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Review Article

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Cosmic evolution - a selfrunner simply grace to the given physical conditions of the universe?

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I. Introductory Remarks

For many thinking people of our contemporary mankind already the attempt to look for a physical explanation of the cosmic evolution appears as a sacrileg, - as a kind of dis-divination of the holy beauty of the god-given universe, as if simply the physical interpretation of the appearing cosmic substrates would already imply the complete loss of their independence, beauty, and excellence, - as if only the attempt to describe the universe as a reflection of natural laws would degrade the creation of the universe to the trivial outcome of a physically commanded mechanical clockwork.

But is‘nt on the other hand the man-made interpretation of the phenomenologically appearing cosmic world a miraculous hint for the fact that this world, as a fully transcendental phenomenon of our consciousness, talks to this mankind, i.e. to its human brains. - And this without any loss of its marvellous transcendentity and independence. Surprisingly enough it rather is, as if mankind "understands" the universe, - and the universe as such thereby is transsubstantiated to a universe which is understood by the human being and its brain, however, without the universe thereby becoming an immanent good of human conscious - because always human consciousness needs to be controlled by the transcendental signs of the universe. Never the explanation of the world originates from the immanent nature of the universe in our minds, always namely our minds are requiring the way-paving input by the transcendental reality to exclude a complete mutual misunderstanding.

Under the presentday convenient, cosmologic view of modern astrophysics upon the world and its upcoming activities the cosmic evolution thus seems to appear as a sheer mechanics of a pure law-conformal evolution in view of which the cosmic occurings resemble more an unavoidable determination than a true evolution understood in a strictly biological sense with some open endings. This is a reason to seriously ask the question whether the pure and strict government of the physical laws of nature can at all enable the upcome of something unforseeably new in real nature or in the universe. Is perhaps the cosmic evolution nothing else but the temporal down-processing of a prefixed and predetermined causal context?

This would at least fit together with thermodynamic views like the one culminating in the second main axiom of thermodynamics, namely that all ongoing processes in physics run into the direction of reducing and minimizing the system-information; meaning that the intrinsic information inherent in the present physical status of a physical system at naturally running processes is always reduced. Thus without a "divine" recreation of the state of the universe, the latter never will come back to its earlier physical conditions. Hence the processes running naturally in this universe will unavoidably dissipate the intrinsic information of this cosmic system and will permanently enhance the internal disorder. Thus the way of cosmic evolution should be an unavoidable way towards ever more and more cosmic chaos - towards finally a pure garbidge universe with nothing evolving anymore - independent from where this universe has ever come from!

By the mere fact, that with the help of human brain power no selfconsistent, selfrestructuring cosmos can be conceived, too often it becomes evident that unfortunately only frustrating solutions can be offered by our brain as explanations for perceivable cosmic structures. Our present day cosmology namely offers only and permanently more badly conceived worlds according to which worlds would exist in none of which we would survive - or would like to survive. [1-3]. We all can be most happy that we need not life in one of these theory-conform worlds that our brain has conceived meanwhile in his own responsibility.

According to standard cosmologic views our universe had its origin in the so-called primordial Big-Bang explosion, - but then it is absolutely non-understandable how from these physically completely unconceivable initial conditions (? infinitely hot and dense, with incredibly strong gravitational fields! etc.) already the precisest guidelines of the evolution of mankind could have been fixed - as for instance aiming at such human beings with a brain that later has to understand the world from which it originated.

The situation would be completely different, in case the present universe is operating as a selfsustaining, multiply backcoupled thermodynamic system operating in action loops within a closed attractor arrangement which conserves its own complexity by acting back to all its stimulating action streams [3]. Then one could much more easily understand that within such a multiply intertwined action system man and mankind may have found their places.

Anyway, the following article aims at proving that the present cosmology at least delivers a badly conceived world whose concepts need a permanent correction, an upgrade and a refixing, if they dont want to serve only as a permanent mis-conception of the reality of the world.

II. Can the Present Cosmology Reflect The Full Ontology Of The Universe?

Modern cosmology, as a prefix and prejudice, generally starts from the assumption that the universe has a begin - and that this begin can be seen as reflected in the present day observable conditions of its present cosmic state. In addition the general, important assumption is made that no space point in the universe has any excellence or preference compared to other equivalent spacepoints (i.e. the so-called "cosmological principle!" which was already a required property of the universe very early in the middle ages by Nikolaus Cusanus, 1280 who expressed it like that: This world is a creation where every space point is in the center of it, and no space point is at the border of it) [4]. Cosmology thus is for everybody the same - be it for the man on Earth or for any extraterrestrial being somewhere in the rest of the cosmos - the view of the universe should be the same for all of them [4-6].

What concerns the begin of such a universe one should perhaps first of all ask how relevant this question is at all. Perhaps there is an analogous situation which should teach us about just this: In view of the weather processes on Earth nobody will ask for the begin of these weather processes, the only important question that is permanently put by us and the meteorologists is: How will the weather be tomorrow concluded from what it is today? Transfered to the situation in cosmology that should advice us: We should better analyse the present status of the universe as good as possible and then dare a prediction of how its state just now coming into presence can be predicted. That however would indicate and strongly recommend a new way of practicing cosmology: namely we should try to understand the world better on the basis of its present status and its indications for the next-to-us future, instead of interpreting the future on the basis of its imputed initial state - the begin. How good is our present insight into the history of the universe? And how good can this insight replace the observable facts in that sense that the prediction is as good as the evolving processes themselves?

III. The Modern Standard Cosmology

In the standard cosmology the imputed homogeneity of the cosmic energy distribution and the assumed curvature isotropy serves to allow, that with the help of the Robertson-Walker metric which applies under these conditions Einstein's set of general-relativistic field equations can be reduced to two non-trivial differential equations which by the quantities $\dot{R}$ *and* $\ddot{R}$ describe the velocity and the acceleration of the cosmic scale R [7-11]. In these essential and basic equations it is also assumed that the massive particles in the universe can be described by their mass density $\varrho = \varrho(R)$ which because of imputed mass- and particle number- conservation is inversely proportional to the world space volume, i.e. inversely proportional to the third power of the scale R, i.e. proportional to $(1/R^3)$.

Furthermore, a constant vacuum energy density is considered in the present cosmology, which by the term Λ following Einstein enters these equations [9]. To each volume in the universe this term ascribes a specific volume-specific energy, whereby the physical nature of this type of energy has not yet fully been understood in physical terms. This term thus does not depend on any nature of particles or photons filling this volume, but simply represents a volume-specific energy which, however, if positively valued, describes an accelerative action upon the cosmic scale evolution. This term thus, opposite to all other particle-induced, energy-representing terms in cosmology, describes an accelerative, instead of a decelerative action on the cosmic scale evolution. The effect of this term now opens up quite a new game with the cosmologic parameters of the competing terms: According to the numerical sizes of the different terms characterizing matter density or vacuum energy density compared to the so-called critical density given by $\rho c = 3H_0^2/8\pi G$ (H_0= Hubble Konstante; G= Gravitationskonstante) the result will be very different concerning the associated cosmologic pasts and futures as demonstrated in the following Figure 1.

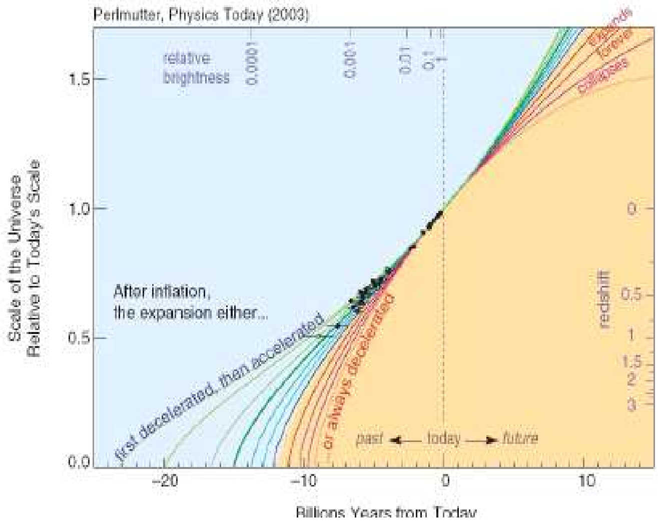

Figure 1: Alternative solutions of the Friedman-Lemaître equations in the frame of the standard-Robertson-Walker cosmology [12].

From the multitude of solutions shown in the above figure one can now try to select that specific solution which, with respect to the given astronomical facts, appears to be the best fitting one. Such astronomical facts, however, do not simply come out of the hand of the astronomical observers, they namely have to be found for these purposes by selected and complicated, theory-immanent methods from existing observations. For example, the cosmic distance of the most distant SN1a supernovae can only be found by the selection of the appropriate cosmology model so that the expected luminosities of these most distant standard radiators in the frame of the standard modelling nicely fit together [13]. At this best-fitting procedure of course a best-fitting consensus model in any case can be found, but the given energy-proportions of such consensus worlds are nevertheless surprisingly strange and head-shaking:

According to Perlmutter et al. the dominant portion of the cosmic energy, namely 72 %, is due to "dark energy", i.e. the vacuum energy described with Einstein's term Λ [13]. The second-important contribution with 23 % comes from the so-called "dark matter", that obscure form of matter that up to now has not at all been confirmed by physicists as existing, but needs to be expected as present in the universe because of a need of otherwise unexplained gravitational binding forces in galaxies [14]. This finally then means, however, concerning the outcome of this fitting procedure that what one thought would make and represent the world by its nature, i.e. just the real matter!, will to everybodies embarassement according to this game only contribute less than 5 %. Consequently as quintessence of this cosmology it turns out: The essential part of this universe obviously is its emptiness, i.e. its energetic vacuum! The important question put by F.W. Leibnitz (1719): "Pourquoi il y a plutot quelques choses, que rien?" should therefore now be changed into: "Pourquoi il y a plutot rien, que quelques choses?" Under such strange cosmic conditions the Hubble-constant $H(x) = \dot{R}(x)/R(x)$ and the cosmic expansion velocity $\dot{R}(x) = R(x)$ would be represented as functions of the Hubble age as shown in Figure 2:

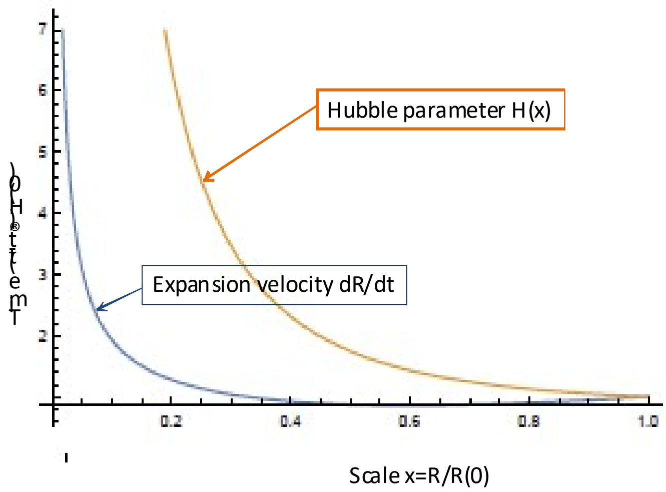

Figure 2: Shown is the Hubble Parameter $H = H(x) = \dot{R}(x)/R(x)$ (yellow curve) and the expansion velocity $\dot{R}(x) = dR(x)/dT$ (blue curve) as functions of the normalized scale $x=R/R_0$ calculated on the basis of best-fitting values of cosmic ingredients for baryons, dark matter, photons and vacuum energy Ω_B,Ω_D,Ω_V and Ω_A (see Figure 1 and Perlmutter et al. (1999))

IV. The Malediction with The Cosmic Vacuum Energy

The question what in fact and precisely means "empty space" - or its synonym "vacuum" - has astonishingly enough not yet been answered up to the present days in form of a physically clearcut and handable definition. But nevertheless it seems that this definition is of profoundest importance, at least when seen for the future of cosmology. Answers to this question given over the last centuries have been analysed and examined by many different authors like and do not need to be repeated here, rather some of the most fundamental aspects of them may first be emphasized here [2,12,15,16]. One of the biggest challenges in this game is that "empty space" despite its conceptual emptiness nevertheless can be considered as "energy-loaded", simply because of its genuine property as physical space to offer disposable, but seperated and identifyable places with coordinate-dependent, different energy depositions. Just this strange and controversial aspect we now shall have to analyse in its cosmic meaning.

In a short-cut first definition we would like to characterize "empty space" as a space-time continuum without any "topifyable" or localizable energy representations, as for example mass singularities in form of point masses like baryons, leptons, darkions or photons, perhaps even without local vacuum fluctuations, even though the modern quantum theory assumes that this latter request can not be fulfilled, since vacuum fluctuations in which form ever cannot be suppressed. Nevertheless it perhaps had to be discussed whether such empty spaces could not be "energy-loaded", by a form of energy which needs to be connected with the sheer volume size or perhaps with the space-geometry, as conceived in general relativity. Nontheless it had to be discussed, whether or not these empty spaces nevertheless can represent some energy just by the size of their volumes. This space energy probably had to be described by the sheer size of the space volume, i.e. related to the volume size or perhaps to the space geometry as conceived by general relativity. Of course this should be without preference of any special space point [3]. If curvature properties play a role here, then only in such a way that they do not favour specific space points, hence they only can be characterized by general, global properties of space as for example the general space curvature.

In this sense Fahr has shown that the conservation of vacuum energy of the dynamical, cosmic spacetime can be formulated as constancy of the proper energy of the cosmic proper volume comoving with that volume [1]. The invariance of this proper energy can of course only be expected, if this quantity does not perform physical work on the dynamic of the cosmic space time. For instance in the frame of the Robertson-Walker cosmology by influencing the evolution of the cosmic scale factor $R = R(t)$ which is related to the cosmic space. If on the other hand such a work is performed, and the vacuum energy influences the space-time dynamics, then automatically thermodynamical conditions must be satisfied, as especially the following relations between vacuum energy density ϵ_{vac} and vacuum pressure p_{vac}:

$$\frac{d}{dR}(\epsilon_{vac}R^3) = -p_{vac}\frac{d}{dR}R^3$$

This latter thermodynamic relation can, however, mathematically only be fulfilled, if vacuum pressure p_{vac} and vacuum energy density ϵ_{vac} are related to eachother by:

$$p_{vac} = -\frac{3-\xi}{3}\epsilon_{vac}$$

where ξ is a pure number, namely the polytropic index of the vacuum which for $\xi = 3$ represents the special case of a vanishing vacuum pressure. This allows to conclude that even at this poor knowledge about the physical nature of vacuum, the above relations between vacuum pressure p_{vac} and vacuum energy density ϵ_{vac} at least have to be fulfilled in a universe that reacts under cosmic vacuum energy influence.

This consensus model best representing present observational facts which is the basis of results displayed in Figures 1 and 2 is questioned by several points that have to be mentioned now: A universe that expands by the action of vacuum energy to larger and larger scales $R_0 \leq R_1 \leq R_2$ does evidently perform mechanical work against the intrinsic gravitational attraction forces of the cosmic matter field. If the vacuum energy is responsible for this expansion, as it happens in the model used by Perlmutter et al., then it logically needs to be expected that the energy of the vacuum because of performing mechanical work has to decrease [13].

If on the other hand, as assumed by Perlmutter et al. in their standard cosmology, it is treated as constant, so we are confronted with the physical absurdity that in this case a physical quantity acts upon the universe without the universe acting back to this quantity, not even being able to react back at all [13,16]. This is fully in contrast to Newton‘s basic axiom: "Nulla actio sine reactionem!". It would mean that the cosmic vacuum, though performing work at the universe, permanently increases its total energy. This would be a universe with a pure "Muenchhausen"-character drawing itself along its vacuum hairs out of its singular gravitational mud and, doing so, even gaining permanently more and more cosmic energy. A miscreation of theory!

Are there perhaps beyond the standard cosmology alternative formulations under which the fate of the universe can appear more rational, but still conform with the cosmologic main facts? The following questions had to be answered perhaps before entering into a new cosmologic model beyond the present standard model:

How does the total mass of the universe behave at the expansion?
How behaves the matter density in a curved universe?
How behaves the vacuum energy in an expanding universe?

V. How Reacts The Total Mass of The Universe With Expansion?

That the total mass of the universe M is a conserved quantity has always been taken as evident in the past years. But still it may be asked why at all should this quantity be constant? And how at all this quantity M should be defined in a physically relevant form? To let this question sound a bit more serious, let us pick up this question here and compare it with an idea of the

Austrian physicist Ernst Mach: Mach was active as Professor of physics at the university of Vienna (Austria) and in the year 1883 wrote an interesting book: " The mechanics in its evolution: A historical, critical representation" [17]. In this book he was speculating on the point that masses in the universe are not genuinely defined, holy quantities or natural constants, but properties which are connected with or related to the size R of the universe [18,19]. This Machían idea, as fascinating it was from the very beginning, never has been seriously implemented into cosmology. Nevertheless fascinating hints are existing, that such a cosmic mass behaviour would make a deep sense for cosmology and in fact would give explanations for many open cosmologic questions [20-26]. If the present cosmology would have to fully respect this fascinating " Machian"- idea, then this would immedeately dethrone the status of the present day cosmology, and simultaneously with that would manifest that the last essential brigg in the ontologic state of our universe has not been found yet.

This becomes evident from a number of reasoning: If one deduces the general relativistic field equations from a variation principle applied to a matter- and metric- relevant action function $L_{g,M}(xi, \dot{x}i)$, this then will lead automatically to a scaling of the rest masses *m* of cosmic particles with their world line elements, which clearly can be interpreted as a Machìan mass phenomenon. On the other hand studying numerically the equivalence of rotations in the choice of reference systems (i.e. principle of equivalence of rotations!), then it turns out, that a rotating earth in a universe at rest only then has identical phenomena with the earth at rest in a rotating universe, if the cosmic masses do in fact linearly grow with the cosmic scale R [20,22,23,27-30].

The question now may pose itself: What is the total mass *M* of the universe? And it leads one to unexpected, but very interesting and basic ideas, as for instance whether at all the total cosmic mass *M* can be added up from all its elementary masses *m* as a simultaneous physical quantity of the universe. For that purpose the four-dimensional space geometry of the universe has to be taken into account, and in addition it has to be respected that mass in this approach is envisioned as a "simultaneous quantity", that means the space-like sum of all masses in the universe whatever physical meaning that may have. Under these auspices it turns out that such a sum for a specific scale R_U, however, approaches a maximum $M(R_U) = M_U$ which finally then could be called the mass of the universe [24]. Hereby the final radius R_U of this summation is interestingly enough given by a quantity, which is inversely proportional to the average cosmic mass density ϱ_0 at a reference scale R_0 and is given by:

$$R_U = \frac{1}{\pi}\sqrt{\frac{c^2}{2G\rho_0}}$$

Here *c* denotes the velocity of light, and *G* Newton's gravitational constant. Inverting the above relation, then it expresses the fact that the cosmic mass density ρ_0 is inversely proportional to the square of the final radius R_U of the universe, i.e. interestingly enough not to the cube of it, as one usually would expect. In addition, it follows from these relations again the Machìan expectation that the instantaneous mass of the universe M_U is proportional to its final scale R_U according to:

$$M_U \sim \rho_0 \cdot R_U^3 \sim R_U$$

a relation that also identically could have been derived from Thirring's relation [20]. On the other hand this also a posteriori shows the connection already concluded from Mach's relation [17].

VI. Mass Generation in the Expanding Universe

Many people like to ask themselves, whether at the evolution of the expanding cosmos something new in form of information or new particles enters into the universe, or is all already from the begin of the universe present? Already it appeared in 1948 to the famous astrophysicist Fred Hoyle that for the purpose of a conservation of the cosmic state a mass generation in the expanding universe has to be admitted. For his "steady state" - theory , i.e. to keep the universe stable in its information, a certain mass generation at a given expansion rate of the universe has to be admitted. Independent on how nowadays the ideas of Hoyle are judged, it is interesting a posteriori to state, that the mathematical and physical formulation for the needed mass generation leads to a universe which analogous to the Einstein - De Sitter universe works with a cosmologic constant Λ, if one only replaces this constant Λ by a matter generation constant $\dot{\rho}$ given by [28,31]:

$$\Lambda = \left(\frac{8\pi G\sqrt{3}}{c^5}\dot{\rho}\right)^{2/3}$$

With this relation it seems to become evident, that vacuuum energy, judged by its cosmologic effect and described by the constant Λ, is equivalent to a cosmic mass generation , at least in case of the steady state universe with $\dot{\rho} \sim \rho = const.$

In a completely independent consideration Fischer discussed, how the gravitational binding energy of cosmic mass should enter the energy-momentum tensor $T_{\mu\nu}$, i.e. the source tensor of the space-time geometry in the general relativistic field equations [26]. Interestingly enough his considerations lead to the result that at least for positively curved universes the corresponding entrance into this tensor by $T^b_{\mu\nu}$ would be given by

$$T^b_{\mu\nu} = -C\frac{\rho}{\Gamma}g_{\mu\nu}$$

Where the metric tensor is denoted by $g_{\mu\nu}$, Γ is the actual curvature radius, and *C* is an appropriately selected constant. This points to two relevant facts: First here again the proportionality of the binding energy with the density ϱ becomes evident. Futhermore the above term has a negative sign and has a proportionality to the metric tensor $g_{\mu\nu}$ and thus formally in the field equations has the same appearance as the term which in connection with the vacuum energy enters the field equations by the quantity Λ.

This seems to manifest a generally overlooked, but very interesting physical connection of vacuum energy and gravitational binding energy. In addition, when taking the time-like tensor components T_{00} and $T_{00}{}^b$ together, also this points to an interesting connection of cosmic matter generation and cosmic binding energy by the following expression:

$$\hat{T}_{00} = T_{00} + T_{00}^{b} = (\rho - C\frac{\rho}{\Gamma})g_{00}$$

The latter relation expresses the fact: By the gravitational binding of the cosmic matter the effectively acting cosmic matter density ρ^* compared to the cosmic proper density ϱ is simply reduced to the following quantity:

$$\rho^* = \rho(1 - C\frac{1}{\Gamma})$$

If in the course of the cosmic expansion the cosmic curvature radius Γ grows, then this means that the binding energy - and as its equivalent - the vacuum energy decreases, while at the same time the effective density ρ^* varies with the following rate:

$$\dot{\rho}^* = \frac{d}{dt}[\rho(1 - C\frac{1}{\Gamma})]$$

In case of Hoyle‘s steady state universe with $d\rho/dt = 0$ this then simply means [27]:

$$\dot{\rho}^* = \rho C\frac{1}{\Gamma^2}\dot{\Gamma}$$

One obtains a density generation rate $\dot{\rho}^*$ which is proportional to the density itself and which is positive at an increasing curvature radius Γ. Or in other words: At decreasing binding energies in the universe the effective density grows at a rate which is identical to Fred Hoyle‘s request [27].

If one introduces the above discussed term for the gravitational binding energy into Einstein‘s field equations, then one finds for positively curved universes cosmologic solutions for which the scale of the universe oscillates between negative ($R \leq R_0$) and positive ($R \geq R_0$) values in line with positive and negative values of the associated cosmic vacuum energy density. Vacuum energy, binding energy and changes of the effective mass density according the above derivations are thus closely connected with eachother, and as consequence, cannot be seen as separate cosmologic ingredients - a new perspective which has not been adapted in the standard cosmology.

VII. Which Mass Density Gravitates In The Relativistic Cosmology?

The question what is the mass density in the universe, contrary to most people‘s believing, is not at all a trivial one. It rather is to be called "a highly problematic question", since mass density is connected with space geometry, which latter one seriously only knows about after obtaining the solutions of the field equations. As density usually a spacelike amount of matter per space volume is denoted. In that sense the density is addressed as "proper density" of the cosmic matter, i.e. as amount of matter in a volume unit in a non-accelerated reference system. In the universe free-flying inertial systems (co-moving inertial rest frames) are certainly existing, however, over finite dimensions of finite volumes unavoidably non-inertial tidal forces are existing, which take care of destroying the local geometry and the size of the volumina. This fact complicates the situation very much, by making the space geometry and the matter content of volumes interdependent.

The effect of this space distortion may be briefly analysed here; screening out a specific mass from the rest of the universe by its Einstein-Straus sphere (local inertial sphere), then this allows to devellop with respect to the mass density of this sphere the following argumentation [27,31]: If we denote the cosmic proper density with ϱ_0, then the proper mass $M(R_{ES})$ of the Einstein-Straus sphere should be given by:

$$M(R_{ES}) = \frac{4\pi}{3}\rho_0 R_{ES}^3$$

The Einstein - Straus sphere in a curved universe does, however, not simply have its Euclidic volume $V_{0,ES} = \frac{4\pi}{3}R_{ES}^3$, but a metrically distorted volume with $V_{ES} \lesseqgtr V_{0,ES}$ which has the consequence that the effective density in this sphere is not equal to the proper density ρ_0, but to a metric-specific density ϱ_{ES} given by the following expression:

$$\rho_{ES} = \frac{\frac{4\pi}{3}\rho_0 R_{ES}^3}{V(R_{ES})}$$

Calculating the space-like volume of the Einstein-Straus sphere using the inner Schwarzschildmetric for the matter-filled sphere , then this leads to an expression for the effective density which for cases $R_{ES} \ll R_U$ can be represented by the following form [27]:

$$\rho = \rho_0(1 - \alpha\rho_0^{1/3})$$

meaning nothing else but thet the effective density is always reduced with respect to the proper density and in fact all the more the higher the proper density is in this cosmos.

We again here want to come back to the local mass M, which belongs to the local Einstein-Straus sphere. This sphere limits the local mass M by a spherical surface at which the inner Schwarzschild metric of the sphere steadily merges into the outer Robertson-Walker metric of the outer universe. In brief, this limit is just there where the cosmic space points of the spherical surface do expand from the Einstein-Straus center just with the general Hubble expansion $\dot{R}_{ES} = H_0 \,.\, R_{ES}$ with [27,28]:

$$\dot{R}_{ES}/R_{ES} = \dot{R}_0/R_0 = H_0$$

VIII. Mass Generation in Gravitationally Bound Systems

Let us assume now a universe with vacuum energy. Then one may want to ask, what kind of work is performed by this vacuum energy at the expansion of the Einstein-Strauss sphere [27]? Asking for the physical work which the vacuum energy performs at the sphere expansion it turns out that this work seen from the inside of the sphere is positive. Starting from the basis that due to energy conservation principles this positive amount of work is reflected by an energy gain of the sphere, then it seems to make sense to assume that this energy gain is reflected as a mass gain of the Einstein-Straus mass M_{ES}. This, however, then has very interesting consequences for this Einstein-Straus mass M_{ES}, namely meaning:

$$\frac{\dot{M}_{ES}}{M_{ES}} = \frac{\rho_{0,vac}}{\rho_{0,mat}}H_0$$

where $\rho_{0,vac}$ and $\rho_{0,mat}$ denote the actual equivalent mass densities of the vacuum and of the matter . For a constant ratio of the energy densities of the vacuum and of the matter this relation, because of $\dot{M}_{ES}/M_{ES} \sim \dot{R}/R$, then simply states a proportionality of the Einstein-Straus mass, and of course also the world mass M, in the form

$$M \sim R$$

just as it was already requested by Ernst Mach [14].

IX. Why Does A Vacuum Gravitate?

Let us ask now, how in view of the above vacuum energy, should be formulated, if in fact it represents a valid analogue to an effective cosmic mass generation and a cosmic binding energy. For a long time in the past cosmologists have asked themselves why at all the cosmic vacuum induces a kind of gravitational attraction when it represents in fact nothing more than emptiness. When, however, as done in present times, energy is ascribed to the vacuum, then this vacuum as all other energy depositions in the universe should in principle contribute also to the cosmic gravitation and to the spacetime geometry. The question then only remains: How does it do this? The general-relativistic action of the vacuum is nowadays formulated via a properly formulated energy-momentum tensor $T_{\mu\nu}^{Vac}$ of the vacuum installed into the field equations. As entrances into this tensor the vacuum energy density $\epsilon_{vac} = \rho_{Vac} C^2$ and the vacuum pressure p_{vac} would have to serve which in case of a constant vacuum energy density would lead to a tensor $T_{\mu\nu}^{Vac}$ simply proportional to the metric tensor $g_{\mu\nu}$ in the form [13]:

$$T_{\mu\nu}^{Vac} = \rho_{Vac} c^2 g_{\mu\nu}$$

The question coming up then is: Does Einstein's cosmologic constant Λ lead to an identical formulation with the above derived one? Are perhaps both formulations identical, and we only must use the one or the other, or both have to be taken into account ? Here it can be shown that in case of a completely empty universe controlled by a pure vacuum this is characterized by an "effective cosmologic constant Λ_{Eff}" given by [9]:

$$\Lambda_{Eff} \equiv \Lambda + \frac{8\pi G \rho_{Vac}}{c^2}$$

In this expression we have two quantities which are unknown by their numbers, namely the cosmologic constant Λ and the energy density or its mass equivalent $\epsilon_{vac} = \rho_{Vac} C^2$ of the empty space. There is, however, an interesting way to solve this problem in one single step by answering the question: What should be expected from an absolutely empty cosmic space? Logically the pure vacuum should have the property of guaranteeing the selfparallelity of a relativistic four vector at its parallel transport over a closed world line [2]. Physically that should imply that the polarisation vector of a linearly polarized , electromagnetic radiation at its propagation over a closed world line is conserved. Mathematically this implies that the commutator of the covariant derivatives with respect to coordinates μ and ν applied to any transported four vector A_λ has to vanish. That on the other hand means that a vacuum which has this property must be described with a cosmologic constant with the following value [12]:

$$\Lambda = -\frac{8\pi G \rho_{Vac}}{c^2}$$

With the consequence that the effective cosmologic constant Λ_{Eff} then vanishes and any geometrical action of the vacuum is completely removed with $\Lambda_{Eff} = 0$.

X. The Cosmic Vacuum in a Matter-Filled Universe

Now the non-trivial question has to be answered, how the action of the cosmic vacuum can be described in case the universe is a matter-filled one, when no apriori requirements can be formulated for the state of the space of the system. It also under these conditions can not be simply assumed that the vacuum energy density of the matter-filled universe is as large as that one of the empty universe. One namely has to expect that matter polarizes the vacuum and this way changes its energy density [5,32].

To better jump on this idea it may help to bring in front of our eyes what must have happened in the past or in the the future of this universe, if the actually supported values for the vacuum energy density and the matter density of the present universe with $\Omega_\Lambda = 0.75$ and $\Omega_M = 0.23$ were to be taken as fixed cosmologic values. In the near future one then, because of the scale-dependence of these quantities, would have values of $\Omega_\Lambda = 1.0$ and $\Omega_M = 0$, while in the past one would have had values of $\Omega_\Lambda = 0$ and $\Omega_M = 1.0$. The cosmologic past thus would have been dictated purely by cosmic matter, while the cosmic future will be completely dictated by vacuum energy. This, however, means one would have to take the fact that just at our times Ω_Λ and Ω_M have about the same orders of magnitude as an absolutely astonishing "anthropical coincidence and miracle". The only viable explanation why this is not an anthropical accident or a miracle is to assume, that the presently given ratio of $\Omega_\Lambda/\Omega_M \simeq 1.0$ represents a constant or a cosmologic quantity valid for all periods of the universe. Reasons for that fact must, however, first be found.

XI. The Zero-Energy Universe

To many people in the world it would give them a good basis to know, that this world consists of "nothing". Because then it would also be easy to understand that this world could originate from nothing, and the plagueing question how the origin of the world could happen at all, would have an easy and evident answer; it came from nothing, it is nothing, and will be nothing for ever. But how such an idea can be put on physical grounds? Physically spoken, - nothing is absense of energy. But is the assumption of complete absense of energy a rational approach towards our universe where evidently the energies of stars and galaxies, added up from all the universe, evidently represent a huge amount of energy? The answer can astonishingly enough ΛS be: "YES"! Namely, if all positively valued energies E are completely balanced by negatively valued energies U, e.g. like binding energies, with the result $E + U = 0$! Whether or not such a condition can be realized at all, can be investigated, but it definitely requires a universe different from that which we presently believe in.

For that purpose let us construct an expression for the total energy. Herby not only the available energies have to be added up over the total cosmic space, which serve as energy equivalents of deposited masses with densities ϱ, but also the thermal and kinetic energies of the masses have to be taken into account, what can be done by accounting for their pressures and bulk velocities. For a total balance, one thereby has to count for baryonic mass densities ρ_b, dark matter densities ρ_d, and the mass equivalent density of the vacuum ρ_{vac}. The same procedure has to be carried out for the respective pressures in the form $p = p_b + p_d + p_{vac}$. The resulting expression E reveals as proportional to the cube of the cosmic scale, i.e. R^3.

Along a similar procedure the gravitational binding energy of the mass- and energy- carrying cosmic matter by adding up scale-per-scale of the gravitating mass and energy in their gravitational binding strength to the rest of the world. Hereby one finds for the total binding energy U an expresssion, which is proportional to the fivth power of the scale R, i.e. R^5.

Requiring now that E and U just compensate, this then leads to the requirement:

$$\frac{3c^2}{2\pi GR^2} = (\rho_b + \rho_d + (\xi - 2)\rho_{vac})$$

Where ξ again is the polytrope of the relation between vacuum pressure and vacuum energy density as given in the form:

$$p_{vac} = -\frac{(3-\xi)}{3}\rho_{vac}c^2$$

As can be recognized from the above, the requirement $E + U = 0$ can only be fulfilled, if all mass densities in the universe are scaling with $\varrho \sim R^{-2}$. That implies that the mass densities ρ_b und ρ_d scale like $\varrho \sim R^{-2}$, different from the generally expected form $\rho \sim R^{-3}$., meaning that a cosmic mass generation according to

$$\dot{\rho}_{b,d} = \frac{\rho}{R}\dot{R} = \rho H$$

Has to happen which exactly corresponds to the mass generation rate, which we have required for bound mass systems in the universe as expression of the work of the vacuum pressure at the expansion of the universe.

This answers easily the question how the required mass generation can be explained; Now the cosmic vacuum energy density is not anymore taken to be constant as in the standard cosmology, but it is reduced in an expanding universe like $\rho_{vac} \sim R^{-2}$, from where one can easily draw the solution $\dot{\rho}_{vac} = -\dot{\rho}$ [13]. This means, however, that in a zero-energy universe vacuum energy has to convert into matter energy with the exciting consequence, at very small cosmic scales , i.e. towards the begin of the universe, the energy of the universe becomes more and more vacuum energy, while the matter energy towards the Big-Bang dissolves, i.e. vanishes. This fits perfectly into the view developped recently by Fahr speculating that the Big-Bang only could happen as an explosion of the initial cosmic vacuum [1].

When the cosmic scale towards that begin has diminished to the Planck scale, i.e. $R \simeq R_{Planck} = 1.6 \,.\, 10^{-33} cm$, this would then also make it understandable that at this scale the vacuum energy would reach its absolut x maximum with a value that quantum field theoreticians always have propagated , i.e. $\varrho_{vac,BB} = 10^{122}\, \varrho_{vac,0}$ [24]. It also nicely would fit together with the idea of Fahr and Fahr and Heyl that the Big-Bang never could have happened without the primordial cosmic vacuum [1].

This does, however, not unavoidably prove that this universe has originated from this Planck 'ian vacuum bubble where the Big-Bang must be seen as the initial explosion of the absolute, primordial vacuum, it rather could perhaps simply mean, that this universe at all times represents a well balanced state of vacuum energy and matter energy, which perhaps in its scale R can be thought as swinging around an equlibrium state $R = R_0$. At least this world which is evident to us as human beings in this universe should be understood as a well balanced system between positively valued and negatively valued energies , which in its present state does not give any hint for its origin in the Big-Bang - a view fully in contrast to the present-day Big-Bang cosmology.

XII. The End of the Perceived Universe

As seen by many of the presentday cosmologists the Big-Bang cosmos presents to his spectateurs a view of a world system that is fully determined from its Big-Bang begin to its cold and dead end. The question, however, is whether we should simply let our human and cosmic end be defined by a badly conceived universe? Perhaps we should better not do this, since looking at this a little bit more in detail, one quickly will recognize, that even in the frame of the Big-Bang cosmology the entropic end of the universe is not at all predictable.

For an adequate description of the actually present cosmic system as a whole the classic thermodynamics can not really serve as a guideline, since the "universe as a whole" is not a well defined and closed thermodynamic system. For this reason the validity of the second main theorem of the thermodynamics can not help here. All the better defined thermodynamic subsystems in the universe, like galaxies and systems of galaxies, are all nonequilibrium systems which practise an efficient energy exchange with their cosmic environments - causing their entropy clocks to run either backwards or forwards dependend on the balance of emitted and absorbed energies. Hereby the biggest cosmic system is the visible stellar cosmos embedded in the radiation background of the 3K - microwave background radiation. Since all stars, however, are hot radiators compared to the cold cosmic background radiation with only 2.735 Kelvin, they can all get rid of energy by wasting it into the radiation background. This, however, allows them to reduce their entropies and organize new structures [24].

The main point why in the universe entropy generation runs under different but Boltzmann-thermodynamic aspects results from the fact that in the universe stars, galaxies, and galaxy systems as micro-entities of the cosmos correspond to atoms and molecules in the Boltzmann-Gibbs statistic and thermodynamic considerations. Between the first and the latter ones there are, however, big differences which have the consequence that the Boltzmann´s energy balancing by the so-called Boltzmann H-function $H(t) = \int f(\vec{v},t) \cdot \ln[f(\vec{v},t)] d^3v$ which in a thermodynamically closed system has permanently to drop to lower values cannot be applied under these conditions anymore.

This fact has the following reason: Boltzmann´s microparticles experience as consequence of collisions within a very short time, compared to the time between collisions, by short-range forces stochastic momentum changes. These short-range forces, however, are not perceived by all the other particles which are not participating in this specific local collision event.. This phenomenon in Boltzmann´s denotation is called the "molecular chaos", or in other words the molecular blindness for the distance. Now it is of big cosmic importance that this phenomenon of Boltzmann's molecular chaos does not prevail under cosmic conditions, since in the universe between stars and galaxies forces of very long range are operating, namely non-saturating gravitational forces. As a consequence in the universe no "microparticle"-chaos exists, but in principle all mircoparticles of the cosmic system do recognize jointly the change in the gravitational force constellations. Thus no approach towards an equilibrium, as in case of the molecular chaos in Boltzmann's collision dominated system, can be expected, but only an approach to a scale-specific and system-specific structure attractor. Hereby the singular substructures of the system enter into temporarily energetic equilibria with their environment, but they do not approach a general entropy equilibrium of the global system.

The thermodynamically prefered structure attractor thereby is determined by the thermodynamical constitution of the system horizon and is at a temporal change of this system horizon of course also time-pedendent [24]. In a system with an open thermodynamic horizon - meaning - as long as the subsystems can get rid of their entropy transporters – like binding-equivalent photons - no final entropy chaos will be able to establish in this universe. The end of the world thus is not as close and annoyant as often claimed in standard cosmologies. One rather has to learn that in the upcoming future permanent revisions of our contemporary cosmologies will have to come up to let cosmologists keep pace with the cosmic structuring events [33-44].

What about starting to think of a world with no begin, but also no end?

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