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About Origin and Evolution of Gravity and Time

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ABSTRACT

We present a theory showing the electromagnetic origin of the ("conventional") Gravity based on some models that demonstrate the close relationship between electromagnetic radiation, matter and Gravity. We also show how Gravity has evolved over Time and the different stages that it has gone through to reach its current state. We also analyze the consequences for the Relativity Theory and the gravitational constant, as well as the future of Gravity and consequently of the Universe.

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Introduction

Detailed studies show that Gravity can be considered an energy for all purposes expressing the close bidirectional relationship among kinetic energy and Gravity. What's more: ***Gravity is a potential energy which must be produced by other energy. Such energy only can be electromagnetic energy. We could use the metaphor of the bow and the archer.*** The bow would be matter, the bowstring would be gravity, and the archer would be electromagnetic energy acting on matter [1].

Light would be the best proof of this Theory: ***Light counteracts the Gravity effect*** (gravitational potential energy) ***due to its own energy in shape of electromagnetic radiation*** (which also can be considered ultimately kinetic energy). The light loses energy as it travels through intense gravitational fields, but it does not loose speed. As light loses energy along its way due to the gravitational fields, its tendency towards the red spectrum increases (redshift) [1].

From this support, our goal is building a consistent Theory about how Gravity may have been shaped by electromagnetic radiation and then deeping into its relevant consequences.

QED (Quantum Electro Dynamics) was considered the "jewel of physics" by Feyman. Not only because it had been proven enough, but also because it is consistent with both quantum mechanics and the theory of relativity. This fact also allow us to study the relationship among electromagnetic energy and matter under both sides: QED and Relativity. Or, in other words, any study carried out based on either of them is directly compatible with the other.

Therefore we're going to study it under the Relativistic side because the results are more intuitive and easy to quantify for the goal that we're looking for.

To understand the close relationship between electromagnetic energy, matter and Gravity, or expressed in another way between the archer, the bow and the bowstring, we could create a model based on a new Einstein metric tensor for a body subjected to an electromagnetic energy source which absorbs part of the electromagnetic energy and emits another part of the energy received as kinetic energy. Then we could easily deduce the times difference ΔT_s induced by the kinetic energy emitted and, as consequence, the energy amount needed for getting a Δg gravity effect. On the other hand, we could deduce from QED how such amount of kinetic energy can be reached at Quantum level in function of the time and the intensity of the electromagnetic radiation. Because of the full compatibility among QED and Relativity, we would reach to the same exact numeric conclussions [2].

We're going to do an approach to such model. Although Gravity has evolved over Time (and not always in a "continuous" way but in different stages), Einstein field equations could be valid for any Universe space-time point doing some changes over the curvature tensor and stress-energy tensor, because they really define the relationships among matter, energy, momentum [3]. Just as example, the stress-energy tensor for Earth in Schwarzschild metric is directly related with mass (and density) of Earth because it explains the Gravity in such current state (the one that we know), but what would have happen in an initial stage, I mean, in a stage where Gravity=0?... Matter contribution to the tensor would not have sense in such initial early stage, because Gravity did not still exist, but there could be other energy contributions instead. My view is such energy would be electromagnetic energy.

We're going to do some suppositions for understanding the huge importance of the electromagnetic energy not only in the early stages of Gravity creation but in any stage (e.g. fusion processes in stars). The reader must have into account that we're talking about an abstraction whose purpose is putting into value the relevance of the interaction among matter and electromagnetic energy over Time.

One of the keys to understand ***how electromagnetic energy*** (kinetic energy in its latest expression) ***has been able to warp space-time*** of matter (I prefer talking about ***Time warping***, that is, ***Time dilation***) is understanding the environment where such processes have happen. We'll talk about it forward but some examples are needed before to know better what we're talking about.

First Model

We're going to take a first step forward to be close to the reality.

What we try with this study is getting to be as close as possible to the reality of matter (Hydrogen) interacting with the electromagnetic radiation coming from the core of the Sun as result of the fusion processes.

We're going to be based on ***Sun's Eddington model***, a very relevant contribution of another of the great physicists of the beginnings of the last century. This model, with very little changes, has lasted until today [4].

The main source of Radiation is gamma rays in the zone of the radiative layer closer to the core but it decreases through the radiative layer till the convective layer is reached. Matter in the radiative zone is so dense (plasma) that photons can travel only a short distance before they are absorbed or scattered/re-emitted in random directions by another particle, gradually shifting to longer wavelength as they do so. In fact it takes around an average of 171,000 years (latest studies show that it could be even of some million of years) for gamma rays travel from the core of the Sun to leave the radiative zone.

The more close to the core, the more percentage of energy is mainly manifested as heating. There's almost no place for kinetic energy.

The more close to the convention layer, the more percentage of re-emission which implies a higher percentage of energy is manifested as kinetic energy (*).

(*) It's an abstraction for this model because it's not easy at all for radiation reaching to the convection layer just as we'll analyze forward.

Therefore the zone where the matter is more sensitive to receive "conventional" radiation (specially in shape of photoelectric effect or photoionization because of the high plasma temperature) is located among the latest zone of radiative layer close to convective layer. In any case, such radiative external layer is dense enough for not allowing the kinetic energy (consequence of the radiation) neither to leave the radiative zone (1).

Therefore we could extrapolate this phenomenon to the simplied following model:

We're going to imagine that we have a set of very small spheres (1 cm. of diameter) composed by Hydrogen with a density equal to the medium density of Sun and whose total weight is that of the Earth. Such spheres are located to 300.000 Km. of the center of the Sun, in the middle zone of the radiative layer. We're going to suppose a density equivalent to the medium density of Sun, but the density in the radiative layer can decrease up from 20 to 0.2 g/cm^3 (density of convective layer) at the same time that temperature gradient decreases.

Our spheres, in a limit model, would be atoms.

We're not going to take into account for our study the effect of the Sun's gravity (vacuum) because we're only interested in knowing the results of the radiation effect.

We're going to imagine in this scenario that Hydrogen reflects 70% of the radiation as electromagnetic energy in shape of kinetic energy (*). And we'll do a simplification: such kinetic energy is "stored or converted to mass" over a very thin layer of 1 mm. over any sphere, according to (1), because the generated kinetic energy is "trapped" into the layer.

(*) 70% is obviously an scenario as ideal as unreal, but we're going to use it like starting point. The reality is the great density of the layer and high temperatures does not allow it. Therefore on one hand there's much less radiation reaching the spheres and on the other hand the percentage of the radiation emitted as kinetic energy is a lot lesser. We'll talk about it forward.

We'll apply a (relatively) very short time of exposition (only 100 years):

Parameters

Spheres: Diameter 1 cm (r = 0.005m), hydrogen with Sun's density, $\rho\odot \approx 1.408\times10^3$ kg/m^3.

Total Mass: $M\oplus = 5.972\times10^{24}$ kg (initial mass without radiation).

Location: $R = 3\times10^8$ m from the Sun, in a vacuum (no Sun's gravity).

Radiation: 70% of received solar radiation is stored as kinetic energy in a 1 mm thin shell (Δr = 0.001m) per sphere, as "equivalent mass," over T = 100 years $\approx 3.156\times10^9$s.

Shell Per Sphere: Each sphere has its own 1 mm thin shell.

Calculus of Number of Spheres

Volume of One Sphere:

$$V = \frac{4}{3}\pi r^3 = \frac{4}{3}\pi(0.005)^3 \approx 5.236\times10^{-7}\text{m}^3$$

Mass of One Sphere (Without Radiation):

$$m = \rho_{\odot}V \approx 1.408\times10^3\times5.236\times10^{-7} \approx 7.372\times10^{-4}\text{kg.}$$

Number of Spheres: $N = \frac{M_{\oplus}}{m} = \frac{5.972\times10^{24}}{7.372\times10^{-4}} \approx 8.102\times10^{27}$

Energy Accumulation Per Sphere

Sun's luminosity: $L\odot = 3.828\times10^{26}$ W. Intensity at $R = 3\times10^8$m:

$$I = \frac{L_{\odot}}{4\pi R^2} = \frac{3.828\times10^{26}}{4\pi(3\times10^8)^2} \approx 3.375\times10^8\text{W/m}^2$$

Cross-Sectional Area: $A = \pi r^2 = \pi(0.005)^2 \approx 7.854\times10^{-5}\text{m}^2$

Power received: $P = IA \approx 3.375\times10^8\times7.854\times10^{-5} \approx 2.65\times10^4$W.

70% as kinetic energy: Pkinetic = 0.7×2.65×10⁴ ≈ 1.855×10⁴W.

Energy over T=3.156×109s: E =Pkinetic T ≈ 1.855×10⁴×3.156×10⁹ ≈ 5.854×10¹³ J

Equivalent mass of the shell: $m_{\text{shell}} = \frac{E}{c^2} = \frac{5.854\times10^{13}}{(3\times10^8)^2} \approx 6.504\times10^{-4}\text{kg}$

Total mass per sphere: $m$total=m+m_{shell}≈7.372×10⁻⁴+6.504×10⁻⁴≈1.388×10⁻³kg

Total system mass with radiation: Mtotal=Nm_{total}≈8.102×10²⁷×1.388×10⁻³≈1.124×10²⁵kg

Added mass from radiation: $M_{\text{radiation}}$=Nm_{shell}≈8.10²×10²⁷×6.504×10⁻⁴≈5.269×10²⁴kg

Initial mass (without radiation): Minitial=$M_{\oplus}$≈5.972×10²⁴kg.

Schwarzschild Radius

With Radiation: $r_s = \frac{2GM_{\text{total}}}{c^2}, \quad G = 6.674\times10^{-11}\text{m}^3\text{kg}^{-1}\text{s}^{-2}$

$$r_s \approx \frac{2\times6.674\times10^{-11}\times1.124\times10^{25}}{9\times10^{16}} \approx 1.671\times10^{-2}\text{m} \approx 16.71\text{mm}.$$

Without Radiation:

$$r_{s0} = \frac{2GM_{\oplus}}{c^2} \approx \frac{2\times6.674\times10^{-11}\times5.972\times10^{24}}{9\times10^{16}} \approx 8.865\times10^{-3}\text{m} \approx 8.865\text{mm}.$$

Comparison: The radiation increases the Schwarzschild radius by: $\Delta rs = rs - rs0 \approx 16.71 - 8.865 \approx 7.845$mm. (direct consequence of the relation $M_{\text{total}} / M_{\text{radiation}}$)

That is, the effect of the radiation over the space-time is almost the same than the produced by the mass.

Stress-Energy Tensor

Average Density: $\rho = \frac{M_{\text{total}}}{V_{\text{shell}}} \approx \frac{1.124\times10^{25}}{1.131\times10^{18}} \approx 9.946\times10^6\text{kg/m}^3$

Single Sphere:
Core: $\rho_{\text{core}} = \rho_{\odot} \approx 1.408\times10^3\text{kg/m}^3$

Shell: $V_{\text{shell, single}} \approx 4\pi(0.005)^2 \times 0.001 \approx 3.142\times10^{-7}\ \text{m}^3$

$$\rho_{\text{shell, single}} \approx \frac{6.504\times10^{-4}}{3.142\times10^{-7}} \approx 2.070\times10^3\text{kg/m}^3$$

Averaged Tensor: $T^{00} \approx \rho c^2 \approx 9.946\times10^6\times9\times10^{16} \approx 8.951\times10^{23}\text{J/m}^3$

$T^0i = T^{ij} = 0$

In another way, using integrals: $T^{\mu\nu}(x) = \sum_i m_{\text{total},i} u^\mu u^\nu \delta^3(x - x_i)$,

yielding the averaged ρ.

Riemann Curvature Tensor
Outside the shell, the metric is Schwarzschild with Mtotal:

$$R_{\hat{t}\hat{r}\hat{t}\hat{r}} = -\frac{2GM_{\text{total}}}{c^2r^3}$$

$$R_{\hat{t}\hat{r}\hat{t}\hat{r}} \approx -\frac{2\times6.674\times10^{-11}\times1.124\times10^{25}}{9\times10^{16}\times(3\times10^8)^3} \approx -6.189\times10^{-11}\text{m}^{-2}$$

Inside, $R_{\rho\sigma\mu\nu}$≈0. Integrated mass:

$$M(r) \approx \int_R^{R+\Delta R} \rho 4\pi r'^2 dr' \approx 9.946\times10^6\times4\pi R^2\Delta R$$

In summary, Stress-energy tensor: T^{00}≈8.951×1023J/m³, T^0i=T^{ij}=0.

Riemann curvature tensor (at r=R): Rtttt≈−6.189×10⁻¹¹m⁻²

Now a **Summary of the Schwarzschild Radius changing the Time parameter:**
(we're not going to detail calculations because they're the same changing Time)

Time (years)	Schwarzschild Radius (mm)	% respect only mass
100	16.71	188.5
50	12.77	144.0
25	10.81	122.0
20	10.42	117.7
15	10.03	113.2
10	9.64	108.8
7	9.41	106.2
5	9.26	104.4

Conclussions
This simplified model ***shows that Electromagnetic radiation shapes Gravity for warping the space-time*** (perhaps we should talk about simply ***Time warping or Time dilation***) around the atoms (atomic level). But quantum warping would barely be affected.

Because of the full compatibility among Relativity and Relativistic QED (Dirac equation), we could reach to the same conclussion by both ways [5].

Although this model must be considered as an starting point, it must be clearly redefined because there're some important parameters to take into account (although difficult to quantify):

- We're supposing that every small sphere is fully affected by the radiation, just as the radiation was falling upon directly on them. This is not true because the radiation must pass through a very wide and dense layer. Or, simplifying under our model view, there will be many spheres ahead before reaching every sphere. As consequence, the radiation should be drastically reduced from 70% to a much smaller number for most of spheres.
- Because of most of the interaction among radiation and matter capable of producing kinetic energy is supposed to be located in the outer zone of the radiative layer, the medium density in such zone could decrease till a 10% of the estimated one. Therefore it would also increase significantly the according time.
- The convective layer "moves" the matter inwards (to the core and fusion processes) and outwards (fused matter) towards the photosphere. Therefore the time that matter is exposed to radiation will be reduced.
- There's still a pending subject for demonstrating the full validity of this Theory. My view is not only that electromagnetic energy warps the space-time around matter creating Gravity how it has been demonstrated. My view is such time dilation (bowstring) created by an archer

(electromagnetic energy) endures over time when the archer tenses the bowstring for a long time. In other words, ***the more the time that electromagnetic energy interacts with the matter (depending also obviously of the intensity), the more the bowstring (gravity, or in other words, time dilation) becomes undeformable***. That is, the "elasticity" of the Time is inversely proportional to the own Time (4)

- We'll talk forward (in the Discussion section) about this expected property of the Time.
- Since matter and gravity are so closely linked (or rather, we should say matter and time), the density and amount of matter are directly proportional to the time warping (consequence of a simple add of times), which is totally in accordance with the theory of relativity.
- Time almost doesn't exist in Quantum, because there must be barely any warping of space-time at quantum level (excepting quantum entanglement which would be consequence of another kind of Gravity). Quantum would be the expression of the balance state closest to the Big-Bang [6].
- Therefore Time would have been shaped by Gravity, that is, as consequence of the relationship among Gravity, matter and electromagnetic energy. The more the matter and density, the more space-time warping, or, in other words, the more Time Dilation. As consequence, Time will run very differently in different areas of the Universe (depending also of the gravity evolution, that is, of its according age), with black holes being the physical-mathematical expression of time running slower, that is, of the greatest time dilation.
- **Collateral Effect:** The increased Gravity of the Sun (or obviously any star) created by the kinetic energy consequence of the electromagnetic radiation should be also taken into account to understand all the forces involved in stars hydrostatic equilibrium.

In summary, we should redefine this model basing on Eddington's Sun model and QED (subjected to the conditions of the radiative layer) to reach a better quantification of the time warping produced by electromagnetic energy over matter.

Second Model

This simplied model is based on the previous one but resorting to QED in order to improve it. That is, we're looking for a better approximation to the actual percentage of kinetic energy trapped and the thickness of the according shell (in this scenario we're not taking into account the time, because we only need to know if kinetic energy is really "trapped" and how it's initially distributed through the layer).

For this goal, we'll dispense with the spheres and we'll work with the following params:

- Distance close to the convection zone (430.000 Km. from Sun's center).
- A layer of 10 Km. of thickness instead spheres.
- Density of the layer: 0,4 g/cm^3

Summary of Params

Location: The layer is located at 430,000 km = 4.3 × 10^8 m from the Sun's center, in the radiative zone, with a density of 0.4 g/cm^3 and an estimated Temperature of 5772K.

Layer Properties: The thickness layer is Δz= 10 km = 10^4 m, composed of atomic hydrogen with a density of 0.4 g/cm^3 = 0.4 × 10^3 kg/m^3 = 400 kg/m^3. For atomic hydrogen (mass per atom ~1.67 × 10^{-27} kg), the number density is:

$$n_H = \frac{\rho}{m_H} = \frac{400}{1.67 \times 10^{-27}} \approx 2.4 \times 10^{29}\text{m}^{-3}$$

And the column density:

$NH=nH\cdot\Delta z=2.4\times10^{29}\times10^{4}=2.4\times10^{33}$ atoms/m^2

Photoelectric Effect: Modeled as photoionization, where photons with $h\nu \geq 13.6$eV ionize hydrogen, imparting kinetic energy to ejected electrons.

Stefan-Boltzmann Law: Used to calculate the solar energy flux.

QED Interaction: The photoelectric effect ionizes hydrogen atoms, ejecting electrons with kinetic energy $E_{kin}=E-I$, where I (ionization energy)=13.6eV.

The **energy flux** at $r = 4.3\times10^8$m is calculated using the Stefan-Boltzmann law, which gives the power radiated per unit area of a blackbody [7]: $j* = \sigma T^4$

Where:

σ=5.6704×10^{-8}W/m2K4 is the Stefan-Boltzmann constant and T is the temperature of the Sun at 430.000 Km., approximately $T\odot$ = 5772K (effective temperature).

Then the power emitted per unit area at such distance is: $j* = 5.6704\times10^{-8}\times(5772)^4$

$(5772)^4 \approx 1.110\times10^{15}$K^4 , then $j* \approx 5.6704\times10^{-8}\times1.110\times10^{15} \approx 6.294\times10^7$W/m^2

The total luminosity of the Sun is: $L_\odot = j*\cdot4\pi R_\odot$, $R_\odot$ =6.96×10^8 m, $4\pi(6.96\times10^8)^2 \approx 6.088\times10^{18}$m^2

$L_\odot \approx 6.294\times10^7\times6.088\times10^{18} \approx 3.832\times10^{26}$W

$$F = \frac{L_\odot}{4\pi r^2}$$

For r=4.3×10^8m: $4\pi(4.3\times10^8)^2 \approx 2.32\times10^{17}\text{m}^2$

$$F = \frac{3.832\times10^{26}}{2.32\times10^{17}} \approx 1.652\times10^9\text{W/m}^2$$

Photoelectric Effect (QED)

Photoionization Cross-Section

Using the QED-based photoionization cross-section for hydrogen, as before, for a photon energy E=100eV (representative of UV/soft X-rays):

$$\sigma(E) \approx \sigma_0\left(\frac{E_0}{E}\right)^{3.5}, \quad E_0 = 13.6\text{eV}, \quad \sigma_0 \approx 6.3\times10^{-22}\text{m}^2$$

$$\sigma(100\text{eV}) \approx 6.3\times10^{-22}\times\left(\frac{13.6}{100}\right)^{3.5} \approx 4.0\times10^{-26}\text{m}^2$$

Kinetic Energy Per Ionization: Ek=100eV−Ie(13.6eV)=86.4eV, where Ie=Ionization energy for Hydrogen.

Optical Depth and Absorption

The optical depth for 100 eV photons: $\tau = nH\cdot\sigma\cdot\Delta z = 2.4\times10^{29}\times4.0\times10^{-26}\times10^4 \approx 9.6\times10^7$

The absorption length:

$$l = \frac{1}{n_H \sigma} \approx \frac{1}{2.4 \times 10^{29} \times 4.0 \times 10^{-26}} \approx 1.04 \times 10^{-4}\text{m} = 0.104\text{mm}$$

Therefore the layer is optically thick, so ionizing photons are absorbed near the surface.

Kinetic Energy Calculation
Assume ~10% of the flux is in ionizing photons (Fion ≈ 0.1×1.652×10⁹ = 1.652×10⁸W/m²), with an average photon energy of 100 eV, as in the previous calculation.

Photon Flux
Ephoton = 100×1.6×10⁻¹⁹ = 1.6×10−¹⁷J

$$\Phi = \frac{1.652 \times 10^8}{1.6 \times 10^{-17}} \approx 1.033 \times 10^{25}\text{photons/m}^2\text{s}$$

Kinetic Energy Fraction

$$f_k = \frac{86.4}{100} = 0.864$$

$$F_{\text{kinetic}} = 0.864 \times 1.652 \times 10^8 \approx 1.427 \times 10^8 \text{W/m}^2$$

Percentage

$$\text{Percentage} = \frac{1.427 \times 10^8}{1.652 \times 10^9} \times 100 \approx 8.64\%$$

Energy Distribution
Due to the high optical depth, the kinetic energy is deposited within the first ~0.1 mm of the layer's surface, following: $I(z) = I0e^{-nH\sigma z}$

Therefore beyond $z \approx 0.1$mm, the intensity is negligible ($\tau \approx 960$).

Summary
The kinetic energy from the photoelectric effect (photoionization) in the 10 km hydrogen layer is approximately **8.64%** of the incident solar energy flux (calculated using the Stefan-Boltzmann law to determine the flux).

This energy is distributed almost entirely within the first 0.1 mm of the layer's surface facing the Sun, due to the high optical depth.

Conclussion
The ***percentage of incident energy converted to kinetic energy*** via the photoelectric effect is approximately **8.64%**, calculated for the ***effective penetration depth (0.1 mm)***. The kinetic energy is ***deposited in a thin surface layer (0.1 mm thick)*** due to the high optical depth ($\tau \approx 9.6 \times 107$).

As we can observe, ***we've reached via QED to the same conclussion: kinetic energy is "trapped"***, "stored" or deposited ***in a thin shell*** (surface layer).

If we change density values (for simulating different zones of the radiative layer), the thickness of the shell is inversely proportional to the density but the percentage of conversion not change.

We're going to go even one step further, merging the models 1 and 2 extending it to a complete relativistic + QED model (2)

Third Model
We're looking for a model as refinated as possible.

In order to satisfy this goal, we're not only to merge models 1 and 2 but we're going to change some params to make them as close as possible to the commonly accepted structure of the Sun.

In this way, we're going to extend our layer to the actual thickness estimated for the radiative layer (300.000 Km.). The radiative layer begins at 150.000 Km. of the center of the Sun, that is, where the Sun's core ends. The radiative layer ends where convective layer begins. Density decreases from 20 g/cm3 (close to core) to 0,2 g/cm3 (convective layer).

We're going to apply a time period of 500.000 years. Although it's not clear the time needed for radiation to cross the radiative layer (it's estimated from 170.000 years to some hundred thousands of years), such time will give us a good aproximation to our goal.

Photoelectric Effect and Kinetic Energy (QED-Based)
The photoelectric effect generates kinetic energy when solar UV photons ionize hydrogen atoms. We'll use the Stefan-Boltzmann law to compute the radiation flux.

Step 1: Solar Radiation Flux via Stefan-Boltzmann
The Stefan-Boltzmann law gives the energy flux at the Sun's surface ($R\odot$ = 6.96×1010cm, $T \approx 5800$ K) [7]:

$$F_\odot = \sigma T^4 = 5.6704 \times 10^{-5} \times (5800)^4 \approx 6.414 \times 10^{10}\text{erg cm}^{-2}\text{s}^{-1}$$

At $r = 1.5 \times 10^{10}$cm:

$$F = F_\odot \left(\frac{R_\odot}{r}\right)^2 = 6.414 \times 10^{10} \times \left(\frac{6.96 \times 10^{10}}{1.5 \times 10^{10}}\right)^2 \approx 1.381 \times 10^{12}\text{erg cm}^{-2}$$

UV flux (~0.1%, for $E\gamma > 13.6$eV): FUV ≈ 0.001×1.381×10¹² ≈ 1.381×10⁹erg cm⁻²s⁻¹

Photon number flux ($E\gamma$ = 50eV):

$$N_\gamma = \frac{F_{\text{UV}}}{E_\gamma} = \frac{1.381 \times 10^9}{50 \times 1.6 \times 10^{-12}} \approx 1.726 \times 10^{19}\text{photons cm}^{-2}\text{s}^{-1}$$

Photoelectric Cross-Section (QED)
Photoelectric cross-section at $E\gamma$=50eV:

$$\sigma_{\text{pe}} \approx 5.475 \times 10^{-21} \left(\frac{13.6}{50}\right)^{7/2} \approx 3.8 \times 10^{-23}\text{cm}^2$$

Kinetic Energy per Interaction
Kinetic energy per electron: Ekin=$E\gamma - IH$=50−13.6=36.4eV

Fraction of photon energy as kinetic energy:

$$\text{Fraction} = \frac{36.4}{50} \approx 72.8\%$$

Density Profile and Number Density
We suppose that Density decreases linearly from 20g/cm³ to 0,2 g/cm³:

$$\rho(x) = 20 - 19.8 \cdot \frac{x}{3 \times 10^{10}}\text{g/cm}^3$$

Number density: $n_H(x) = \frac{\rho(x)}{m_H} \approx 1.198 \times 10^{25}\left(1 - 0.99 \cdot \frac{x}{3 \times 10^{10}}\right)\text{cm}^{-3}$

Kinetic Energy Distribution
Optical depth: $\tau(x) \approx 4.552 \times 10^2 (x - 1.65 \times 10^{-11} x^2)$

At $x = 3 \times 10^{10}$cm: $\tau(3 \times 10^{10}) \approx 6.76 \times 10^{12}$

Energy absorbed per unit volume:

$$E_{abs}(x) \approx 2.86 \times 10^{10} \left(1 - 0.99 \cdot \frac{x}{3 \times 10^{10}}\right) e^{-\tau(x)} \text{erg cm}^{-3}\text{s}^{-1}$$

Over 500,000 years:

$$E_{total}(x) \approx 2.86 \times 10^{10} \times 1.578 \times 10^{13} \left(1 - 0.99 \cdot \frac{x}{3 \times 10^{10}}\right) e^{-\tau(x)} \approx 4.513 \times 10^{23} \left(1 - 0.99 \cdot \frac{x}{3 \times 10^{10}}\right) e^{-\tau(x)} \text{erg cm}^{-3}$$

Percentage: UV flux is 0.1%, with 72.8% as kinetic energy → % ≈ 0.001×72.8% ≈ **0.073%**

Kinetic Energy to Mass Conversion
As we've done in previous models, we're going to convert the kinetic energy "trapped" in this layer to mass, in order to calculate Einstein tensors:

Volume: $V \approx 1.104 \times 10^{32} \text{cm}^3$

Energy peaks at: $x \approx 2.197 \times 10^7$cm≈ **219.7 km**.

Average energy density: $E\text{total} \approx 2 \times 1020$ erg cm^{-3}

Total energy: $E_{kin,total} \approx 2 \times 10^{20} \times 1.104 \times 10^{32} \approx 2.208 \times 10^{52} \text{erg}$

Equivalent mass: $m = \frac{2.208 \times 10^{52}}{(3 \times 10^{10})^2} \approx 2.453 \times 10^{31} \text{g}$

Original mass:
$$\bar{\rho} \approx 10.1 \text{g/cm}^3$$
$$M_{original} \approx 10.1 \times 1.104 \times 10^{32} \approx 1.115 \times 10^{33} \text{g}$$

Total mass: $M_{total} \approx 1.115 \times 10^{33} + 2.453 \times 10^{31} \approx 1.140 \times 10^{33} \text{g}$

General Relativity Calculations
Stress-Energy Tensor
Average density:

$$\rho = \frac{1.140 \times 10^{33}}{1.104 \times 10^{32}} \approx 10.33 \text{g/cm}^3$$

$$\rho_{energy} \approx 10.33 \times (3 \times 10^{10})^2 \approx 9.297 \times 10^{14} \text{erg/cm}^3$$

$$T^{\mu\nu} = \begin{pmatrix} 9.297 \times 10^{14} & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \end{pmatrix} \text{erg/cm}^3$$

Schwarzschild Radius

$$r_s = \frac{2GM}{c^2} = \frac{2 \times 6.674 \times 10^{-8} \times 1.140 \times 10^{33}}{(3 \times 10^{10})^2} \approx 1.689 \times 10^6 \text{cm} \approx 16.89 \text{km}$$

Riemann Curvature Tensor
At $r = 1.5 \times 10^{10}$ cm:

$$\frac{2GM}{rc^2} \approx 1.126 \times 10^{-3}$$

$$R^r_{trt} \approx -\frac{2GM}{r^3 c^2} \approx -\frac{2 \times 6.674 \times 10^{-8} \times 1.140 \times 10^{33}}{(1.5 \times 10^{10})^3 \times (3 \times 10^{10})^2} \approx -5.00 \times 10^{-27} \text{cm}^{-2}$$

Kinetic Energy Density

$$E_{total}(x) = 4.513 \times 10^{23} \left(1 - 0.99 \cdot \frac{x}{3 \times 10^{10}}\right) e^{-4.552 \times 10^2 \left(x - 1.65 \times 10^{-11} x^2\right)} \text{erg cm}^{-3}$$

Behavior: Peaks at ~219.7 km, drops rapidly.

Summary and Interpretation
Kinetic Energy from Photoelectric Effect: ~0.073% of solar energy flux becomes kinetic energy, peaking at ~219.7 km depth.

Kinetic Energy to Mass: Total energy trapped in the radiative layer ~2.208×10^{52}erg, equivalent to 2.453 x 10^{31} g for the final time in this series of calculations, as the timeframe is extended to 500,000 years.

The most of equivalent mass of the kinetic energy is trapped at the first hundred of Km., with a peak for 219.7 Km., then it decreases exponentially.

The curvature tensor, stress-tensor and Schwarzschild Radius limited to the radiative layer are the result of increasing the initial mass (of the complete radoative layer) in approx. 2,2% by the "trapped" kinetic energy. However we must take into account that the region where most of the trapped kinetic energy (converted to mass) is located is limited to approximately 300 Km. Therefore the associated deformation of space-time/gravity (time dilation) would be much greater if we limit our calculations to that region.

This is a real first approximation that demonstrates our theory but it could be clearly improved to achieve a better degree of quantification of the calculated values.

There're some relevant parameters to be considered in detail: e.g. (increasing) Time, a different density distribution, the change of some QED parameters that could influence the rate of conversion of electromagnetic energy into kinetic energy over the radiative layer or a model of the flow of matter between the core and the convective layer, because matter is not static at all being its motion gradient a function of pressure, temperature and density gradients (3).

We have supposed in the previous model that all Sun's matter had a predefined gravity based on its mass. However that is not the real scenario. The actual scenario (see "Gravity Evolutionary Stages" forward) is that the matter initially present in the Sun (that is, the matter that would have created it) had only a percentage of its "final" or known gravity because such matter would have gone through previous stages of time-warping before becoming part of the star.

Due to the previously explained interactions between electromagnetic radiation and matter, e.g. Hydrogen would achieve its gravity as we currently know.

From (4) we could infer that as the gravity attached to an element goes through different stages, more time of electromagnetic interaction is needed for increasing its gravity.

Thats the reason because any element that has surpassed the stages 1 and 2, although in different circumstances must tend to a same limit with relatively very few differences. Such limit would be the current gravity (time dilation) created by such element at atomic level.

Where Gravity begins?...

At first time we should recall that there're really two kinds very different of Gravity: the well-known "conventional" gravity and the gravity reached by Lense-Thirring and shearing effects [3]. We're talking in this cae about the conventional gravity.

The geometric beginning of the Gravity effect is strictly linked to the location of the Time warping. The kinetic energy coming from electromagnetic radiation works at atomic scale, not at quantum scale. That is, the kinetic energy in the previous scenarios (1)(2)(3) should be trapped in some point close to the atomic scale.

Such point must be also directly related to the geometric end of the Quantum world. That is, superposition and entanglement effects should find a boundary clearly related to this point.

I'm going to name this point (waiting for better suggestions) like ***Warping Boundary (WB)***.

This is also consistent with the different experiments both about limits for Gravity and Quantum effects.

It's possible that Quantum world can have a very little warping, but in any case not enough to be considered any kind of Quantum Gravity. Time dilation almost would not exist in Quantum. In any case, it's expected a very limited transition environment among Quantum (no Gravity) and the Warping Boundary (WB) where time dilation (and consequently Gravity) is expressed. Such warping space would be associated to a huge time warping gradient, because although the time dilation is so small, the geometric distance is relatively even smaller. Therefore it's expected that contradictory phenomens could be detected in this narrow strip.

Gravity Evolutionary Stages

How many fundamental evolutionary stages has gravity gone through to reach its current state?...

My view is there has been three.

First Stage: The first one had been very intense, after the formation of the first hydrogen atoms. It had been consequence of the interaction among the primitive electromagnetic energy following the Big Bang and the primitve matter. It is not the purpose of this study to analyze current cosmological models of the early Universe, but what everyone agrees on is that electromagnetic radiation was the dominant form of energy, being intense and initially predominating clearly over matter. The intensity of such radiation would have been greater than that emanating from a fusion process but the way of interaction among radiation and matter would have been the same that we talked above.

As a result, this strong electromagnetic radiation would have created a fairly homogeneous initial gravity across the different hydrogen atoms, their isotopes, and the first formations of He. This initial gravity would have been enough to create the first stars, galaxies, and black holes in a much shorter period than previously estimated.

What's more. Such gravity could have been not enough under some circumstances for a galaxy could keeping star creation for a long time.

In fact the JWST points out to the creation of galaxies in very early periods, of just a few hundred million years. It also points out to some galaxies who died young.

In any case, the approximate weighting of the "percentage" of influence of this early or initial gravity on the primordial matter should be perceived in a relatively short time by observations from the JWST and new telescopes.

Rather than gravity, we should call it deformation of space-time bound to each atom of basic matter (H), or, better yet, simply time warping (dilation). This deformation would be the result of the interaction of electromagnetic energy with matter as we previously have shown. The kinetic energy produced by the emitted photons and electrons would have created a time warp in the environment immediately surrounding the atom, but with very little influence on the quantum world.

Suppose it were around the 50% of the current gravity. That could have been enough to allow creating the first stars and galaxies in the first hundreds of millions of years from the Universe's creation.

This time warping would remain intimately linked forever to the corresponding matter. The accumulation of matter would produce an "accumulation of time warps," whereby the greater the density of mass, the greater the accumulated gravity.

Second Stage: The second stage would be a direct consequence of the interaction of matter with the electromagnetic energy resulting from fusion processes in stars as we analyzed previously (1)(2)(3). The kinetic energy emitted by matter in its interaction with the electromagnetic energy resulting from fusion would have continued to distort time (to simplify) in its surroundings. In this case, gravity (for each element) would be somewhat more heterogeneous, given that the fusion processes, the intensity, and the time that the corresponding elements had been exposed to electromagnetic radiation would have varied depending on the characteristics of the star and its environment.

Third Stage: The evolution of the Universe leads to stability, but not stagnation. Electromagnetic radiation would continue to influence matter at a slower pace, slowly but inexorably increasing the distortions in space-time.

Furthermore, when a star collapses, its associated matter and that of its planets can follow different fates, one of which could be to become part of a black hole. The fact that light is unable to escape from the black hole doesnt mean that this electromagnetic energy can't continue to interact with matter, increasing its associated gravity (we could call it induced gravity). Or, to put it another way, black holes also have internal dynamics that would increase the internal tensions produced not only by their own gravity as a result of new inputs of matter, but also by induced gravity.

Ultimately, gravity would continue to evolve ("increasing") in this third stage, until it would decelerate the expansion of the universe to such an extent that it would end up contracting until it collapsed.

Discussion

Then … Does it mean that ***celestial bodies with the same mass and composition could produce different gravity*** levels in the Universe?...

YES, depending on the evolution of their elements, that is, the time and intensity of the interaction with electromagnetic energy over the different stages of their evolution and, specially, from their second stage.

Therefore, the gravity of each element would depend both on the epoch of the Universe in which it was formed and the environment in which it is located. There would be different gravities for the same element shaped at one point in the space-time of the Universe and another because its degree of warping of Time could be different.

The Relativistic metric and curvature tensors should be calculated for each specific region of the Universe.

For nearby environments (for example, the Solar System), it is conceivable that the origin of the different elements that make up its planets would have the same origin or a very close one in space-time. Therefore, Newtonian or relativistic theory would not produce major differences when applied to the Solar System, but in any case, it is more than likely that the gravitational constant on some planets will present slight differences to the expected by the classic theory.

In other words, ***the Gravitational constant would not be constant anymore.***

It's obvious that, for validating this theory, we should demonstrate the expected property of the Time (4) and changing the Einstein's field equations to incorporate it, reflecting the fact that such property ("Time elasticity") should be inversely proportional to the dilation of time, that is, to the Gravity. Or, under other view, to the density of the matter. The own gravity that would have given meaning to time (time dilation) would act as an inertia to continue dilating it.

This view would also have a profound impact on the physics of black holes.

The singularity would never be reached, because time dilation would always have a limit and could never be infinite.

I must add finally that a subtle decrease in time elasticity was observed in the experiments I conducted associated with my works [1,6].

The longer I prolonged the exposure time at high rotation speeds, the longer it took for the scale to return to its zero position.

Since my experimental instruments were not optimal, longer, in-depth experiments are needed to confirm (and quantify) the results with approved scientific tests.

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