GRAVITATIONAL STABILITY FOR A VACUUM COSMIC SPACE CRYSTALLINE MODEL

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ABSTRACT

Using a generalization of the Heisenberg's uncertainty principle it is shown that the local gravitational stability condition for an infinite tridimensional crystalline model of the quantum vacuum cosmic space (which is existing from an infinite time before the occurrence of our local actual big bang event) implies to obtain an equation formally equivalent to the relation first used by Gamow to predict the present temperature of the microwave background from the matter density. The compatibility condition between the quantum and the relativistic approaches has been obtained without infinities arising from the quantum analysis or singularities arising from the relativistic theory. The action, which leads to our theory, is the least action possible in a quantum scheme. The energy fluctuation involved in the gravitational stabilization of vacuum space, inside the actual volume of our universe, is 5×10^{-41} times the energy of the crystalline structure of vacuum space inside the present Universe volume. The same process of quantum gravitational stabilization of such crystalline structure occurs everywhere (by pairs of cells of similar sizes under the action of tension-compression gravitational stresses very near to mechanic-gravitational equilibrium) in the infinite cosmic vacuum space.

Key Words: Big Bang Theory; Cosmology; Cosmic Microwave Background Radiation, Gravitational stability, Heisenberg´s uncertainty principle.

1. Introduction

Here a brief review about two inter related subjects, who are fundamental for our research will be presented: The first one refers to theoretical relevance of the concept of cosmic space as deduced from a proposal of Heisenberg (Heisenberg, 1958) of a natural system of units of measurement based on universal constants. The second one refers to the concept of cosmos as defined by Carl Sagan and its deepest implications.

The modern concept of a physical quantity in science follows that of Maxwell, where every expression of a quantity consists of two factors or components. One is the chosen standard quantity technically called the unit, and the other is the number of units required to make up the physical quantity (Maxwell, 1954, originally in 1891). From this conceptual scheme two different lines have been developed. One, the most important from a practical point of view, attends to the necessity to provide the basic units for measurements used in science, technology and everyday life (Flowers, 2001). The other line is devoted to the philosophical search for a deeper foundation of physical constant; see for instance works due to Maxwell (Maxwell, 1954), Planck [Kuhn 1989] and Heisenberg (Heisenberg, 1958).

Heisenberg's proposal of a natural system of units of measurement based on universal constants is a very interesting one, and is justified as follows (Heisenberg, 1958): "The universal constants determine the scale of nature, the characteristic quantities that cannot be reducing to other quantities. One needs at least three fundamental units for a complete set of units. A unit of length, one of time and one of mass is sufficient to form a complete set. The theory of relativity is connected with a universal constant in nature, the velocity of light, c. The quantum theory is connected with another universal constant of nature, Planck's quantum of action, h. There must exist a third universal constant in nature, this is obvious for purely dimensional reasons. An only a theory which contains this third unit (constant) can possibly determine the masses and other properties of the elementary particles. Judging from our present knowledge of these particles the most appropriate way for introducing the third universal constant would be the assumption of a universal length the value of which should be roughly $10^{-13}\ cm$, that is some smaller than the radii of light nuclei. When from such three units one forms an expression which in its dimensions corresponds to a mass, its value has the order of magnitude of the masses of the elementary particles". Following Heisenberg's proposal, it is possible to consider that some new physical result obtained in a previous paper (Montemayor Aldrete, 2005) requires further analysis. In particular the possibility that vacuum cosmic space could have a crystalline structure, with a lattice parameter $r_N = {R_{OU}}/{(3.07 \times 10^{41})}$ (r_N similar to neutron radius) where $R_{OU} = 4.3 \times 10^{28} cm$ is the present Universe radius (Bielewicz & Banday 2011), deserves a careful exploration.

Accordingly to Carl Sagan (Sagan, 1980) "The Cosmos is all that is or ever was or ever will be. Obviously, the Sagan definition implies the energy conservation of all that is or ever was or ever will be. Related to this idea are the seminal works due to Hoyle 1948 (Hoyle, 1993, 1994, 1995). Within such way of thinking there are also the works due to Joseph (Joseph, 2010 a, b). However the appealing features of the models due to Hoyle and Joseph, our analysis take into account their basic considerations in the following way: We start by considering the Sagan enunciation of Cosmos, and specifically we consider as a model that the basic component of the cosmos is: A quantum vacuum space with crystalline structure (the lowest energy per unit volume) which have a lattice parameter of about the size of neutron in absence of gravitational stresses (Montemayor Aldrete et al. 2005). In a local way such crystal is subjected to little gravitational, quantum, electromagnetic and so on fluctuations around their equilibrium values. As considered by Hoyle, Sagan and Joseph the energy of such cosmos is conserved and extends to infinite in every spatial direction, and exist with no time limitations in the past or in the future. Under the action of little fluctuations such crystalline vacuum cosmic space has a Euclidean nature, at long range.

From our point of view our physical analysis requires the study of compatibility conditions between the General Theory of Relativity and Quantum Theory when we apply it to the crystalline vacuum cosmic space model. This is because a theory, which physically describes the metric of cosmic space and its evolution, and a quantum theory that allows determining the masses of elementary particles (neutrons) existing in such metric, are simultaneously required to analyze such problem.

The main purpose of this paper is to study the immediate implications about the gravitational stability of a model that considers that the vacuum cosmic space has a crystalline structure with a lattice parameter of the order of the neutron radius. $r_N = 1.4 \times 10^{-13}\, cm$: Gibbs and Gibson (1991).

2. Formalism

Our model for the vacuum cosmic space is an infinite crystalline structure characterized by a lattice parameter roughly with the size of the neutron radius which is the distance between the physical energy packages (physical entities supposed very similar to neutrons) that form the crystalline structure of the cosmic vacuum space. Here vacuum means, by definition, the state of lowest or minimum energy per unit volume. The state $|0\rangle$ is the state of such crystalline structure without deformation. Here by construction the energy content of such a crystalline vacuum structure without gravitational deformation for the actual Universe volume is about to 2.0×10^{40} times bigger than de actual matter content of the Universe (1.41×10^{84} baryons). Considering that the granular structure or lattice parameter of vacuum space without gravitational deformation is about the neutron radius evidently the energy density of such vacuum space is a minimum for a crystalline structure. According to Einstein's gravitational theory, applied to this crystalline structure there is a gravitational attraction between such energy packages, very similar to neutrons, which physically form the crystalline space, and also there appears an interaction between them due to crystalline lattice deformation. These phenomena lead to a gravitational instability of such vacuum cosmic space, which will be treated by using the uncertainty principle due to Heisenberg's, in their form of time-energy uncertainty. Before that, let us to make a brief mention about some related issues like: some principles of General Relativity in connection to vacuum cosmic space, the vacuum cosmic space itself, and later the different conceptual ways used to apply the Time-energy uncertainty principle.

According to Puthoff (Puthoff, 2002): The principles of General Relativity (GR) are generally presented in terms of tensor formulations in curved space-time. Such an approach captures in a concise and elegant way the interaction between masses, and their consequent motion. In a more elegant way Wheeler states that in General Relativity, gravity is not a force but a deformation of space ‘‘Matter tells space how to curve, and space tells matter how to move.’’, (Wheeler, 1973). As a result, in principle, Newton’s law of gravitational attraction to a central mass is therefore interpreted in terms of the space-time structure as expressed in terms of the metric tensor coefficients. However according to our analysis, the maximum average deformation of our crystalline space model due to gravitational instabilities controlled by a quantum- gravitational fluctuation is about 5×10^{-41} ; therefore for practical purposes such scheme is a very good approximation to Newtonian physical concepts relative to “forces” and “stresses” provided that we are far enough of some Big Bang event in which the lattice deformation is not negligible as compared with the equilibrium lattice parameter of such crystalline space. Evidently, such theoretical frame suppose the existence of gravitational waves, which however are still theoretical in strict sense because no direct evidence has been found yet of their actual existence (Hough, Rowan & Sathyaprakash, 2005); has a solid indirect support about their existence because the observational evidence given by the binary pulsar PSR 1913+16 who has played a key role in the unfolding story of gravitational waves (Hulse & Taylor, 1975). According to a recent review (Ju, Blair & Zhao, 2000) this system has proved Einstein’s theory of general relativity to high precision, including the quadrupole formula which states that the total emitted gravitational wave power from any system is proportional to the square of the third time derivative of the system’s quadrupole moment. The pulsar loses energy exactly as predicted by such theory. Hulse and Taylor, who discovered the system more than 30 years ago, were rewarded by a Nobel prize in 1993, by which time careful monitoring had shown gravitational wave energy loss from the system in agreement with theory to better than 1%.

About the emerging role of the vacuum cosmic space as the as central structure of modern physics, Puthoff (Puthoff, 2010) states that: (1) within the context of quantum theory the vacuum is the seat of energetic particle and field fluctuations, and (2) within the context of general relativity the vacuum is the seat of a space-time structure (metric) that encodes the distribution of matter and energy. And he also states that Perhaps the most definitive statement acknowledging the central role of the vacuum in modern physics is provided by 2004 Nobel Prize winner Frank Wilczek in his recent book *The Lightness of Being: Mass, Ether and the Unification of Forces* (Wilczek, 2008): “What is space? An empty stage where the physical world of matter acts out its drama? An equal participant that both provides background and has a life of its own? Or the primary reality of which matter is a secondary manifestation? Views on this question have evolved, and several times have changed radically, over the history of science. Today the third view is triumphant.” By considering that the cosmic vacuum space is the primary reality and by considering also our supposition about its crystalline nature, then the most simple assumption is that lattice parameter of crystalline vacuum space is very similar to the size of most elementary baryon with no electric charge, because neutron resembles a punctual defect of such crystalline structure; and neutron it is the building block for the rest of atoms.

Relative to the time energy uncertainty principle we know that has been conceptually discussed recently for different authors as: Hilgevoord (1996, 1998) and (Bush, 2007). In particular in the exhaustive review due to Bush it is clear that there exist different types of time energy uncertainty relation which could indeed be deduced in specific contexts, but that there is no unique universal relation that could stand on equal footing with the position–momentum uncertainty relation.

And therefore in quantum theory there are threefold role of time. The External Time:

The description of every experiment is based on a spatio–temporal coordinatisation of the relevant pieces of equipment. For example, one will specify the relative distances and orientations of particle sources and detectors, as well as control the times at which external fields are switched on and off, or record the times at which a detector fires. Such external time measurements are carried out with clocks that are not dynamically connected with the objects studied in the experiment. External time is sharply defined at all scales relevant to a given experiment. Hence there is no scope for an uncertainty interpretation with respect to external time. However, it has been argued that the duration of an energy measurement limits the accuracy of its outcomes. Intrinsic Time: As a physical magnitude, time is defined and measured in terms of physical systems undergoing changes, such as the straight line motion of a free particle, the periodic circular motion of a clock dial, or the oscillations of atoms in an atomic clock. In accordance with this observation, it can be said that every dynamical variable of a physical system marks the passage of time, as well as giving an (at least approximate) quantitative measure of the length of the time interval between two events. Observable Time: A standard experimental question in the study of decaying systems is that about the temporal distribution of the decay events over an ensemble. More precisely, rather than the instant of decay one will be measuring the time of arrival of the decay products in a detector. A related question is that about the time of flight of a particle. Here, this last kind of time energy uncertainty concept will be used. In nature we have a lot of systems, which, in principle, are unstable against some kind of force, but thanks to quantum forces, which arise from Heisenberg's uncertainty principle, the system gets stability. Here we mention two examples: the atom and the nucleus. As we know, in the hydrogen atom, which classically is an unstable system, we can obtain stability by using Heisenberg's uncertainty principle, which introduces something like a compensatory quantum force, which stabilize, the system.

For the case of the hydrogen atom, where the Hamiltonian is given by

$$H = \frac{p^2}{2m_e} - k\frac{e^2}{r}, \quad E = \langle H \rangle = \frac{1}{2m_e}\langle p^2 \rangle - ke^2\left\langle \frac{1}{r} \right\rangle$$

where symbols have their usual meaning. Assuming that

$$\Delta p \approx p, \; \Delta r \approx r$$

and from the requirement that

$$\frac{dE}{dr} = 0$$

we obtain that the radius R_m that minimize the energy is the Bohr radius

$$Rm = \frac{\hbar}{ke^2 m_e} \quad (1)$$

The main point here is that, in contrast to classical mechanics, the energy is bounded from below because of the uncertainty principle.

Similarly, for the case of nuclear forces, in the deuteron the stability can be explained by using again Heisenberg's uncertainty principle, or in nuclei with several nucleons, the stability can be achieved appealing to this principle as Yukawa did in 1935, explaining the nuclear force by the particles exchange, through the relation

$$m_\pi c^2 = \frac{\hbar c}{r_N} \quad (2)$$

Following the same arguments as above, we can extend these ideas to a system, which interacts by gravitational forces. In the same way that Heisenberg's uncertainty principle is appealed for stabilizing a system like the hydrogen atom or a light nucleus, in this work this principle is used to prevent the collapse of a crystalline structure due to the action of gravitational stresses. The way to apply the Heisenberg's uncertainty principle to our problem requires a generalization of the uncertainty principle in the following way: starts from consider that the quantum gravitational system response against instability occurring in an n-particles system requires the quantum physical response from each of the n-gravitational interacting particles which compose the system.

In our crystalline model of vacuum cosmic space with lattice parameter of the order of the neutron radius r_N, the number of physical lattice points (physically and energetically similar to neutrons) which exist for such crystal inside a volume, $V_{OU} = \frac{4}{3}\pi R_{OU}^3$, N_{CVS} is $2.9 * 10^{124}$, provided that R_{OU} is the radius associated to the most usual value for the Universe age: 13,750 million years (Shuang Wang, Xiao-Dong Li & Miao Li, 2010). Einstein's gravitational theory states that such physical arrangement is unstable under the action of long-range gravitational stresses. In such scheme, when in a region of volume equal to the actual size of our universe a compression stresses occur because gravitational attraction between the lattice points, in their immediate neighboring region of equal size a tension gravitational stresses occur; in such a way that the average gravitational stress of the two contiguous regions is zero. Other physical implication of such coupling between contiguous gravitational stresses zones will be treated elsewhere. We can restore the equilibrium or stability of this system around average gravitational stresses with zero value by using Heisenberg's uncertainty principle. Each of the N_{CVS} entities inside V_{OU} behaves as a linear harmonic oscillator. In general we have $3N_{CVS}$ degrees of freedom in this system for vibration modes (Landau, 1963), but due to the radial symmetry of the gravitation interaction we have only N_{CVS} degrees of freedom, which correspond to $3N_{CVS}$ linear one dimensional harmonic oscillators. Each of the N_{CVS} physical lattice points of the crystalline vacuum cosmic space inside the volume V_{OU}, contributes with a stabilization energy $\Delta\varepsilon_{OU}$

against gravitational forces, given by

$$\Delta\epsilon_{OU}\Delta t_{OU} \geq {}^{h}/_{2\pi} \quad (3)$$

where $\Delta t_{OU} \equiv R_{OU}/c$, is the time that gravitational waves require to traverse the Universe's radius R_{OU}. Thus, Eq. (3) can be written as

$$\Delta\epsilon_{OU} \geq {}^{hc}/_{2\pi R_{OU}} \quad (4)$$

Now by using the relation $\lambda\nu = c$ and defining $\nu_{OU} \equiv \frac{c}{\lambda_{OU}} = \frac{c}{2\pi R_{OU}}$, Eq. (4) can be written

$$\varepsilon_{OU} = \Delta\varepsilon_{OU} \geq h\nu_{OU} \quad (5)$$

Eq. (5) describes the fundamental quantum of gravitational waves, which, in principle are responsible for the gravitational stability of the vacuum cosmic crystalline structure.

It is important to note that in the three cases that we have considered, the stabilization of fundamental physical systems against instabilities arising from electromagnetic forces, nuclear forces and gravitational forces, which has led to Eqs. (1), (2) and (4), the stability radii are inversely proportional to the rest energy (self-energy) of the "particle" which is orbiting. For the three cases the De Broglie matter theory (De Broglie, 1946) states that each "particle" orbiting around a radius r, satisfies the De Broglie relation $\lambda(r) = {}^{h}/_{p}$, where p is the momentum of the orbiting physical entity, circling in a stationary wave.

For low frequencies, the relation between absolute temperature, T, and the photoenergy (Einstein, 1905) and (Arons, 1965) is given by:

$$E_P = h\nu = kT \quad (6)$$

where k is the Boltzmann constant. In addition, for weak gravitational fields, which correspond to the linear region of the Einstein's equations, there is a strong analogy between Maxwell's and Einstein's equations, so electromagnetic and gravitational waves have a similar behaviour. We assume then that Eq. (6) is also satisfied by gravitational waves, leading to $kT_{OU} \geq h\nu_{OU}$, or equivalently,

$$T_{OU}\lambda_{OU} \geq \frac{hc}{k} \quad (7)$$

where T_{OU} is the Kelvin temperature associated with gravitational waves with wavelength of the order of the present Universe radius, $2\pi R_{OU} \approx \lambda_{OU}$, which corresponds to the temperature $T_{OU} \cong 5.3 \times 10^{-32} K$. Let us consider the relations $\Delta tOU \geq \frac{\hbar}{\Delta\varepsilon_{OU}} = \frac{\hbar}{h\nu_{OU}} \approx \frac{1}{\nu_{OU}}$, combining the last result with Eq. (7), we obtain

$$\Delta t_{OU} T_{OU} \geq \frac{h}{k} \quad (8)$$

Eq. (7) for gravitational waves which stabilize the cosmic vacuum crystalline space (CVCS) resembles the Wien's displacement law for electromagnetic black body radiation (Lide, 1991, 1992)

$$\lambda_{\max} T = \frac{hc}{k}\left(\frac{1}{4.96511423}\right) \quad (9)$$

The N_{CVS} gravitational waves quanta required to stabilize the crystalline structure of vacuum space in a volume $V_{OU} = \frac{4}{3}\pi R_{OU}^3$, lead to an adiabatic compression process due to the gravitational attraction effect between them. According to Peebles (Peebles 1993) during an adiabatic expansion of gravitational waves, the fractional change in the frequency $\frac{\Delta\nu}{\nu}$ and the fractional change in the radius $\frac{\Delta r}{r}$ of the volume enclosing the gravitational waves, are related through

$$\frac{\Delta\nu}{\nu} = -\frac{\Delta r}{r} \quad (10)$$

The same expression applies to the adiabatic gravitational compression process derived by their own gravitational attraction.

On the other hand, for an isentropic process of expansion by electromagnetic radiation (Garcia, 1998), we have

$$T^3 V = \text{constant} \quad (11)$$

where V is the cavity containing the electromagnetic radiation. For an spherical cavity or radius r, $Tr = \text{constant} \equiv c_0$. So,

$$dr = -\frac{c_0}{T^2} dT \quad (12)$$

From Eq. (10) and Eq. (12), $\frac{d\nu}{\nu} = \frac{dT}{T}$. Integrating this expression, gives,

$$T\lambda = \text{constant} \equiv c_2 \quad (13)$$

Applying for T_{OU}, becomes $T_{OU}\lambda_{OU} = c_2$, then by comparing with Eq. (7) a value for c_2, is obtained $c_2 \geq \frac{hc}{k}$. So, in general,

$$T\lambda \geq \frac{hc}{k} \quad (14)$$

Or equivalently,

$$\frac{T}{\nu} \geq \frac{h}{k} \quad (15)$$

Eq. (14) is a generalization of Eq. (7).

But Eq. (14) appears in a new physical-geometrical aspect by considering the De Broglie equations and its geometrical meaning; if we use the relation $n\lambda(r) = 2\pi r$ into Eq. (14) the gravitational waves temperature is then given by the following expression:

$$T(r) \geq \left(\frac{hc}{k}\right)\frac{n}{2\pi r} \quad (16)$$

If this equation is applied for $r = R_{OU}$ and for $r = r$ it is clear that the following equation is obtained,

$$T(r)r = T_{OU}R_{OU} \quad (17)$$

or

$$\frac{T(r)}{T_{OU}} = \frac{R_{OU}}{r} \quad (18)$$

During the adiabatic gravitational wave compression process, the total energy $E_{OU}(R_{OU}) = 2.9 \times 10^{124}\epsilon_{OU}$ of the N_{CVS} gravitational quanta required to stabilise the CVCS of volume $V_{OU} = \frac{4}{3}\pi R_{OU}^3$ remains constant. Due to Energy conservation the energy densities of these gravitational waves, U, are related through the expression $U_{OU}R = U_U(r)r^3$.

Or, equivalently

$$\frac{R_{OU}}{R} = (\frac{U_U(R)}{U_{OU}})^{1/3} \quad (19)$$

which combined with Eq. (18) gives

$$\frac{T(r)}{T_{OU}} = \frac{U_U(r)}{U_{OU}} \quad (20)$$

Eq. (20) resembles an equation previously obtained by Gamow. According to Penzias [Penzias 1977]: once pair production has ceased ρ, the matter density, varies simply as

$$\frac{T_1}{T_0} = \frac{L_0}{L_1} = \left(\frac{\rho^1}{\rho_0}\right)^{\frac{1}{3}} \quad (21)$$

(Where T_1 and T_0 are absolute temperatures, L_1 and L_0 are radial distances). If we take T1 and ρ1 to be the radiation temperature and matter density at the time of deuterium formation ($10^9 K$ and $10^5 gcm^{-3}$), we have the relation first used by Gamow to predict the present temperature of the microwave background from the density of matter.

The resemblance between Eqs. (20) and (21) is evident. However Eq. (20) refers to a physical situation of an adiabatic process of compression of gravitational waves under their own interaction; occurring in a previous existing crystalline vacuum cosmic space whereas Eq. (21) refers to the adiabatic expansion of matter after the Big Bang, during an expansion of cosmic space. In fact, the physical process which leads to Eq. (20) explains the possibility of the Big Bang event without cosmic space creation, without singularities, or infinities, as a transformation process of the fundamental gravitational quanta, mentioned before, into matter quanta.

3. Discussion and Conclusions

3.1. By using Heisenberg's uncertainty principle to deal with collective quantum gravitational fluctuations it has been shown that the vacuum cosmic space with crystalline structure and lattice parameter of about the neutron radius could be gravitationally stable. The crystalline model for such vacuum space has a lattice parameter of the order of the neutron radius and the volume used to obtain gravitation stability from the collective quantum fluctuations is about the present Universe volume. Then Heisenberg's uncertainty principle allows to stabilise not only microscopical systems against electromagnetic or nuclear forces but also to stabilise macroscopically system against gravitational forces.

3.2. The big bang would have resulted from a previous adiabatic compression process of gravitational waves. In other words, from the analysis of the adiabatic process of compression between the gravitational waves, which stabilises the vacuum cosmic space with crystalline structure, an equation, which describes the relationship between temperature, radial distance and gravitational wave energy density, has been obtained, Eq. (20). Such an equation is formally equal to the equation used by Gamow's team to predict the present microwave temperature background from the density of matter, Eq. (21). This last equation has been obtained by Gamow from the General Relativity Theory applied to the big bang event, in particular arising from the Friedmann-Robertson-Walker Equation. But Eq. (20) is also formally identical to a previous result obtained by Homer Lane in 1869, called by Chandrasekhar "The Lane's Theorem" (Chandrasekhar 1939).

In a global way, by using energy conservation, we show that 2.9×10^{124} quantum of gravitation energy, each one with energy $h\nu_{OU} = {hc}/{2\pi R_{OU}}$ becomes into 1.41×10^{84} neutrons as required by the Gamow analysis previously mentioned. By using the energy conservation principle it is possible to show that the diminishing in the gravitational energy of the crystalline gravitational field during the adiabatic compression of the gravitational waves from R_{OU} to the radius which envelopes 1.41×10^{84} neutrons formed at the end of the contraction phase is the energy source require to produce an electromagnetic radiation with a total energy of$1.39 \times 10^{20}\ E_{OU} = 1.39 \times 10^{104} u_N$. This electromagnetic radiation is produced by the acceleration of dipolar charges on the polarized vacuum space, under the perturbation caused by the nearby travelling gravitational waves; and gives the energy for a hot matter expansion through a preexisting space.

This physical consideration gives the conditions for a hot big bang in our theoretical scheme. The expansion cycle will be treated at detail in a future paper.

3.3. Conditions for compatibility between the quantum analysis of the gravitational stability of the vacuum crystalline space and the relativistic analysis of the big bang have been obtained without the least action principle but also it is not possible, by theoretical construction, that any other model exhibits a least action than our model. The required action for our model is more o less equal to that involved in the Gamow approach; if the growing of the huge quantity of energy due to the continuous space expansion, implied by some usual interpretation of the Friedman-Robertson-Walker equation, is neglected.

3.5. At difference of the big bang theory, our scheme is a theory with initial conditions; this characteristic opens up the possibility that its predictive power will be greater than the big bang theory.

3.6. In our crystalline structure scheme of vacuum cosmic space a relativistic theory for the big bang does not violate the energy conservation principle; but the standard big bang theory does, in a huge way. This is because on the one hand, in our scheme the crystalline vacuum cosmic space is an eternal structure and the energetic fluctuation involved in the gravitational stabilisation of each volume V_{OU} is about 5.0×10^{-41} of the energy per unit volume of the crystalline vacuum cosmic space, which is compatible with Heisenberg's uncertainty principle. And on the other hand, in the standard theory of the big bang the vacuum cosmic space is growing together with the Universe expansion. The Friedman-Robertson-Walker equation obeys the energy conservation by neglecting the quantum energy arising from the increase of the vacuum cosmic space volume, which for cosmological volumes is a huge quantity.

3.7. It is clear that in our scheme the only energy which enters in the Einstein's field equations is due to the long - range quantum fluctuations of the crystalline vacuum cosmic space in the form of gravitational waves, electromagnetic energy and matter and antimatter.

3.8. This work links a quantum analysis about collective interactions between all the elements of a macroscopically system with a non-quantum relativistic cosmological model which has an objective physical reality. In our analysis an objective quantum picture of the crystalline vacuum cosmic space arising from the long - range interaction between their lattice entities appears. This conclusion contradicts the Neils Bohr and Stephen Hawking consideration (among few other) about that there is no objective picture at all, and which considers that: actually there is nothing "out there" at the quantum level. Some how, reality emerges only in relation to the results of "measurements" made by human beings. Quantum theory, according to this view, provides merely a calculation procedure and does not attempt to describe the world as it actually "is". Following Penrose's (Penrose, 1989) and Barrow's analysis (Barrow, 1986) it is clear that both Bohr's and Hawking's analysis mislead the point by confusing between "measurement" made by human observers and physical interaction. Physical interactions, which occur, between any physical entities all the time in all the places of the Universe governed by Heisenberg's uncertainty principle as has been shown here and in many other applications do no require the existence of human beings to take place. In other words, according to our model the physical reality at quantum level as applied to the so-called Universe does not require the presence of a conscious being to exist. And, it is clear that "our" universe is one of an infinite number of coupled local universes and anti-universes which live and die in the infinite cosmos, continually being recycled as a consequence of a quantum fluctuation of the infinite crystalline structure of the cosmos to local gravitational instabilities.

3.9. There are many problems which remain to be solved in our theoretical scheme for instance: the thermo dynamical aspects related to the formation of quantum matter packages, the evaluation of the cosmological constant implied by our model, the very low entropy value at the starting of the big bang, the quantum aspects of the formation process of the quantum matter packages, the relation between the matter and antimatter production coupled to local tension compression gravitational states, etc. All these problems will be addressed in further contributions.

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