Two thermodynamic particularities of the dynamic glass transition in liquids: 
Glarum-Levy defects and Fischer speckles – cosmological consequences

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A new thermodynamics for liquids related to von Laue’s approach (1917) substitutes some particle priors of Gibb’s rational thermodynamics. This allows the definition of a new dynamic entity (G defect) whose diffusion properties also claim a largest causal region (F speckle). In the frame of the hidden charge model it is discussed, whether this new thermodynamics can be applied to an initial liquid for cosmology, where the G defects lead to the later galaxies and the F speckles to a finite expanding universe of diameter \( R \). Far below a "hadronic" Compton wave length \( \lambda_0 \) of order 1 fermi, \( R \ll \lambda_0 \), there is no room left for too small filter elements, that would, however, be necessary for a filter convergence to an isolated cold quantum mechanical point particle. When the expansion of the universe comes to \( \lambda_0 \), i.e. for \( R \approx \lambda_0 \), then many hadrons are created. The related negative pressure gets large amounts and leads to an intense hadronic cosmological inflation.

- The G defects are formed by the shaping power of Levy distribution (preponderant component, hierarchy, damping factor). A relation between the number of galaxies, the tilt in the density fluctuation, and the temperature amplitude of the CMB is obtained. For \( R \gg \lambda_0 \) (much vacuum), the "electromagnetic" \( M_4 \) tangent objects are large and flat. This allows a geometric interpretation of the "stony" dark energy as flatness on the "golden" side of the Einstein equation, \( \Omega_\Lambda = 1 - \Omega_M \).

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2. power spectrum  
3. dark energy theory  
4. gravity
1. Introduction

About 1960, a change in education and evaluation of general phenomenological thermodynamics was observed. Before 1960, it was mainly based on arguments by Carnot, Kelvin and Clausius. After 1960, it was mainly based on the Gibbs distribution of statistical mechanics. This Gibbs rational thermodynamics has the following priors for a system of interacting structureless particles:

1. The only general entities are the particles; the rational is obtained from the thermodynamic limit: number of particles \( N \to \infty \) under the condition of finite density \( (N/V = \text{given}) \),

2. There is a large heat reservoir that feeds the temperature \( T \) as an equivalence-class index into the system,

3. The non-fluctuation of the reservoir temperature, \( \delta T = 0 \), is transferred into the definition of the general temperature (to justify the sharp \( k_B T \) denominator in the Boltzmann factor for energy in the Gibbs distribution).

These priors are tried and tested in systems where the spatial infinities, sufficiently separated from the particles, are contained inside the system itself, quasi as an internal heat reservoir. Examples are the infinite lattice in a solid or an infinite vacuum of vacuum elements in a gas with isolated particles imbedded. We ask, whether these priors can be applied to liquids, especially to liquid dynamics, where such separated infinities are not obvious.

The existence of two experimentally well-tried particularities could be useful for cosmology by starting the universe from an initial liquid (initial liquid hypothesis). Smaller ones (Glarum Levy defects for dynamic heterogeneity of the dynamic glass transition, \( G \) defect as a new entity) could be the seeds for the later galaxies – we use now the symbol \( N \) for their number in the universe –, and a larger one (Fischer speckle) could be the largest causal region in the initial liquid, wherefrom the increasing diameter \( R(t) \) of the expanding universe results.

In the dispersion zone of the dynamic glass transition of a classical molecular liquid, the \( G \) defects must dynamically be described by a Levy distribution with a Levy exponent \( \alpha \), \( 0 < \alpha < 1 \) for relaxation (frequency \( \omega \leq 10^{11} \text{rad/s} \)). This follows from the representativeness theorem (section 3.1). The difference \( 1 - \alpha > 0 \) is called tilt and is later related to the tilt \( 1 - n_S \) of the spectral index \( n_S \) in cosmic density fluctuations. The preponderant component of the Levy sum for \( \alpha < 1 \) corresponds to a Levy diffusion step of a molecule through the cage door of its nearest neighbor particles. A relation between the small \( G \) defects and the large \( F \) speckle is obtained via an "analytic continuation" of the diffusion steps. If the application to the cosmological initial liquid is reliable, a relation results between the number of galaxies \( N \) in the universe of diameter \( R \) and the tilt \( 1 - n_S \). All this is worded by the phrase "shaping power of Levy distribution".

The thermodynamic entity is the key concept of this second paper[11]. This entity is defined dynamically by a representative containing one \( G \) defect which is formally labeled by one Boltzmann constant \( k_B \) from an internal quantum mechanical experiment of Nyquist (1928), cf. the Remark of section 3.1. The internal experiment is a "self-experiment" in the liquid – without any reservoir and without any conscious observer – that is thermodynamically described by the fluctuation dissipation theorem (FDT).

This self-experiment may be understood as a common filter construction of the hidden charge model[1], common in relation to several particles, or to quantums in a Nyquist transmission line. In the model, a common filter construction from several eigensolutions must be allowed for the construction of e.g. a baryon: from a 1-class lepton, a 2-class prebaryon and a 3-class confinon eigensolution. The entity is, so to speak, a common thermodynamic "culminating event" of the model.

The term defect diffusion was introduced by Glarum[1]. An experimental retardation function that could later be identified with the characteristic function of the symmetric Levy distribution was detected by Kohlrausch in 1847. Many experimental hints of the connection of glass relaxation data with an underlying Levy distribution where collected, e.g. by Ngai[3]. A theoretical review was e.g. by Shlesinger[4]. The Fischer dispersion zone[5] and his speckles[6] are reviewed by himself. The Levy character of the defects was further developed in the book[7] containing also the representativeness theorem. The FDT as an equation for thermodynamic self-experiments was developed on
the base of the Nyquist model, first in 1982 and later sophisticated in . Glass transition arguments were used in cosmology e.g. in the paper of She. The hidden charge model is discussed in part I.

2. Thermodynamic entities. von Laue vs. Gibbs thermodynamics

In classical liquids, local Glarum-Levy defects (G defects) are necessary, densely neighbored dynamic phenomena. The Levy property is a consequence of the representativeness theorem (section 3.1), their locality (finite volume, equation below) is a consequence of the local high-frequency break throughs they are (“levy instability”, otherwise a general negative pressure would be obtained), and the dense arrangement is a consequence of their mutual coexistence condition emerging from spatial aspects of the individual Levy damping factors \((n^{-1/\alpha})\). The G defects are connected with thermodynamic (= internal quantum mechanical) self-experiments. – On the other hand, the rational Gibbs thermodynamics is not the consequence of such a self-experiment, if a large external heat reservoir – i.e. a macroscopic apparatus or observer – is considered to be necessary.

2.1 Temperature fluctuation

The absence of infinitive attributes for self-experiments means that there are no further restrictions to equilibrium fluctuations. Then the G-defect entity can be connected with an internal temperature fluctuation \(\delta T\). The rational Gibbs thermodynamics has no such a \(\delta T\), because \((\Delta T^2)^{1/2} = 0\) is supposed, and new entities (besides the particles) cannot be described there. von Laue suggested a thermodynamics for two independent pairs of variables (entropy \(S\) and temperature \(T\), volume \(V\) and pressure \(p\)) that allows to calculate the average temperature fluctuation of a representative subsystem:

\[
\Delta T^2 = \frac{k_B T^2}{C_V},
\]

where \(C_V\) is the extensive heat capacity, \([C_V] = J/K\), and defines the size of the subsystem. The smallest representative (in the time scale of the dynamic glass transition) contains one G defect – otherwise it would not be representative –, its characteristic volume is therefore.

\[
V_{mt} = \frac{k_B T^2}{C_V / \rho \cdot (\delta T)^2}
\]

where the index \(mt\) means the main transition, i.e. the dispersion zone of the dynamic glass transition; the small letter \(cV\) is the specific heat capacity, \([cV] = J/kg\cdot K\). The cubic root of \(V_{mt}\) is called the characteristic length, \(\xi_{mt} = V_{mt}^{1/3}\). The characteristic volume can be determined by dynamic heat capacity, e.g. similar results are obtained from dynamic compressibility, \(\partial V / \partial p(\omega)\). For high temperatures (and frequencies) a characteristic volume of order the volume one molecule is obtained, for low temperature near the conventional glass temperature \(T_g\), the order of 100 molecules is systematically reached. This behavior suggests that the characteristic length is a reasonable quantity.

2.2 Gibbs prior consequences

If a similar formula would be throwed together from Gibbs, a thermodynamic compliance \(\Delta c_V\) is obtained instead of a modulus \((\Delta(1/c_V)\) in equation:

\[
V_{mt}^{Gibbs} = \frac{k_B T^2}{\Delta c_V / \rho \cdot \delta T'^2}
\]

where \(\delta T'\) is now calculated from the \(mt\) transformation interval corrected by freezing-in effects. Using the same set of experimental data as for equation, the \(V_{mt}^{Gibbs}\) values are much larger than \(V_{mt}\) from – reflecting the Landau-Lifshitz subsystem size based on statistical independence as defined by the Gibbs distribution (or static correlation functions) – and do not show a systematic increase with falling temperature. This behavior suggests that the construct is not a reasonable quantity.
2.3 Experimentum Crucis for G defect entities

Today, the majority of thermodynamic colleagues does not believe in equation (2). To prove unambiguously the existence of such an entity, we need another experiment that uses a definite, continuously varying length testing the glass transition zone (mt) at different temperatures $T$ and frequencies $\omega$, e.g. a wave vector $Q \approx 2\pi/\text{length}$, and which length can be compared with the characteristic length from thermodynamics. Static X-ray or neutron scattering is not suitable, because the appropriate contrast in pure liquids is too low. More suitable is e.g. the dynamic neutron scattering (DNS) in partly deuterated, otherwise pure liquids. But today, a direct comparison with e.g. dynamic calorimetry (DC) is not possible because there is a frequency gap between the former ($\gtrsim 10 \text{ Mz}$) and the latter ($\lesssim 0.01 \text{ Mz}$) method. According to an judgement of leading people in DNS, e.g. Dieter Richter\cite{[18]}, the gap can be closed in some years, in 2012, say. If the lengths obtained from the two methods would be consistent (and well outside the Gibbs formula), then this Experimentum Crucis would be positive for the new entity.

A log $\omega – \log Q$ plot could be used for the comparison. The relevant (diffusion, relaxation) part of the dynamic intermediate scattering function gives a Levy extended-exponential time $\tau_{mt}(Q)\cite{[18]}$ that can be transferred (via the Levy exponent $\alpha\cite{[21]}$) in a frequency $\omega(Q)$. From this, a raster of DNS isotherms in the above plot can be constructed. The $(\omega, T)$ points from DC can be put in this raster, and the lengths from DNS-$Q$ values on the abscissa, say, can directly compared with characteristic lengths from DC. It remains to check the minor uncertainty, how density and entropy responses can be compared.

3. Length relation between $G$ defects and $F$ speckles
3.1 Shaping power of Levy distribution for $G$ defects

Let us explain the concept of shaping power of Levy distribution in more detail than above. Consider a common space in two dimensions: the $x$ axis be the natural space across the $G$ defect and the $\omega$ axis be the frequency axis of the event space of probability. After a common scaling (shorter modes are quicker, i.e. have a higher probability), the center $x = 0$ is the middle of the defect with the larger frequency $\omega$ values (“$\omega \rightarrow \infty$”) and the periphery is the borderline region to the neighbor defect with the lower $\omega$ values. Center and periphery of the $G$ defect substitute thermodynamically a cooperatively rearranging region\cite{[19]}, an entity with low density contrast. In the common space, the particular properties of the Levy distribution are differently located. This is called shaping power. The preponderant component\cite{[21]} with an influence of order of the tilt $(1-\alpha)$ on the whole Levy sum of random variables, and the upper, fractal hierarchy of this ordered sum (by $n$) are located at the center; while the damping factor $n^{-1/\alpha}$ of the ”lower hierarchy” (large $n$) is arranged near the periphery in the entities where the sum breaks down by diving below the neighbor defect. In other words, irrespective of the low ”static” density contrast, the borderline between the entities is defined by the mutual disturbance of the differently centered (in space) shaping powers of neighboring $G$ defects; the borderlines define the characteristic volume \cite{[21]}. Since the Gauss distribution ($\alpha = 2$) has no particular properties such as hierarchy etc., a shaping power cannot be defined for Gauss and Gibbs: The shaping power is for the dynamic heterogeneity.

The Levy distribution density $p(\omega)$ is thus realized by a spectral density $x^2(\omega)$ in the measure $d\omega$ with $dx = x^2(\omega) d\omega$. For large frequency at the $G$ defect center we find fractality,

$$p(\omega) \sim \omega^{-1-\alpha}.$$ \hspace{1cm} (4)

The center is then connected with the local break through of the mobility (Levy instability). The preponderant component corresponds to the diffusion step of the molecule through a cage door of neighbor molecules in the center. As known from probability theory\cite{[20]}, for $\alpha < 1$ the Levy exponent $\alpha$ is often the only important parameter of the limit distribution. Theoretically, the Levy exponent $\alpha$ must be realized during a renormalizing limit process of the sum, $n \rightarrow \infty$. The Levy exponent $\alpha$ depends on a plurality index $q$ that depends for a given defect on the kind of disturbance / response, on temperature, and pressure. The reason for plurality is that the numbers $n$ for the Levy sum of a $G$ defect are not so large as e.g. the huge number of filter elements for the renormalization of charge and mass of elementary particles, where a pure huge-number approximation seems to be a reasonable approach (cf.\cite{[10]},
sections 5.2 and 5.3 there).

As a consequence of this picture, the local diffusion is determined by the fractality, as observed by DNS\textsuperscript{23}. A sublinear \textit{Levy diffusion} is obtained as

\[ \omega \rightarrow \omega^\alpha, \quad \tau \sim \xi^{2/\alpha} \]  

having the Cauchy limit \( \alpha = 1 \) for \textit{normal diffusion}, \( \tau \sim \xi^2 \) (\( \xi \) being the relevant length).

Remark. Very general reasons are necessary to apply the above shaping-power scenario to a cosmological initial liquid. Example. The representativeness theorem\textsuperscript{7} shows that the Levy dynamic heterogeneity of the dynamic glass transition (\textit{mt}) can even be derived from arguments of classical thermodynamics alone. This theorem says that the dynamic compliances have Levy-distributed times with a Levy exponent \( \alpha \leq 1 \), whereas the corresponding "static" spatial correlations have a Gauss distribution (\( \alpha = 2 \)). Roughly: The Levy distribution follows from a general limit theorem of probability theory (excluding others than Gauss and Levy, cf. Feller in\textsuperscript{21}), since fluctuation (variance) and expectation is infinite due to the Levy instability in the cage. This is a new entity, thermodynamically a minimal representative with one \( G \) defect (representative for the whole system, cf. the equation (2) arguments); the infinities follow from the negative pressure inside, especially \( \alpha \leq 1 \) follows from the infinitive expectation of the diffusion step. Since the probability density of classical systems is symmetric, the characteristic function is proportional to \( \exp(-a|t|^\alpha) \) leading directly to the experimental Kohlrausch function. The use of compliance (instead of a modulus) follows from the relation to the additivity of the ordered Levy sum via the FDT as measuring equation.

3.2 Largest causal region (\( F \) speckle) from Levy diffusion (\( G \) defects)

One of the greatest surprise in classical glass transition research was the discovery that the Debye Büche inhomogeneities in frozen glasses\textsuperscript{24} correspond to a slow dispersion zone. These "Fischer modes" \( \phi \) have relaxation times e.g. \( 10^7 \) times longer and mode lengths e.g. 50 times larger than those of the dynamic glass transition (\textit{mt})\textsuperscript{15,16}. The corresponding Fischer speckles contain, according to the length ratio \( \phi/mt \), a large number \( N_G \) of \( G \) defects. The origin of such large numbers is the next task.

We assume – against wild structural speculations in the literature, e.g. Fischer clusters – that the Fischer modes are a direct consequence of the dynamic glass transition \textit{mt} without any structural input\textsuperscript{17}. Then we have to look for a physical \( G \) defect process that eats its way through large space \( \xi \) and time \( \tau \) ranges: a Levy diffusion process equation (5). We expect, therefore, that the tilt \((1-\alpha)\) with the Levy exponent \( \alpha \) defines the large number \( N_G \) (figure 1).

Forward, how probes the fast \( G \) defect process the slow \( \phi \) process? The \( G \) defects have a large density, in classical liquids \((1/V_{mt})\) from equation (2) of order \( 1/nm^3 \). The molecular diffusion is therefore step by step with short times \( \tau_{mt} \) and short lengths \( \xi_{mt} \), from one \( G \) defect to the next neighboring one along a diffusion line (figure 2a). We find therefore the Levy diffusion (5) as observed\textsuperscript{23}, along to full distances of the \( F \) speckles by "analytic continuation" with the sublinear slope.

Backward, how probes the slow \( \phi \) process the fast \( G \) defect process? In the large \( \phi \) time order \( \tau_{\phi} \), the fast dynamics of the small \textit{mt} subsystems are mutually statistically independent (for \( \tau_{mt} \ll \tau_{\phi} \)). The many \textit{mt} subsystems allow a quasi thermodynamic treatment. The thermodynamic variables \( X \) have a finite variance. The relaxation can then be described by \( \Delta X = -\text{const} \Delta X \), with a positive constant. This gives the exponential decay leading via a Cauchy law \((\alpha = 1)\) to normal diffusion in equation (5).

Consequently, we find the space and time scales for the \( F \) speckles \((\xi_{\phi}, \tau_{\phi})\) at the upper \((\phi)\) corner of the triangle in figure 1: The Levy diffusion, to be effective, must be faster than the normal diffusion. In larger scales, beyond the \( \phi \) corner, the construction is exhausted, which means that the \( F \) speckle defines a largest causal region in the classical liquid.
To get a formula, we start from the triangle basis $\varepsilon$. This is the logarithm-of-time difference between the normal and Levy diffusion at the $G$ defect length scale $\xi_{mt}$. The Levy diffusion is at high "fractal" frequencies near the $G$ defect center at the cage door, i.e. at some $\bar{t}$ in the short-time tail of the $mt$ process. The normal diffusion, however, is near an average of time (in logarithmic measure), $t_{av}$:

$$\varepsilon = \log_{10}(t_{av}/\bar{t})_{mt}$$

(6)

i.e. $\varepsilon$ is of the order $1/\alpha$, the width of the response function on the $\log_{10} \omega$ axis (figure 3.7b of [7]).

Both ratios tend to infinity for vanishing tilt, $1 - \alpha \to 0$ (or $\alpha \to 1$, Cauchy). Large ratios can therefore easily be obtained for small tilts, also such ones as observed in the classical liquids [7]. Example. The number $N_G$ of $G$ defects as claimed by the Fischer speckles as largest causal region in $d$ dimensions is

$$N_G = \left( \frac{\xi_\phi}{\xi_{mt}} \right)^d = 10^{\frac{d\alpha\varepsilon}{2(1-\alpha)}} = 10^{\frac{d\alpha\varepsilon}{1-\alpha}}$$

(8)
For $\{d = 3, \varepsilon = 1, 1 - \alpha = 0.13\}$ we get $N_G = 10^{10}$; this value can also be obtained e.g. for $d \cdot \varepsilon = 0.83$ and $(1 - \alpha) = 0.04$, and so on.

For cosmological applications (section 6), we should discuss the relation of the $G$ defect tilt $(1 - \alpha)$ to the scalar index tilt $(1 - n_S)$ from the power law fit of the density fluctuation spectrum. It seems useful, however, first to devote the next sections 4 and 5 to gravitation and inflation of our model.

4. Graviton as torus for a charge, randomly constructed from four $\vartheta$ segments of the hidden charge model

Our model does not have an eigensolution for gravitons. If the graviton is some type of charge (gravitation as a charge is discussed by Feynman[25]), and if a charge is characterized by at least one $S^1$ torus in the model, then an extra torus beyond the eigensolutions must be constructed: A circle $S^1$ from four $\pi/2$ segments of $\vartheta$ may be linked by four random connections called spots (● in figure 3). The mass concentration into galaxies can give spots in the particle environment, if the culminating-point filter construction from large to small filter elements is considered as some map of the universe in the Mach’s principle layer of the tangent objects (I, table 2 of appendix C there). E.g. the central black holes of galaxies may give the randomly selected linking spots in the ”dollhouse universe” around any particle (section 7).

![FIG. 3: Graviton torus from four $\pi/2$ $\vartheta$ segments in the tangent objects of any particle.](image)

The number of spots is equal to the number of galaxies in the universe, $N_G \approx 10^{10}$. Assuming some statistical independence in the random selection of the four spots, we get a probability for the graviton of about

$$P (\text{graviton}) \approx 1/N_G^4.$$  \hspace{1cm} (9)

This probability may be compared with the probability of order $P = 1$ to find a charge torus for the other particles participating in an interaction considered. This means that the gravitation is, for given ”distances”, weaker by a factor of order $10^{40}$ than the electroweak and strong interaction.

A review of our model constructions for particles (eigensolutions [I, section 3], for common eigensolutions [I, section 5], for exchange boson construction [I, appendix C], and for the dollhouse universe (section 7, below) seems to show that now the application of torus constructions for particles is exhausted (table 1). Our model is now complete.

Via an adapted van der Waerden (vdW) construction[26], the gravitation torus of figure 3 defines a metric tensor $g_{ik}(x)$ with spin $S = 2$ on the reality space from $M_4$ tangent objects. Because the gravitation is so weak and stems from the far universe, we can speak about a shadow metric over the reality $M_4$ space, if the particles or mass concentrations are widely isolated in a vacuum (”much vacuum”).

5. Hadronic inflation of cosmological expansion

In our model, quantum-mechanically behaving cold hadrons are not realized before the expansion of the universe reaches the length scale of order $R \approx 1$ fermi. Moreover, in this scale the first black holes are formed in the center of
TABLE I: List of $S^3$ torus topologies defining charges of our model.

| torus coordinates | name | application |
|-------------------|------|-------------|
| $(\varphi_1, \varphi_2)$ | $S^1$ in the $S^3$ Heegaard tori | electrical charges |
| $(R, -R)$, figure 6 there | | |
| $\tau$ | $S^1$ tori of the hidden space $S^1 \times S^3$ | photon identity |
| $\vartheta$ | dollhouse from four tori, identity | graviton |
| $\pi/2$ segments | | figure 3 |

$G$ defects.

The empirical mass scale $m_0$ above the neutrinos is from MeV to TeV, without the electrons we find a scale from GeV to TeV; inclusive the stable atoms. In sufficiently large $M_4$ tangent objects, we have a Compton wave-length of

$$\lambda_c = \frac{2\pi\hbar}{m_0c} \approx \frac{1.24 \text{ fermi}}{m_0/\text{GeV}}, \quad 1 \text{ fermi} = 10^{-15} \text{m.} \quad (10)$$

Assuming that only the heavy particles are of cosmological influence for a cold expansion, then the energy scales for quantum flavor dynamics (QFD) and chromo dynamics (QCD) have length scales of

$$\Lambda_{\text{QFD}} \approx 250 \text{ GeV}, \quad \lambda_{\text{QFD}} \approx 0.005 \text{ fermi} \quad (11)$$
$$\Lambda_{\text{QCD}} \approx 150 \text{ MeV}, \quad \lambda_{\text{QCD}} \approx 8.3 \text{ fermi}.$$  

Shortly, we call this generous region "hadronic":

$$100 \text{ MeV} \ldots 250 \text{ GeV}, \quad 0.005 \text{ fermi} \ldots 10 \text{ fermi} \quad (12)$$

with $\lambda_0 = 1 \text{ fermi} \approx 1 \text{ GeV}$ and the proton mass $m_p$ as typical parameters. For high temperatures, $k_B T \gg m_0 c^2$, the de Broglie wave lengths are much shorter. This is called "hot"; our hadronic scale \[12\] is then called "cold". We try to describe the expansion of the universe as a cold phenomenon, because our model mass scale is confined from above by existential instability (generalisation of figure 5 in [11]).

5.1 Cold inflation

Consider in advance a box with a length $l$ ($l$ in meters). Without $x/\psi$ or $M/E$ separation, the box must be filled with particles that must be hot for small boxes $l < \lambda_0$ (because of the quantum mechanical uncertainty relation). With $x/\psi$ or $M/E$ separation, however, an empty small box is possible: A culminating-point particle at $x$ supposes the existence of small filter elements $l' < l$. This is not possible for cold particles in case of $l < \lambda_0$, because then smaller elements ($l' < \lambda_0$) are not possible due to the upper limit of the hadronic region (equation \[12\], see also figure 6 of [11]). The uncertainty relation follows from $\psi(x)$ assuming the possibility of existence of a particle at $x$ as the basic prerequisite. This must be assumed for a manifold diffeomorphism (without $x/\psi$ separation), but this is excluded for cold particles in the too small boxes ($l < \lambda_0$) from our independent culminating-point particles (with $x/\psi$ separation).
Let us now specify the concept of filter elements sometimes used above. Since a filter is considered as some kind of a map from the hidden $H$ in the reality $M$ space, it contains things from the origin $H$ (e.g. vacuum elements) and the image $M$ (metric for $M_4$ or $E^4$ tangent objects). Our mathematical filter sets contain, therefore, a certain size variation and get some relation to a Cauchy filter (figure 1b of [I]). The filter sets of vacuum elements resulting from existential instability are therefore called filter elements.

The method used for our inflation scenario is the cutoff filter of figure 4. The filter elements on the $M_4$ tangent objects for cold model hadrons (in the vdW spinor space) should not become smaller than the hadronic scale $\lambda_0$, because then the Compton wave length (as condition for their cold quantum mechanical existence) is not available for virtual filter elements in the too small universe ($R \ll \lambda_0$). Such cold quantum mechanical particles cannot exist as points there, but only as larger constructs of the model, hidden by the eigensolutions on the $H$ space ($S^1 \times S^3$), and lurking there for their convergence to particles in the reality space for $R \gtrsim \lambda_0$. In other words, for $R \ll \lambda_0$ there is no room enough to realize a cold quantum mechanical particle (a hadron) in the reality space (cf. with the box discussion above).

![Diagram](image)

**FIG. 4:** Filter construction on $M_4$ and $E^4$ tangent objects. a (left). For cold particles we find a cutoff filter for $R > \lambda_0$. The cutoff at $R \approx \lambda_0$ has a negative pressure from creation of many hadrons during expansion. b (right). For non-isolated dark matter particles in an $E^4$ Euclidean environment, the filter is not cut and we find always positive pressure, $p > 0$. If, however, because of expansion, dark matter particles become isolated, i.e. if they will be imbedded in Minkowski space − then they are also to be treated by the left hand side cutoff scenario (a).

This holds also for 2-class particles (e.g. dark matter or prebaryons) with "internal" $E^4$ tangent objects, if they are isolated by imbedding in an "external", sufficiently large Minkowski space from $M_4$ tangent objects of the other particles or other participants of common culminating points. This does not hold, however, if they are not isolated, i.e. if they are living in an $E^4$ environment from tightly neighboring particles of 2-class eigensolutions, e.g. from dark matter particles. The missing time in $E^4$ does not allow to define the Planck constant $\hbar$ needing the seconds. Then the filter is not cut (figure 4), and cold dark matter particles (and prebaryons) can also exist at high density for $R \ll \lambda_0$. Dark matter particles are preferred in the small universe.

In other words, if the cosmological expansion of a cold initial dark-matter universe crosses the hadronic length scale, $R \approx \lambda_0$, then many hadrons (and hadron pairs) are formed which were absent before in the reality-space of the universe. This is a typical situation for negative pressure, $p < 0$ (figure 4 again). [Remember: Thermodynamically, the pressure $p$ is one of the variables that are necessary for maintaining the considered equilibrium state. For representative subsystems with length $l$, here for $l \ll R$, this pressure $p$ would be the "external" pressure. There is a widespread misunderstanding, that negative pressure can be defined by radially escaping particle trajectories. Such behavior would also be typical for positive external pressures $p'$ with $0 < p' < p$.] During a period of forming many new particles, controlled by the Lagrangian, the (stationary) state can only be maintained, if the pressure $p$ is
negative, \( p < 0 \), and the system (our universe), therefore, is expanding.

This expansion stage directly driven by hadronic forces is called \textit{hadronic inflation}. If this is connected with a "hadronic cosmological constant", suitably compared to gravitation, we would get the factor \( 10^{40} \) of equation (9). The cold hadronic inflation is therefore an extremely violent stage of expansion without hot \( X \) particles from a gauge unification at \( 10^{16} \) GeV.

### 5.2 Stages of the hadronic inflation

The resulting scenario for the hadronic inflation is characterized by the following concepts (figure 5). The infinitely large liquid system ("primeval soup") is called "original", because it exists also before the universe comes into being as consequence of a Linde type of fluctuation. The developing small \( (R \ll \lambda_0) \) universe is called "initial", because it is related to its beginning and its independence; it is a first step in a series of processes, developing from a Linde fluctuation in a maximal causal region claimed by an \( F \) defect of the original liquid. The violent increase near \( R \approx \lambda_0 \) is called "hadronic inflation" as defined above. Immediately after this violent hadronic pulse, the universe cannot be controlled by the too weak gravitation. Later, however, for \( R \gg \lambda_0 \), the expansion control is captured by gravitation and is then called "primordial".

![FIG. 5: Terminology of the hadronic inflation scenario.](image)

The stages of the scenario are discussed according to our model with respect to the crumbled space (mix of \( M^4 + E^4 \)), to gravitation, and to expansion.

\textit{Original state.} Assuming a large volume of the original liquid, we get point particles from 1-, 2-, and 3-class eigensolutions via the non-virtuality of the small filter elements, e.g. photons, hadrons, and dark matter point particles. The high density corresponds to a crumbled space of \( M_4 \) and \( E^4 \) tangent objects. Although \( G \) defects seem to bee possible, we get no gravitation, because their number \( N_G \) tends to infinity in the large volume \( (1/N_G \to 0) \) and, additionally, the links for gravitons (● in figure 3) are expected to be too weak because of their weak contrast. Dynamic \( F \) speckles as a consequence of \( G \) defects should still define maximal causal regions for Linde fluctuations.

\textit{Initial liquid.} Since only the dark matter particles and prebaryons remain points for \( R \ll \lambda_0 \), their fraction in the expanding Linde fluctuation should be large. We expect a fluctuation (Boltzmann zacke) with many dark matter particles in the high-density liquid, and with no isolated hadrons because of virtuality in their cut off filter. If there are cold photons (no \( \lambda_c \)) but too weak for an imbedding \( M_4 \) space, we extremely get an Euclidic \( E^4 \) space, or at least a crumbled space with a high \( E^4 \) fraction. In the extremum, time seems to be standing still, and we find only a "shape of time", some succession of fourdimensional Euclidic \( E^4 \) spaces. The reason for the expansion in this stage is therefore highly speculative also in the frame of our model and rests on a certain cold photon fraction. E.g., one possibility would be the vanishing of the original \( M_4 \) particles (hadrons) due to their transfer into the virtuality in such a Boltzmann zacke (figure 4a). This could mean a positive pressure \( p' \), \( 0 < p' < p \), in the universe for \( R \ll R_0 \).
The total topology of the whole universe from the $F$ speckle may be formed in this expansion stage. $R$ is the radius of the emerging universe in meters. The topology may be induced from the two hidden Heegaard tori of the charge symmetry and from imbedding of $R$ in a crumbled space with dominating fourdimensional $E^4$ tangent elements. This is, I think, a situation that favors a total $S^3$ sphere instead of a $D^3$ disk, irrespective of local curvature fluctuations inside.

*Hadronic inflation.* For $R \approx \lambda_0$ the hadrons come into the play. This generates the negative pressure leading to a violent expansion transferring the dark matter particles in the isolation. They are then imbedded in the Minkowski space allowing their quantum mechanical behavior for $R \gg \lambda_0$. If the $G$ defects from the zacke are intensified to become the links for the gravitons, then gravitation is switched on during the inflation. This intensification could be possible by their transfer to black holes (section 5.3). [This would mean that the galaxies come finally from the shaping power of Levy distributions, section 3.1.]

*Primordial stage.* If we put on a material variant then the emerging particles drive the expansion, not a vacuum field: this stage develops from the motion of interacting "hadronic" particles. In the inflation stage ($R \approx \lambda_0$) and for high particle density in the cold universe, the gravitation has no or at most a minor influence ($10^{-40}$, equation 9). In the further expansion, we get increasing distances between the particles and particle congregations. For electric neutrality, the vacuum gets influence via the gravitation (section 5.3). A control by gravitation, however, is only possible for not too small $R$. The expansion can then be captured by the Friedmann Lamaitre (FL) equations, containing besides the Newtonian gravitational constant $G_N$ the mysterious cosmological parameter for gravitation, $\Lambda$ (section 7.2).

This material variant has no superluminar particle velocities and is based on special relativity in the Minkowski space from the $M_4$ tangent objects. We have no serious horizon exit and reentry problems during and after the violent pulse from cold inflation. Our material variant is an alternative to the conventional vacuum variant: The superluminal velocities there may result from requirements to the FL equations, e.g. stationary during inflation: $1/H = \text{constant}$, density $\rho_V = \text{const}$, and a field $\phi$ for the vacuum $V$. Let us repeat: It is the field $\phi$ that is considered in the vacuum variant, not cold particles with mass in the material variant as used here.

### 5.3 Cold Hawking unification?

The Hawking temperature for black holes,

$$k_B T_H = \frac{hc^3}{8\pi G_N M},$$

connects gravitation ($G_N$), hole mass from particles ($M$), photon ($c$) and thermodynamics ($k_B$). Equation (13) is sometimes considered as the basis for an unification of gravitation with the other interactions. Using, however, conventional gauge invariance principles, the unification with gravitation is usually obtained in a hot universe that is characterized by temperatures or energies of order the Planck mass ($m_{Pl} = (hc(G_N)^{1/2} \approx 10^{19}\text{GeV}$). We try to find a cold alternative in the frame of our model.

Consider the $G$ defect as representative thermodynamic entity (from which the one $k_B$ for the Hawking temperature comes). The physical process for the equilibration of temperature is now the exchange of particles (mass $m_0$) at the horizon of the black hole. – We consider first the particle concentration inside the $G$ defect. In "cosmological approximation", the extensive entropy is equal to the number of particles in the mass concentration of the $G$ defect, identified with $M$:

$$S_m/k_B \approx N_{\text{particles}} \approx M/m_0 \propto M.$$  

The corresponding Bekenstein Hawking entropy for the black hole is
\[
\frac{S_A}{k_B} = 4\pi G_N M^2/\hbar c \propto G_N M^2 \propto M^2.
\] (15)

We ask where the two formulas cross each other \((T^X, \lambda^X = r_S^X, M^X)\), equation (14) for the \(G\) defect mass concentration without a black hole, and (15) for a black hole formed by this mass concentration of the \(G\) defect (figure 6).

FIG. 6: Crossing of particle entropy of a \(G\)-defect mass concentration \(S_m\) with a horizon area entropy \(S_A\) for a corresponding black hole. The drawn lines are from an entropy maximum principle, the broken lines are extrapolations. \(\lambda^X\) is the cross length scale related to the Schwarzschild radius of the black hole, \(r_S\). Below \(\lambda^X\) of order the hadron Compton length (equation (18) below), the particle concentration of the \(G\)-defect with no black hole is the optimum.

Using the Schwarzschild radius

\[
r_S = 2G_N M/c^2
\] (16)

we get from (14) and (15) for the crossing of figure 6

\[
M^X = \lambda_0 c^2 / G_N 8\pi^2, \quad \lambda_0 = \hbar/m_0 c,
\] (17)

where \(m_0\) is the mass of particles considered. Then we have

\[
r_S^X = \lambda_0 / 4\pi^2 \quad \text{and} \quad k_B T^X = \pi \hbar c / \lambda_0.
\] (18)

Schwarzschild radius and Hawking temperature at the formation of first black holes are in the hadronic region. The number of particles with mass \(m_0\) is

\[
M^X / m_0 = \hbar c / 8\pi^2 m_0^2 G_N \propto 1 / m_0^2 G_N.
\] (19)

For protons \((m_0 = m_p)\) we get a mass \(M^X\) of the first black holes of order \(10^{10}\)kg, for dark matter particles
Gravitation is first realized by strengthening of torus links, this is called “cold Hawking unification”. The gravitational interaction comes into being not before the inflation.

Remark. There is no danger in the LHC experiment that such cosmological black holes can artificially be generated. The corresponding $E = mc^2$ energy is of order $10^{46} \text{eV}$ (calculated with protons), whereas LHC gets maximally $10^{15} \text{eV}$. Higher dimensions as from string theory for small black holes are excluded in our model. Our earth experiments cannot generate a second central black hole in our galaxy.

The crossover mass $10^{17}$ for protons ($10^{16} \text{kg}$) is of order $10^{-20}m_{\odot}$ ($m_{\odot}$ is the sun mass) and is much smaller than the mass of the today central black holes of the galaxies ($10^{10}m_{\odot}$). There are two reasons for this smallness in our scenario. 1. The first black holes from mass concentration are in the center of $G$ defects smaller than the $G$ defects themselves. In a liquid, the center is at the fractal tails of their Levy distributions at large frequencies $\omega$; the preponderant component of the Levy distribution is a part of the mass concentration. In the $E^4$ space, this corresponds to large wave vectors $k$ (section 6). This means that the first black holes are formed at a small part not only of $G$ defects, but also a very small part of the much larger $F$ speckles defining $R$ of the universe. The first black holes are formed at diameters $R$ larger than $\lambda_0$, i.e. at a later stage of hadronic inflation. 2. Since $T_H$ is decreased during the inflation (figure 6), the growing black hole enters at some time a nonequilibrium state, and the further growth becomes irreversible. This is a self-amplifying process, because larger black holes become stronger spots $\bullet$ in figure 3 which strengthens to linking of $\vartheta$ graviton segments increasing the gravitational constant, $G \rightarrow G_N$. There is much enough material left for forming of the galaxy structure. A structure can also be formed in the early primordial state where essential ingredients such as mass concentration and central black holes are already available.

In formulas, the results can bee summarized as

\[
\begin{align*}
\rho_S &\ll \lambda_0 : S_m \gg S_A, \quad T_H \gg \lambda_0, \quad \text{equilibrium,} \\
\rho_S &\gg \lambda_0 : S_m \ll S_A, \quad T_H \ll \lambda_0, \quad \text{non-equilibrium.}
\end{align*}
\]

If the optimum is really defined by the maximum of entropy from the Boltzmann probability, $S = k_B \ln W_B$, we conclude

a) The first black holes of the expanding universe are formed in the spatial center of the $G$ defects during later stages of the hadronic inflation, (where $\rho_S \approx \lambda_0$ is reached).

b) These black holes are formed in thermodynamic equilibrium; later in the larger expanding universe, the black holes fall out of the equilibrium, and their growth becomes irreversible and is mechanically controlled by the Newtonian gravitational constant $G_N$.

In our model scenario, gravitation is unified with the other three interactions insofar as they are relevant to our cold hadronic inflation: via the Hawking temperature equilibration in the hadronic scale $\lambda_0$ of the expansion, $R \approx \lambda_0$. This is called “cold Hawking unification”. The gravitational interaction comes into being not before the inflation: Gravitation is first realized by strengthening of torus links $\bullet$ for the graviton torus of figure 3.

From a methodical point of view, the cold unification corresponds to some calibration of mass values for leptons and hadrons. The filter construction (section 5.3 there) calculates sharp mass ratios, e.g. $\log(m_{\vartheta}(2)/m_{\vartheta}(1))$, that can be related e.g. to $m_{\vartheta}(1)$ as electron or to the proton mass. “Absolute” values can be obtained by comparison with gravitation in the primordial state of the universe. The gravitational constant $G_N$, however, has some fundamental randomness from the number $N_G$ of $G$ defects inside the Fischer speckle (equation 19 and figure 2b leads to the relative order of $1/\sqrt{N_G} = 10^{-5}$ for the fluctuation variance), whereas e.g. the parameters of the electroweak interaction are sharp from the huge numbers of the filter construction.
6. Relation between tilt \((1 - n_S)\), number of galaxies in the universe \((N_G)\), and CMB temperature fluctuation amplitude \((\Delta T)\)

The way from a Levy tilt \((1 - \alpha)\) in the original liquid to the tilt \((1 - n_S)\) of cosmic density fluctuation in the primordial stage is discussed in this section. First three model priors:

a. In the classical liquid, the number of \(G\) defects \((N_G)\) in the maximal causal region \((F\) speckle) can bee estimated using the relevant Levy exponent tilt \((1 - \alpha)\) with \(\alpha = 1\) for the classical Cauchy diffusion (equation (8), figure 1). Small tilts \((1 - \alpha)\) correspond to large numbers \(N\). The estimation is based on an analytic continuation of the Levy diffusion from the \(G\) scale to the \(F\) scale (figure 2).

b. The initial liquid before the hadronic inflation is dominated by Euclidic \(E^4\) tangent objects (section 5.1). To get a tilt in the initial liquid, the shaping power from a classical diffusion Levy instability by free volume may be substituted by the shaping power from an \(E^4\)-potential Levy instability in the initial liquid. The elliptic type of interaction between dark matter particles favors high densities in \(E^4\) instead high frequencies from large local free volume in classical liquids.

c. The first black holes emerge from a mass concentration in the center of \(G\) defects of the initial liquid (section 5.2).

Now three changes of the tilt. First change. During the way from the original classical liquid in \(M_4\) to the initial liquid in \(E^4\) the time is lost (Hawking’s shape of time). Instead of a frequency \(\omega\) for diffusion (besides three spatial dimensions) we have then a fourth wave vector component for density fluctuation in four spatial dimensions. We assume that the Levy exponent \(\alpha\) for the Levy diffusion is transferred into a tilt in the new \(k\) direction. Since \(E^4\) is symmetric, the transfer effect must be distributed in all the four \(k\) directions.

Second tilt change. In the further way, the loss of time cannot be absolute; we need a time for the definition of expansion \(\dot{R}(t)\). In the speculation of section 5.1, this time is connected with photons as “massless points” from the filter elements. There remain only three \(k\) directions which means a second change of the tilt, giving \((1 - n'_S)\) for a density fluctuation before the inflation.

Third tilt change. The next stage of the way is the hadronic inflation up to the primordial stage from which the cosmic microwave background CMB is measured today. The primordial tilt \((1 - n_S)\) follows after this third change \((n'_S \rightarrow n_S)\) during the inflation.

Assume that, via the above three changes, a small Levy tilt \((1 - \alpha)\) in the original liquid results in another small but finite tilt in the primordial state, measured as the deviation \((1 - n_S)\) from the Zeldovich Harrison scaling \(n_S = 1\). Then we get from the three above priors, the three changes, and equation (7),

\[
N_G = 10^{(d \cdot \hat{c} \cdot \alpha\cdot \epsilon/2(1 - \alpha)\cdot 3n_S \cdot \epsilon/2(1 - n_S))},
\]

(21)

where the three changes are collected by the factor \(\hat{c}, n_S = \hat{c}\alpha\). I think that \(\hat{c} = 0(1)\).

Equation (21) shows that a finite universe (containing a finite number of galaxies \(N_G < \infty\)) as consequence of a Linde type expansion can only exist for a finite tilt \((1 - n_S > 0)\). For \((1 - n_S) \rightarrow 0\) we would have \(N_G \rightarrow \infty\) and, because of equation (7), the gravitational constant tends also to zero, \(G_N \rightarrow 0\). Without the finite tilt, i.e. for Zeldovich Harrison scaling of density fluctuation, we would get an infinitely large universe \((N_G \rightarrow \infty)\) with no gravitation.

The average CMB temperature fluctuation \(\Delta T\) can be estimated from Gauss statistics of the smallest representative subsystems, i.e. from the number of galaxies, \(N_G\). The consistency of Levy distribution for estimation of the size of universe and the Gauss distribution for smaller (and therefore faster) subsystems is explained in the text around figure 2. The size of \(\Delta T\) can therefore estimated by

\[
\Delta T/T \approx 1/\sqrt{N_G} \approx 10^{-5} \text{ for } N_G \approx 10^{10}.
\]

(22)
In the model, the finiteness of the CMB temperature fluctuation components \( l(\Delta T) > 0 \) follows from the finiteness of the universe \( (R < \infty) \) and is, from equation (21), related to a finite tilt in the density fluctuation.

7. Intrinsic flatness vs. gravitational dark energy

The model allows to treat the cosmological constant \( \Lambda \) exclusively on the golden side of the Einstein equation; the dark energy can be reduced to the flatness of the underlying \( M_4 \) tangent objects giving \( \Omega_{de} = \Omega_\Lambda = 1 - \Omega_M \). This degrades the dark energy density parameter to \( \Omega_\Lambda = \Omega_\Lambda(t) \) figures of arithmetics of the golden side.

The main idea is: Feeding the torus construction for the graviton (figure 3) into the algebraic vdW spinor construction with physical coordinates for the tangent object defines the manifold diffeomorphism with \( g_{ik} \) for the Einstein Hilbert action. This gravitational \( g_{ik} \) is very weak \( (10^{-40}) \) when compared with the electromagnetic nature of the flat \( M_4 \) tangent objects in a state with much vacuum. It is therefore the geometric golden side of the Einstein equation which determines flatness, not the energetic stony side.

7.1 Mach’s principle of the model

The filter elements mediate some kind of map between the universe and the immediate environment on the \( M_4 \) tangent object of any isolated culminating point particle (section 5.1). Because of conformal invariance of the hidden space, the large filter elements pass over the whole universe down to the small elements of size the particle ('s Compton wave length). Assume that the central black holes of galaxies are mapped into spots on the tangent objects, we get a dollhouse universe around any particle (figure 7). These spots are related to the links of gravitons (● in figure 3) and can therefore be included in the Einstein equation. Since the gravitation is a small interaction (equation 9), we find for isolated objects an additional shadow metric as varying part of \( g(x) \) over the flat \( M_4 \) tangent objects. This defines a new, the Mach principle layer of the tangent objects ([1], appendix C there).

![Mach's principle map](image)

**FIG. 7:** Mach’s principle maps \((- - -)\) the \( G \) defects (more precisely: the galaxies emerging from the \( G \) defects of the original or initial state) of the reality universe via the filter elements into the \( G \) spots on the (corresponding layer of the) tangent objects around any culminating point particle: the dollhouse universe.

If this dollhouse universe from the filter is put on the stony side of the Einstein equation, we would get some "field" \( \phi \) that is neither independent nor a quantizable Higgs field. It is located "wherever" a particle is located, we do not find this field without a particle there. It suits, however, to the equivalence principle of the gravitation theory, since it represents the same situation around any particle.

7.2 Image constraints of the map: shadow metric \( \mapsto \) cosmological standard model

From the viewpoint of a map from a finer model (original) to a coarser model (image), the priors of the latter are image constraints of the map ([1], section 4 there). The finer model may now be characterized by \{flat \( M_4 \) tangent
objects around isolated particles or matter congregations, dollhouse universe, shadow metric}, the coarser model by the total manifold with \( g(x) \) metric, priors of cosmological standard model. We consider the primordial stage (and later ones) of the universe: much vacuum, i.e. only flat and very large \( M_4 \) tangent objects around culminating-point constructions such as leptons, hadrons, dark matter particles, baryons etc., and also around particle congregations such as stars and black holes. We try to reduce the dark energy problem to flatness of the underlying \( M_4 \) tangent objects in the vacuum of the universe.

A prior of the general theory of relativity (gravitation theory) is the \( g(x) \) field that is described by the Einstein Hilbert action,

\[
S(\text{field}) = \left(\frac{1}{16\pi G_N}\right) \int (R_{\Box} - 2\Lambda)\sqrt{-g}d^4x,
\]

where \( g = g(x) \) is then a Einstein Riemann metric assumed to be a manifold for all things of the cosmos. \( R_{\Box} \) is the Ricci scalar curvature. From equation \( 23 \) follows by a variation \( \delta(x) \) and by addition of a material term \( (T_{ik}) \) the Einstein equation. It occurs in two forms, a geometric form with the cosmological parameter \( \Lambda \) on the "golden" side, or an energetic form with \( \Lambda \) on the "stony" side:

\[
\text{geometric, golden} \quad R_{ik} - \frac{1}{2}R_{\Box}g_{ik} = (8\pi G_N/c^4)T_{ik},
\]

\[
\text{energetic, stony} \quad R_{ik} - \frac{1}{2}R_{\Box}g_{ik} = (8\pi G_N/c^4)T_{ik} + \Lambda g_{ik}.
\]

Flatness is a concept for \( \Lambda \) on the golden side (curvature is diminished by \( \Lambda > 0 \) for given \( T_{ik} \)), dark energy is a concept of the stony side (energy is raised by \( \Lambda > 0 \)). [In the literature, the golden side is sometimes called a modification of gravity.] Absolutizing the metric diffeomorphism, both sides cannot be distinguished. The \( x/\psi \) separation, however, can distinguish golden from stony, the two equations are not longer equivalent.

The additional prior of the conventional standard cosmology is the Copernican principle (total homogeneity, isotropy, and cosmic time) that usually is condensed in a Robertson Walker metric for the supposed manifold,

\[
ds^2c^2dt^2 - R^2(t)\left(\frac{dr^2}{1-kr^2} + r^2(d\theta^2 + \sin^2\phi d\phi^2)\right),
\]

with \( k = \{1, 0, -1\} \) as indicator for the Gauss curvature of \( \{S^3, E^3, L^3\}, L = \text{Lobachevsky} \). At the moment, \( k \) is a symmetry parameter of a total Copernican solution, not of the Einstein equation.

The total Copernican prior for the standard model of cosmology are therefore the Friedmann Lamaitre (FL) equations,

\[
\dot{R}/R = \frac{1}{3}[\Lambda - 4\pi G_N(\rho + 3p/c^2)],
\]

\[
(\dot{R}/R)^2 \equiv H^2 = \frac{1}{3}(8\pi G_N\rho + \Lambda) - kc^2/R^2,
\]

where \( (\rho, p) \) are the energy density and the pressure of matter and radiation. The expansion is accelerated by the dominance of \( \Lambda \), with the consequence that the Hubble rate \( H \) increases with larger \( \Lambda > 0 \).
In the language of the stony side, an energy is connected with \( \Lambda \), the dark energy. For a time \( t_0 \) in the primordial or a later stage, e.g. the expansion stage today ("why me, why now\footnote{29}"), the density parameters for matter and radiation (\( M \)) and for \( \Lambda \) are defined as

\[
\Omega_M = \frac{\rho_M}{\rho_{\text{crit}}} = \frac{\rho_M}{\rho_{\text{crit}}}, \quad \Omega_\Lambda = \frac{\rho_\Lambda}{\rho_{\text{crit}}} = \frac{\rho_\Lambda}{\rho_{\text{crit}}} = \frac{3H_0}{8\pi G_N},
\]

(29)

with \( H_0 = H(t_0) \) and \( \rho_\Lambda = \Lambda c^3/8\pi G_N \). Then the space curvature \( k \) is determined by the mysterious dark energy density \( \rho_\Lambda \). For decreasing \( \rho_M \) and given \( \Omega_\Lambda \), the dominance of dark energy \( \rho_\Lambda \) starts at a certain time \( t'_0 \) ("now"); \( \ddot{R}/R > 0 \) for large dominating \( \rho_\Lambda \) is also possible for a flat space.

Experimental flatness means a local (not the total) property \( k \approx 0 \), i.e. \( \Omega_M + \Omega_\Lambda \approx 1 \). The total \( S^3 \) or \( L^3 \) topology may be consistent with small local fluctuations near local flatness, \( \Omega_M + \Omega_\Lambda \approx 1 \), especially for sufficiently large \( R \) and large \( t \) (very much vacuum).

In our language of the golden side, much vacuum between widely isolated phenomena is necessary for a measurable influence of \( \Lambda \). In these large primordial scales, the vacuum is based on the \( M_4 \) tangent objects from the biquaternion construction\footnote{I}. They are flat because the hidden electromagnetic structure is conformal. - Photons and gravitons are the only massless (free) particles in the empty space. The "cosmological" photons in the shadow metric are not bound and change, therefore, their frequency during the primordial expansion. The flat \( M_4 \) tangent objects do not come from photons alone but are bound to the charges of our model (appendix C\footnote{I}). Their \( M_4 \) properties, therefore, do not change during the expansion: they remain exactly flat. The electromagnetic structure of the tangent objects is always much "stronger" than the gravitons for the shadow (equation (22)). This means that the empty basic space (much vacuum) underlying the shadow metric is always experimentally flat irrespective that the curved additional shadow metric is decisive for the gravitational aspects of the primordial universe. Both the flatness and the shadow curvature can be placed in the FL equations, i.e. in the priors of conventional standard cosmology.

On the golden side, the above stony alternative is then to be interpreted by the local relation \( \Omega_\Lambda + \Omega_M \approx 1 \). The stony term \( \rho_\Lambda = \Lambda c^3/8\pi G_N \) is not an energy in the golden-side interpretation; i.e. the stony dark energy is geometrically defined by golden flatness,

\[
\Omega_\Lambda \approx 1 - \Omega_M.
\]

(30)

The universe is experimentally flat since the primordial stage. The \( \Omega_\Lambda = \Omega_\Lambda(t) \) term in equation (30) is degraded to figures of arithmetics. There is no extra dark energy in the cosmos and a search for it, e.g. in form of certain Higgs particles, is not necessary from the viewpoint of our model.

Guth’s flatness is possible without GUTs.

The destiny of our model universe is local flatness without matter, \( \Omega_M \to 0 \), i.e. \( \Omega_\Lambda \to 1 \). If the universe has got a total \( S^3 \) topology (section 5.1), then the universe in the limit gets practically the state of the hidden charge, conformality without gravitation, and the play can start anew, without any trace from the foregoing universe, but with the same parameters so far as they are determined by the culminating point filters. [On the other hand, this means, e.g. that the new gravitational constant is not exactly the same, since there is a variance of the number of \( G \) defects inside the Fischer speckles (of order of \( 10^{-5} \) for \( N_G = 10^{10} \), cf. the end of section 5.3)].

7.3 Two properties from the dollhouse universe

1. Equation of state parameter \( w = -1 \). Introduce a new parameter of the stony side, \( w = p/\rho \). Because of the huge number of vacuum elements in our model, we have no fluctuation of the stony \( \phi \) field. From thermodynamics, especially from the fluctuation dissipation theorem FDT, we get no response from no fluctuation. From the FL equations we obtain, via
\[
\dot{\rho} = -3H\rho(1 + \frac{P}{\rho}) \tag{31}
\]

the relevant response as

\[
d\ln \rho / d\ln R = -3(1 + w). \tag{32}
\]

From no response we have then \( w = -1 \) as announced. This justifies also the only use of \( \Lambda \) alone in section 7.2.

2. The photon/baryon ratio is of order \( 10^{10} \). The pass-over of the large filter elements corresponds to one "cosmic interaction diagram" between a Feynman vertex of the baryon pro one galaxy spot. The spot acts as catalyst, because in the large number approximation there is no feedback from the Feynman vertex to the galaxy. The vertex forms a surviving baryon in the model lepton capture reaction with a confinon and a prebaryon (I, equation (19) there). The surviving rests on a different partial chirality of the participating prebaryon (II, appendix C). Since the prebaryon has an electric charge, we assume that there is about one photon pro one interaction. For \( N_G = 10^{10} \) we obtain the announced ratio.

8. Conclusion

The hidden charge model (shortly: the model) is introduced by two concepts: conceptual separation of mass and energy behind \( E = mc^2 \) and a new entity for an initial cosmological liquid. The model remains in four dimensions, has a clearly arranged particle spectrum confined by the TeV scale, and is supplied with a rich thermodynamics. This allows a serious proxy representation and a heuristic approach which two are suited to the early stage of the conventional new standard cosmology. The model is much simpler and more robust than highly sophisticated approaches, e.g. string theory.

A hadronic inflation emerges because cold baryons can first be realized in the length scale of \( R \approx \lambda_0 = 1 \text{fermi} \). For \( R \ll \lambda_0 \), the filter elements for culminating-point baryons with \( M_4 \) tangent objects are too small for quantum mechanics in a cold reality. Dense dark-matter liquids, however could be realized for \( R \ll \lambda_0 \) because their tangent objects are \( E^4 \) Euclidean allowing points smaller than \( \lambda_0 \). The sudden occurrence of baryons (and hadron pairs) at \( R \approx \lambda_0 \) generates a large (hadronic) amount of negative pressure and therefore a violent pulse for inflationary expansion. During its cosmic time scale the first small black holes emerge that allow a cold Hawking unification of the four interactions.

The new entities in the liquid are called Glarum Levy defects (G defects). It is finally the shaping power of the Levy distribution that forms the galaxies of the universe and allows a relation between their number \( N_G \) and the tilt \((1 - n_S)\) in the density fluctuation. \( N_G \to \infty \) would mean no tilt and no gravitation.

The decrease of the filter element size during forming the culminating points corresponds to a map of the universe in the \( M_4 \) tangent objects near culminating point particles. In this dollhouse universe are, in accordance with Mach’s principle, the galaxies mapped to small spots that are used to construct gravitons as charges from four hidden \( \vartheta \) segments randomly connected by the spots. This defines gravitation, in the vacuum as a shadow metric over flat \( M_4 \) tangent objects as basis. The underlying flatness is based on electromagnetism, much stronger than the weakness of the shadow metric from gravitation (factor \( 10^{40} \)). This allows a purely geometric interpretation of the cosmological parameter \( \Lambda \) (that was called dark energy before) as a consequence of this flatness since the primordial stage of the universe, \( \Omega_\Lambda = 1 - \Omega_M. \)

Not all reality objects are quantized so as usually assumed. The electroweak interaction remains quantized in the form that follows from Feynman path integrals. Dark matter, if not isolated in the vacuum of Minkowski space, is not conventionally quantized (e.g. in dense liquids). Somewhere between these limiting cases is the quantization of strong interaction for hadrons, in particular for baryons where \( E^4 \) tangent objects are inside from prebaryons, and
also the gravitation. Although gravitons are constructed as charges, the possibility of a further general quantization of the Einstein Riemann metric manifold must seriously be questioned. "Dark energy" as geometrical flatness does not allow any quantization.

Some conventional priors important for cosmology are substituted by the model as follows: There are no Higgs particles because corresponding eigensolutions are missing; the filter elements are not independent fields and cannot be quantized because they do not fluctuate due to their huge numbers. A hot big bang is not necessary, because cold dark matter particles remain points also at large densities in the initial liquid for they cannot be quantized in the Euclidean $E^4$ tangent objects there. The cosmological parameter $\Lambda$ needs not to be an dark energy, because it can be reduced to spatial flatness. – In the frame of our hidden charge model, a search for Higgs particles or independent dark energy is not useful.

Note added at July 2010

The above part of the paper corresponds to arXiv 0901.1050 v2 [physics.gen-ph] 20 Jan 2009, apart from twenty-two short adaptions and six corrections of mistakes. It seems useful to explain how this paradigmatic result was obtained.

I used a neural network method without computer. The author motivated systematically, since 1964, the neuron structure in his own head to find possibly new paradigmatic ideas in astroparticle physics. Partitions into a growing number of promising "remainders" of the known physics in growing specific time were used as changing starting conditions. At the end there are roughly twenty remainders. The iterations of the method were organized only by internal consistencies: completely inside the paradigm, i.e. consistencies with all foregoing internal consistencies: between the changing remainders, between their binary relations, and the many new relations between foregoing consistencies.

Most of these internal iterations were documented by the author (all in German): the first with number 1 is of 4 May 1964 (physical point and its environment), the last with number 1381 is of 19 Oct 2003 ($\vartheta$ torus for graviton). Several hundreds of additional iterations became later implicit parts of rejected papers (about a dozen papers).

Two further examples. 1. A new spin statistic theorem (SST) was firstly documented with number 352 of 16 May 1970 with headline SST. Its derivation from a threedimensional rotation excluded later SUSY (supersymmetry); see Part I, Sect. 4.1, Table 1, and Eqs. (7), (8), and (9) there. 2. The mass operator was indicated in number 899 of 8 Dec 1986 with headline pair generation, and was documented in number 948 of 9 Aug 1987 with the headline: Difference between charge (coordinates $\varphi_1$ and $\varphi_2$) and mass (coordinates $\vartheta$ and $\tau$), see again Part I, Section 4.1 there. The mystery of the Higgs particles and their connection with the flatness puzzle compensation in the universe (M. Veltmann, Facts and Mysteries in Elementary Particle Physics, World Scientific, New Jersey 2003, Section 10 there) gets a paradigmatic background from our application of the $90^0$ polar $\vartheta$ coordinate for both, the mass operator and the graviton torus.

It turned out that the development of conventional new physics and the paradigmatic iterations diverge, i.e. they are drifting away one another, especially if the conventional (i.e. communicable) was organized as alternative ($y/n$) sequence. Communicable is defined by only a few (e.g. three or less) new concepts for understanding. An "off-site convergence" of the paradigmatic iterations was reached in 2008. This convergence was defined as the event where an important phenomenon not analyzed before could be explained without introduction of any new specified idea. This was the so-called "dark energy" of Part II (in Section 7.2 of our paper). As mentioned above, roughly two thousand internal paradigmatic iterations were necessary. Nevertheless, the paradigm did not become communicable and remains woolly today. The woolliness is assumed to decrease in the future.

To improve understanding, it seems useful to characterize the new paradigm by three "basic principles A, B, C".
This will be tried here for the example of the 1-class solution (Part I, Tab. I there). The basic idea is a map from a hidden thing to the physical space (A $\xrightarrow{B} C$).

A. Conformal hidden charge model (I, section 2.2, points (1), (2), (3) there).

B. Existential instability as a consequence of the maximum for the lepton masses (I, Fig.6 there). This excludes relevant particles above the hadronic region (II, Eq.(12) here).

C. Electroweak Feynman fabric in the physical space (I, Fig.2 there) as a consequence of the above A conformality.

The relationship between the present new physics and an off-site converging paradigm was briefly presented in a Comment; see arXiv: 0906.2425 v2 [physics.gen-ph] 3 Aug 2009. This is a radical variant of a discussion in the common probability space for an alternative new physics sequence and the off-site development of a converging paradigm. Sociological aspects of the hierarchies in the present large collaborations are also presented. The radical excludes any perceptible probability to find a new paradigm inside the new physics.

In reality, the relationship may be gentler. From my experience with the common probability space, I think that the probability to find a new paradigm inside a sequence of communicable new physics remains rather small.

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