We can't solve problems by using the same kind of thinking we used when we created them.

Albert Einstein

WORLD – UNIVERSE MODEL WITH TIME VARYING GRAVITATIONAL PARAMETER

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ABSTRACT

World – Universe Model is based on three primary assumptions:

1) The World is finite and is expanding inside the Universe with speed equal to the electrodynamic constant c. The Universe serves as an unlimited source of energy that continuously enters into the World from the boundary.

2) Medium of the World, consisting of protons, electrons, photons, neutrinos, and dark matter particles, is an active agent in all physical phenomena in the World.

3) Two fundamental parameters in various rational exponents define all macro and micro features of the World: Fine-Structure Constant α, and dimensionless quantity Q. While α is constant, Q increases with time, and is in fact a measure of the size and the age of the World.

The World – Universe Model explains experimental data accumulated in the field of Cosmology over the last decades: the size and age of the World; critical energy density and the gravitational parameter; temperature of the cosmic microwave background radiation and cosmological redshift. Additionally, the Model makes predictions pertaining to masses of dark matter particles and neutrinos; proposes new types of particle interactions (Super Weak and Extremely Weak) and recommends introducing a new fundamental parameter Q in the CODATA internationally recommended values for calculating time dependent parameters of the World.

1. Introduction

In 1937, Paul Dirac proposed a new basis for cosmology: the hypothesis of a time varying gravitational "constant"; and later added the notion of continuous creation of matter in the World. Our World – Universe Model follows these ideas, albeit introducing a different mechanism of matter creation.

The constancy of the universe fundamental constants, including Fermi coupling constant G_F, Newtonian constant of gravitation G, Planck mass M_P, Planck length L_P, is now commonly accepted, although has never been firmly established as a fact. All conclusions on the constancy of G are model-dependent [1, 2].

In our opinion, it is impossible to either prove or disprove the constancy of G. Consequently, variability of G with time can legitimately be explored. Alternative cosmological models describing the Universe with time varying G are widely discussed in literature (see e.g. [1] and references therein).

A commonly held opinion states that *gravity has no established relation to other fundamental forces, so it does not appear possible to calculate it indirectly from other constants that can be measured more accurately, as is done in some other areas of physics* [Wikipedia, Gravitational constant].

The World – Universe Model holds that there indeed exist relations between all Q-dependent, time varying parameters: G_F, G, M_P, L_P, H_0 (Hubble's parameter), R (Size of the World), A_t (Age of the World), ρ_{cr} (Critical energy density of the World), T_{MBR} (Temperature of the microwave background radiation), m_a (Axion mass), m_ν (Neutrino mass), etc. [1].

The objective of this work is to give a digest of World – Universe Model published in papers [1, 2].

2. Overview of the World – Universe Model

The World – Universe Model (WUM) is built on two major assumptions: the universality of physical laws and the cosmological principle. The cosmological principle states that on large scales the World is homogeneous and isotropic.

The World consists of the Medium (protons, electrons, photons, neutrinos, and dark matter particles) and Macroobjects (Galaxy clusters, Galaxies, Star clusters, Extrasolar systems, etc.) made of these particles. There is no empty space in frames of the Model. The Universe serves as an unlimited source of energy that continuously enters into the World from the boundary.

According to the Model, the World is a Black hole whose radius equals to the Hubble radius. Residing inside of a Black hole, we can conduct no observations of the outside Universe, and learn nothing about its characteristics.

The black body spectrum of the cosmic microwave background radiation is due to thermodynamic equilibrium of photons with low density intergalactic plasma consisting of protons and electrons. The calculated value of microwave background radiation temperature $T_{MBR} = 2.7252\ K$ is in excellent agreement with experimentally measured value of $2.72548 \pm 0.00057\ K$ [3].

The Model is developed around two fundamental parameters: Fine-structure constant α and dimensionless quantity Q. While α is a constant, Q increases with time, and in fact defines the size and the age of the World.

About 14.223 billion years ago the World was started by a fluctuation in the Universe, and the Nucleus of the World was born. The radius of the World's Nucleus at the Beginning was

$$a = 2\pi a_0 = 1.7705645 \times 10^{-14}\ m \qquad 2.1$$

where a_0 is the classical electron radius. The extrapolated energy density of the World at the Beginning was much smaller than the nuclear energy density.

Prior to this event, there was nothing but the Universe. The World has since been expanding through the Universe with speed equal to the electrodynamic constant c for time t (and now has the radius of $R = ct$), consuming energy as the World – Universe boundary advances.

Generation of particle – antiparticle pairs is occurring at the Front (the moving World – Universe boundary) due to high surface energy density of the Universe. The Front has a temperature invariant surface enthalpy $\sigma_0 = \frac{hc}{a^3}$ (h is Planck constant). Amount of energy added to the World is proportional to the increase of the area of the Front. The total amount of the World energy is thus

$$E_W = 4\pi R^2 \sigma_0 \qquad 2.2$$

The proposed mechanism of creation of matter at the Front differs from the continuous creation of matter discussed by Paul Dirac in 1974 [4]:

- *One might assume that nucleons are created uniformly throughout space, and thus mainly in intergalactic space. We may call this **additive creation**.*
- *One might assume that new matter is created where it already exists, in proportion to the amount existing there. Presumably the new matter consists of the same kind of atoms as those already existing. We may call this **multiplicative creation**.*

The energy density of the World ρ_W is inversely proportional to the radius of the World R:

$$\rho_W = \frac{3\sigma_0}{R} \qquad 2.3$$

From General Relativity, recall the well-known equation for the critical energy density of the World ρ_{cr}:

$$\rho_{cr} = \frac{3H_0^2 c^2}{8\pi G} \qquad 2.4$$

where H_0 is the Hubble parameter:

$$H_0 = \frac{1}{t} = \frac{c}{R} \qquad 2.5$$

Equation 2.4 can be rewritten as

$$\frac{4\pi G}{c^2} \times \frac{2}{3}\rho_{cr} = H_0^2 = \frac{c^2}{R^2} \qquad 2.6$$

The principal idea of our Model is that the energy density of the World ρ_W equals to the critical energy density ρ_{cr} (to satisfy the theoretical need for our observationally flat World):

$$\rho_{cr} = \rho_W = \frac{3\sigma_0}{R} \propto \frac{1}{R} \qquad 2.7$$

We see from 2.6 that the gravitational parameter G is also proportional to $\frac{1}{R}$ and is decreasing in time as $G \propto \frac{1}{t}$.

The very first ensemble of particles, including protons, electrons, photons, neutrinos, and dark matter particles (see Section 4), was generated at $\sim 10^{-20}$ s after the Beginning. The very first objects built from them were generated at $\sim 10^{-18}$ s after the Beginning. Nuclei of main-sequence stars and red stars were initiated at that time.

All macroobjects of the World (galaxy clusters, galaxies, star clusters, and stars) have cores made up of different dark matter (DM) particles. The theory of fermion compact stars made up of DM particles is well developed. Scaling solutions are derived for free and an interacting Fermi gas in [1]. The calculated parameters of fermion compact stars show that

- White Dwarf Shells around the nuclei made of strongly interacting WIMPs or neutralinos compose the cores of stars in extrasolar systems;
- Dissociated DIRACs to Monopoles form cores of star clusters;
- Dissociated ELOPs to Preons constitute cores of galaxies;
- Sterile neutrinos make up cores of galaxy clusters;
- Tauonic neutrinos reside in the cores of galaxy superclusters.

The energy consumption rates are greater for galaxies relative to extrasolar systems, and for the World relative to galaxies. It follows that new stars and star clusters can be created inside of a galaxy, and new galaxies and galaxy clusters can arise in the World. Structures form from top (the World) down to extrasolar systems in parallel around different cores made of different DM particles. Formation of galaxies and stars is not a process that concluded ages ago; instead, it is ongoing.

Nucleosynthesis of all elements occurs inside stars during their evolution (Stellar nucleosynthesis). The theory of this process is well developed, starting with the publication of a celebrated B^2FH review paper in 1957 [5]. With respect to WUM, stellar nucleosynthesis theory should be enhanced to account for annihilation of heavy dark matter particles (WIMPs and neutralinos). The amount of energy produced due to this process is sufficiently high to produce all elements inside stellar cores.

Age of the eldest star HD 140283 (14.46 ± 0.8 Byr) aligns better with the age of the World calculated by WUM (14.223 Byr) than with the commonly accepted age of the Universe (13.798 ± 0.037 Byr). According to WUM, the World is some 425 million years older than commonly accepted. This additional period helps explain the rise of second-generation stars.

The World is continuously receiving energy from the Universe that envelopes it. Assuming an unlimited Universe, the numbers of cosmological structures on all levels will increase: new galaxy clusters will form; existing clusters will obtain new galaxies; new stars will be born inside existing galaxies; sizes of individual stars will increase, etc. The temperature of the Medium of the World will asymptotically approach absolute zero.

3. Related issues in physics

T. Davis and B. Griffen have this to say about Cosmological constant [6]: "*The critical observational result that brought the cosmological constant into its modern prominence was the discovery that distant type 1a supernovae (0<z<1), used as standard candles, were fainter than expected in a decelerating universe (Riess et al. 1998, Perlmutter et al. 1999). Since then many groups have confirmed this result with more supernovae and over a larger range of redshifts. Of particular importance are the observations that extremely high red shift (z>1) supernovae are brighter than expected, which is the observational signature that is expected from a period of deceleration preceding our current period of acceleration. These higher-redshift observations of brighter-than-expected supernovae protect us against any systematic effects that would dim supernovae for reasons other than acceleration". Apart from its density and its clustering properties* (no clustering), *nothing is known about dark energy. Quantum field theory predicts a cosmological constant much like dark energy, but 120 orders of magnitude larger than that observed. The nature of dark energy is one of the most challenging problems in cosmology* [Wikipedia, Physical cosmology].

The World – Universe model gives the following explanations for supernovae 1a distance measurements and their relation to redshift:

All macroobjects of the World, including supernovae, were fainter in the past. As their cores absorb new energy, the sizes of macroobjects and thus their luminosity are increasing in time $\propto t$. For example, taking the age of the World $\cong$ 14.2 Byr and the age of solar system $\cong$ 4.6 Byr, it is easy to find that the young Sun's output was only 67.6% of what it is today. Literature commonly refers to the value of 70%. So-called "Faint young Sun" paradox is thus resolved.

In accordance with Hubble's law, distance d to galaxies for $z \ll 1$ is found to be proportional to z:

$$d = \frac{c}{H_0} z = Rz \qquad 3.1$$

where H_0 is the Hubble's parameter. The relationship of distance d to the redshift z for large values of z is not presently conclusive, active research is conducted in the area. In the World – Universe model, the distance to galaxies equals to:

$$d = \frac{c}{H_0}\frac{z}{1+z} = R\frac{z}{1+z} \qquad 3.2$$

which reduces to 3.1 for $z \ll 1$ and $d = R$ for $z \to \infty$. Thus for z>1, the distance to supernovae is smaller than expected and hence supernovae are brighter. There is then no reason to introduce dark energy in order to explain the nonlinear relationship of distance to the redshift. The theoretical need for additional energy distinct from the baryon matter and dark matter to form our observationally flat World is satisfied with the considerably larger fraction of the neutrino energy density in the total energy density of the World:

$$\Omega_\nu = 30\pi\alpha = 0.68775928 \qquad 3.3$$

Consequently, we are dealing with well-known particles instead of dark energy.

4. Main results of World – Universe Model

There are three prominent hypotheses on nonbaryonic DM, namely Hot Dark Matter (HDM), Warm Dark Matter (WDM), and Cold Dark Matter (CDM). The most widely discussed models for nonbaryonic DM are based on the CDM hypothesis, and corresponding particles are most commonly assumed to be Weakly Interacting Massive Particles (WIMPs) [Wikipedia, Dark matter].

The gravitational effects of DM are well understood, as it behaves like a cold, non-radiative fluid that forms haloes around galaxies. DM has never been detected in the laboratory, and the particle physics nature of DM remains completely unknown [Wikipedia, Physical cosmology]. *The Universe today is far more lumpy and contains far less deuterium than can be accounted for without DM* [Wikipedia, Big Bang].

A neutralino with mass m_N *in* $100 \Leftrightarrow 10{,}000\ GeV/c^2$ *range is the leading DM candidate* [Wikipedia, Neutralino]. *Light Dark Matter Particles that are heavier than WDM and HDM but lighter than the traditional forms of CDM (neutralino) are DM candidates too. Their masses* m_{WIMP} *fall into* $1 \Leftrightarrow 10\ GeV/c^2$ *range* [Wikipedia, Light dark matter]. Subsequently, we will refer to the light dark matter particles as WIMPs.

It is known that a sterile neutrino with mass m_{ν_s} *in* $1 \Leftrightarrow 10\ keV/c^2$ *range is a good WDM candidate* [Wikipedia, Warm dark matter]. *The best candidate for the identity of HDM is neutrino* [Wikipedia, Hot dark matter]. In our opinion, a tauonic neutrino is a good HDM candidate.

In addition to fermions discussed above, the World – Universe model offers another type of DM particles – bosons, consisting of two fermions each. There are two types of DM bosons: DIRACs possessing mass of $m_0 \cong 70\ MeV/c^2$ that are in fact magnetic dipoles, and ELOPs having mass of $\frac{2}{3}m_e$ – preon dipoles (m_e is the electron mass).

Dissociated DIRACs can only exist at nuclear densities or at high temperatures. A DIRAC breaks into two Dirac monopoles with mass $\frac{m_0}{2}$ and charge $\mu = \frac{e}{2\alpha}$. In our opinion, these monopoles are the smallest building blocks of fractal structure of constituent quarks and hadrons.

ELOPs break into two preons whose mass m_{pr} equals to one third of an electron's mass: $m_{pr} = \frac{m_e}{3}$ and charge e_{pr} – to one third of an electron's charge: $e_{pr} = \frac{1}{3}e$. Preons are the smallest building blocks of a fractal structure of quarks and leptons.

We did not take into account the binding energies of DIRACs and ELOPs, and thus the values of their masses are approximate. They have negligible electrostatic and electromagnetic charges because the separation between charges is very small. They do however possess non-negligible electrostatic and electromagnetic dipole momentum.

In the WUM, dark matter particle masses are related to and proportional to m_0 multiplied by different exponents of α. Consequently, masses of various types of DM particles can be predicted:

CDM particles (Neutralinos and WIMPs):

$$m_N = \alpha^{-2} m_0 = 1.3149950 \ \ TeV/c^2 \tag{4.1}$$

$$m_{WIMP} = \alpha^{-1} m_0 = 9.5959823 \ \ GeV/c^2 \tag{4.2}$$

DIRACs:

$$m_{DIRAC} = 2\alpha^0 \frac{m_0}{2} = 70.025267 \ \ MeV/c^2 \tag{4.3}$$

ELOPs:

$$m_{ELOP} = 2\alpha^1 \frac{m_0}{3} = 340.66606 \ \ keV/c^2 \tag{4.4}$$

WDM particles (sterile neutrinos):

$$m_{\nu_s} = \alpha^2 m_0 = 3.7289402 \ \ keV/c^2 \tag{4.5}$$

These values fall into the ranges estimated in literature.

The Model holds that the energy densities of all types of DM particles are proportional to the proton energy density in the World's Medium:

$$\Omega_p = \frac{2\pi^2 \alpha}{3} = 0.048014655 \tag{4.6}$$

In all, there are 5 different types of DM particles. Then the total energy density of DM is

$$\Omega_{DM} = 5\Omega_p = 0.24007327 \tag{4.7}$$

which is close to DM energy density discussed in literature: $\Omega_{DM} \cong 0.23$ [Wikipedia, Dark Matter].

The total baryonic energy density Ω_B is

$$\Omega_B = 1.5\Omega_p = 0.072021982 \tag{4.8}$$

The main suggestion for experimentalists dealing with observations of Dark Matter is to concentrate their efforts on particles possessing masses shown above.

It is now established that there are three different types of neutrinos: electronic ν_e, muonic ν_μ, and tauonic ν_τ, and their antiparticles. Pontecorvo and Smorodinskii discussed the possibility of energy density of neutrinos exceeding that of baryonic matter [7]. Neutrino oscillations imply that neutrinos have non-zero masses.

In the WUM, neutrino masses are related to and proportional to m_0 multiplied by Fundamental Parameter $Q^{-\frac{1}{4}}$ and different coefficients. Consequently, masses of neutrinos can be predicted:

$$m_{\nu_e} = \frac{1}{24} m_0 \times Q^{-\frac{1}{4}} = 3.1250 \times 10^{-4}\ eV/c^2 \tag{4.9}$$

$$m_{\nu_\mu} = m_0 \times Q^{-\frac{1}{4}} = 7.4999 \times 10^{-3}\ eV/c^2 \tag{4.10}$$

$$m_{\nu_\tau} = 6m_0 \times Q^{-\frac{1}{4}} = 4.5000 \times 10^{-2}\ eV/c^2 \tag{4.11}$$

The squared values of the muonic and tauonic masses fall into the ranges of mass splitting Δm_{sol}^2 and Δm_{atm}^2 for solar and atmospheric neutrinos respectively estimated in literature [1].

The sum of the calculated neutrino masses

$$\Sigma m_\nu \cong 0.053\ eV/c^2 \tag{4.12}$$

is in a good agreement with the value of $0.06\ eV/c^2$ discussed in literature [8].

One of the principal ideas of World – Universe Model holds that energy densities of Medium particles are proportional to proton energy density in the World's Medium (4.6). Therefore the total neutrinos energy density (in the Medium and in macroobjects) equals to:

$$\Omega_{\nu tot} = \frac{45}{\pi}\Omega_p = 30\pi\alpha = 0.68775927 \tag{4.13}$$

The total neutrinos energy density is almost 10 times greater than baryonic energy density, and about 3 times greater than Dark Matter energy density.

At the very Beginning (Q=1) all extrapolated fundamental interactions of the World – strong, electromagnetic, weak, Super Weak and Extremely Weak (proposed in the WUM), and gravitational – had the same cross-section of $\frac{a^2}{4}$, and were characterized by the Unified coupling constant:

$$\alpha_U = \alpha_S = \alpha_{EM} = \alpha_W = \alpha_{SW} = \alpha_{EW} = \alpha_G = 1 \tag{4.14}$$

At that time, the extrapolated energy density of the World ρ_{cr0} was

$$\rho_{cr0} = \frac{3hc}{a^4} = 6.0638901 \times 10^{30} \frac{J}{m^3} \tag{4.15}$$

which is four orders of magnitude smaller than the nuclear energy density.

The average energy density of the World has since been decreasing and its present value is given by

$$\rho_{cr} = \rho_{cr0} \times Q^{-1} = 7.9775 \times 10^{-10} \frac{J}{m^3} \tag{4.16}$$

The gravitational coupling parameter α_G is similarly decreasing:

$$\alpha_G = Q^{-1} \propto t^{-1} \tag{4.17}$$

The weak coupling parameter is decreasing as follows:

$$\alpha_W = Q^{-\frac{1}{4}} \propto t^{-\frac{1}{4}} \tag{4.18}$$

The strong and electromagnetic parameters remain constant in time:

$$\alpha_S = \alpha_{EM} = 1 \tag{4.19}$$

The super weak coupling parameter α_{SW} and the extremely weak coupling parameter α_{EW} are decreasing as follows:

$$\alpha_{SW} = Q^{-\frac{1}{2}} \propto t^{-\frac{1}{2}} \tag{4.20}$$

$$\alpha_{EW} = Q^{-\frac{3}{4}} \propto t^{-\frac{3}{4}} \tag{4.21}$$

The proposed Model provides a mathematical framework based on a few basic assumptions that allows to calculate the primary parameters of the World in good agreement with the most recent measurements and observations. To the best of our knowledge, there is no other Model that would allow one to calculate these values:

$R = 1.3456 \times 10^{26}\ m$ — Size

$A_t = 4.4885 \times 10^{17}\ s = 14.223$ billion years — Age

$H_0 = 2.2279 \times 10^{-18}\ s^{-1} = 68.746\ \frac{km/s}{Mpc}$ — Hubble's parameter

$\rho_{cr} = 7.9788 \times 10^{-10}\ \frac{J}{m^3}$ — Critical energy density

$\rho_{cr0} = 6.0638901 \times 10^{30}\ \frac{J}{m^3}$ — Critical energy density at the Beginning

$\sigma_0 = 3.5788363 \times 10^{16}\ \frac{J}{m^2}$ — Surface enthalpy of the Front

$E_W = 8.1435 \times 10^{69}\ J$ — Total energy of the World

$\Omega_p = 0.048014655$ Proton density in the Medium

$n_p = 0.25485 \ m^{-3}$ Proton concentration in the Medium

$T_{MBR} = 2.7252 \ K$ Microwave Background Radiation Temperature

$\Omega_{\nu tot} = 0.68775927$ Total neutrinos density

$\Omega_{DMtot} = 0.24007327$ Total dark matter density

$\Omega_B = 0.07202198$ Total baryonic density

$\Omega_e + \Omega_{rad} = 0.00014548$ Electron plus radiations density

$T_{st} = 28.95 \ K$ Cosmic dust temperature

$m_N = 1.3149950 \ TeV/c^2$ Neutralino mass

$m_{WIMP} = 9.5959823 \ GeV/c^2$ WIMP mass

$m_{DIRAC} = 70.025267 \ MeV/c^2$ DIRAC mass

$m_{ELOP} = 340.66606 \ keV/c^2$ ELOP mass

$m_{\nu_s} = 3.7289402 \ keV/c^2$ Sterile neutrino mass

$M_{Smax} = 3.4644 \times 10^{32} kg \ (\cong \ 174 \ M_{Sun})$ Maximum stellar mass

5. Time Varying Primary Parameters of the World

In accordance with WUM, the basic parameters of the World can be expressed as follows [1]:

- Newtonian parameter of gravitation G :

$$G = \frac{a^2 c^4}{8\pi hc} \times Q^{-1} \quad 5.1$$

- Hubble's parameter H_0 :

$$H_0 = \frac{c}{a} \times Q^{-1} = \frac{8\pi hc}{a^3 c^3} \times G \quad 5.2$$

- Age of the World A_t :

$$A_t = \frac{a}{c} \times Q = \frac{a^3 c^3}{8\pi hc} \times G^{-1} \quad 5.3$$

- Size of the World R :

$$R = a \times Q = \frac{a^3 c^4}{8\pi hc} \times G^{-1} \quad 5.4$$

- Temperature of the microwave background radiation T_{MBR} :

$$T_{MBR} = (\frac{15}{4\pi^3})^{\frac{1}{4}} \frac{E_0}{k_B} \times (2\alpha \frac{m_e}{m_p})^{\frac{1}{4}} \times Q^{-\frac{1}{4}} =$$

$$= (\frac{15}{4\pi^3})^{\frac{1}{4}} \frac{E_0}{k_B} \times (2\alpha \frac{m_e}{m_p})^{\frac{1}{4}} \times (\frac{8\pi hc}{a^2 c^4})^{\frac{1}{4}} \times G^{\frac{1}{4}} \qquad 5.5$$

where k_B is Boltzmann constant, m_p is the mass of a proton, and basic energy unit E_0 equals to

$$E_0 = \frac{hc}{a} = 1.1219288 \times 10^{-11} \, J = 0.070025267 \, GeV \qquad 5.6$$

Observe that today we can substantially increase the precision of H_0 , A_t and T_{MBR} based on G in accordance with 5.2, 5.3, and 5.5 [2].

In [2] we proposed the following expression for Fermi coupling parameter G_F :

$$\frac{G_F}{(\hbar c)^3} = \sqrt{30} \frac{m_p}{m_e} \frac{1}{E_0^2} \times (2\alpha \frac{m_e}{m_p})^{\frac{1}{4}} \times Q^{-\frac{1}{4}} = 1.166364(5) \times 10^{-5} \, GeV^{-2} \qquad 5.7$$

where $\hbar$ is Dirac constant. Observe that the relative value of T_{MBR} is proportional to the relative value of G_F and the ratio of them does not depend on time:

$$\frac{k_B T_{MBR}}{E_0} = (\frac{1}{15\pi^3})^{\frac{1}{4}} \frac{m_e}{2m_p} \times \frac{G_F E_0^2}{(\hbar c)^3} \qquad 5.8$$

The value of Fermi coupling parameter G_F is now known with the highest precision. We can calculate the value of Fundamental parameter Q_F based on the average value of G_F in 5.7:

$$Q_F = 0.759960(13) \times 10^{40} \qquad 5.9$$

Based on Q_F , we can predict:

- The value of Newtonian parameter of gravitation G

$$G = 6.67420(11) \times 10^{-11} \, m^3 kg^{-1} s^{-2} \qquad 5.10$$

Compare to the CODATA recommended value of G published in 2010:

$$G = 6.67384(80) \times 10^{-11} \, m^3 kg^{-1} s^{-2} \qquad 5.11$$

- The value of the temperature of the microwave background radiation T_{MBR}

$$T_{MBR} = 2.725218(12) \, K \qquad 5.12$$

- The value of the Hubble's parameter H_0

$$H_0 = 2.228017(38) \times 10^{-18} \, s^{-1} = 68.7494(12) \, \frac{km/s}{Mpc} \qquad 5.13$$

- The age of the World A_t

$$A_t = 4.488296(77) \times 10^{17} \, s = 14.22255(24) \, Byr \qquad 5.14$$

- The size of the World R

$$R = 1.345557(23) \times 10^{26}\ m \qquad 5.15$$

As mentioned above, the (almost) constancy of G has been established on the grounds of different theoretical models. But if these theories are slightly inaccurate then the experimental methods would not give accurate values for G.

Perhaps the constancy of G is valid. What this result gives us:

- A commonly held opinion that *gravity has no established relation to other fundamental forces, so it does not appear possible to calculate it indirectly from other constants that can be measured more accurately, as is done in some other areas of physics* [Wikipedia, Gravitational constant];

- Published values of G that vary rather broadly, and some recent measurements of high precision which are, in fact, mutually exclusive. Out of the three distinct groups of G measurements [2], how shall we identify the correct one?

On the contrary, the World – Universe Model holds:

- There indeed exist relations between all Q-dependent, time varying parameters: Gravitational parameter, Fermi coupling parameter , Hubble's parameter, Size of the World, Age of the World, Critical energy density of the World, Temperature of the Microwave Background Radiation, Axion mass, Neutrino mass, etc.;

- The possibility to calculate the value of G indirectly from other Q-dependent parameters. Today, Fermi coupling parameter is known with the highest precision. Based on its value we can make the choice of the group of G measurements and significantly increase the precision of all Q-dependent parameters;

- Recently, the precision of the Temperature of the Microwave Background Radiation seems to be improving the fastest. Once it is measured with relative standard uncertainty that is lower than 30 ppm, precision of G and all other Q-dependent parameters will improve.

To summarize: Primary parameters of the World G_F, G, H_0, A_t and T_{MBR} are all inter-connected. The obtained set of values and the fundamental parameter Q are recommended for consideration in CODATA Recommended Values of the Fundamental Physical Constants 2014.

Looking forward, better precision in measurement of any Q-dependent parameter may potentially increase the precision of all others.

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