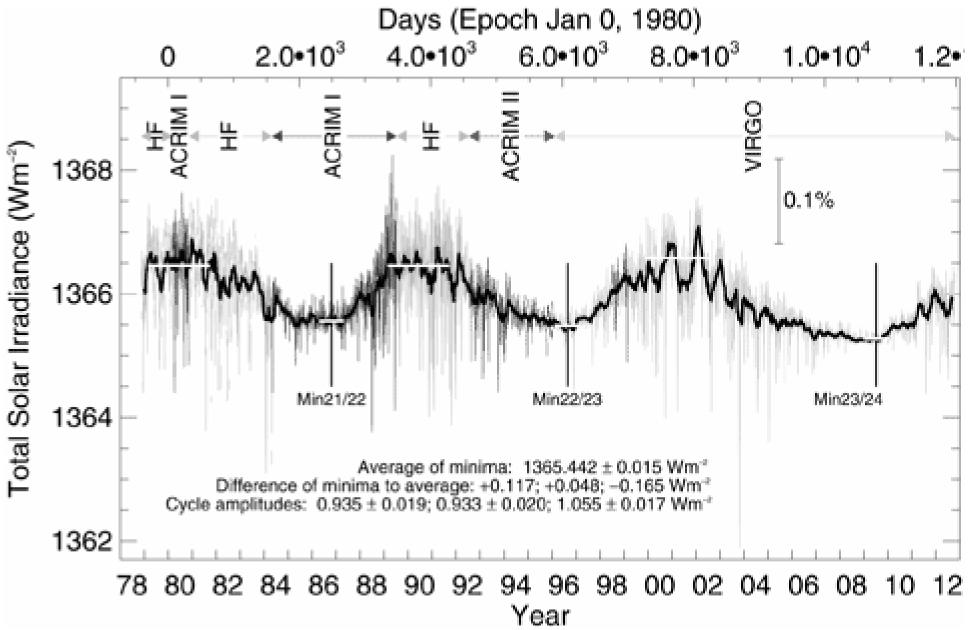

Fig.1 – *Total Solar Irradiance.* Image credit: Claus Fröhlich. The description of the procedures used to construct the composite from the original data shown in Figure 1 (upper panel) can be found in Fröhlich and Lean [8]; Fröhlich [9].

Based on *Stefan-Boltzmann law*, we can write that $D_0 = \sigma T_0^4$ and $D = \sigma T^4$; $\sigma = 5.67\times10^{-8} W.m^{-2}K^{-4}$ is the Stefan-Boltzmann constant .Thus, it follows that

$$\frac{D}{D_0} = \left(\frac{T}{T_0}\right)^4 \qquad (21)$$

Substitution of Eq. (21) into Eq. (20) yields

$$\frac{T}{T_0} > 3\times10^{-6} f^{\frac{3}{8}} \qquad (22)$$

The *Wien's displacement law* is given by $\lambda_{\max}T = b$ where $\lambda_{\max}$ is the peak wavelength, T is the absolute temperature, and b is the *Wien's displacement constant*, equal to 2.8977685(51) $\times10^{-3}$ m·K. Based on this equation, we can write that $\lambda_{\max}/\lambda_{\max(0)} = T_0/T$ or as function of frequency:

$$\frac{f_{\max(0)}}{f_{\max}} = \frac{T_0}{T} \qquad (23)$$

Making $f = f_{\max}$ in Eq. (22) and comparing with Eq. (23), we get

$$\frac{T}{T_0} > 1.5\times10^{-9} f_{\max(0)}^{\frac{3}{5}} \qquad (24)$$

Since $f_{\max(0)} = 5.5\times10^{14} Hz$ (current value for sunlight) then Eq. (24) shows that, when

$$T > 1.05 T_0 \qquad (25)$$

(T_0 is the current value of T) *the gravitational masses of the water droplets become negative*.

It is known that, the solar "constant" can fluctuate by ~0.1% over days and weeks as sunspots grow and dissipate. The solar "constant" also drifts by 0.2% to 0.6% over many centuries. Note that the *Gravitational Ejection of Earth's Clouds starts when the Sun's temperature is increased by 5% in average* † ‡ . Under these circumstances, according to Newton's gravitation law, the force between the Earth and the water

† According to the *Wien's displacement law*, an increasing of 5% in the Sun temperature produces a decreasing of 5% in the peak wavelength ($\lambda_{\max}$). This means that the peak of the solar spectrum is shifted to blue light. In this way, the sunlight becomes colder.

‡ After some millions of years, the stars' internal structures begin to have essential changes, such as variations (increases or decreases) in size, temperature and luminosity. When this occurs, the star leaves the *main sequence*, and begins a displacement through the HR *diagram*. Significant increases in temperature can then occur during this period.

droplets (*negative gravitational mass*) becomes *repulsive*. Then, by means of gravitational repulsion, the clouds will be ejected from the atmosphere of the planet, stopping the hydrologic cycle. Thus, the water evaporated from the planet will be progressively ejected to outerspace together with the air contained in the clouds.

Note that the effect will be negligible if the phenomenon to persist for only some days. However, if the phenomenon to persist for some years, then most of animals will be dead. If it persists for several centuries, then the water of rivers, lakes and oceans will disappear totally from the planet, and its atmosphere will become rarefied.

This phenomenon can have occurred in Mars a long time ago, and explains the cause of the rivers, lakes and oceans dry found in Mars [10, 11]. Note that this phenomenon can also occur at any moment on Earth. In this case, there is no salvation to mankind, except if it will be transferred to another planet with an ecosystem similar to the current Earth's ecosystem. Only *Gravitational Spacecrafts* [12] are able to carry out this transport.

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