Further Aspects Concerning the Evolution of a Relativistic Domain Universe.

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Abstract

This paper carries on from [1], and concerns further aspects of the evolution of a Relativistic Domain Universe. The subject matter primarily concerns the first phase, where initially, the formation of a physical boundary is discussed. Subsequently, the means by which galactic masses accumulate at the centre is then presented. Next, the dynamic relationship between the radius of the physical boundary and the gravitational radius is analysed, to show how the $3\alpha_u$ criterion is realised. Finally, the radius of the point of inflexion in the second phase of evolution is developed.

1 Introduction.

This paper returns to the evolution of a Relativistic Domain Universe as developed in detail in [1]. Initially, the emergence of a definable boundary is discussed, so resulting in the establishment of the gravitational radius and thereby the $3\alpha_u$ criterion. Three further subjects are then addressed.

The first, by analysing the gravitational acceleration experienced by a galactic celestial body in Phase I, shows how celestial material accumulates at the core in the form of a large number of adjacent masses in close proximity.

The next subject analyses the dynamic relationship between the physical and the gravitational radii. The result shows how the difference between these two parameters is reduced to the critical level, whereby the physical radius is equal to three times the gravitational radius, so initiating the second evolutionary phase.

The third subject concerns the second phase of evolution, and derives the physical radius of the Universe at the point of inflexion, i.e. the point at which the inward gravitational migration of all galactic bodies towards the centre, is halted by the repulsive gravity field generated within the Universe in the second phase. It also shows that the Acceleration Potential at the boundary at this point is always positive, thereby ensuring that the Universe starts to expand again.

For a full understanding of the material presented in this paper, it is essential that reference [1] be read thoroughly first.

In the interests of brevity, unless necessary for complete clarity, a parameter will only be defined in this paper if it has not previously been so in either [1] or [2], with which familiarity is assumed.

2 Further Aspects Concerning the Evolution of a Relativistic Domain Universe.

2.1 In Phase I - The Emergence of the Boundary and the Accumulation of Celestial Material at the Core.

In the very early stages of Phase I, a physical boundary will depend upon the distribution of matter in the local vicinity, and would be expected to be at best very diffuse and ragged. However, as more and more matter was gravitationally drawn from the surrounding space, such material would become increasingly sparse. This would gradually result in a better defined boundary emerging as the Universe grew. Firstly, as a result, a firm initial value for the gravitational radius would be established. This would in turn establish the $3\alpha_u$ criterion although, at this early stage, the gravitational radius would be so small compared to the physical radius, that the latter would be far greater than the $3\alpha_u$ criterion.

Secondly, despite the increasing sparseness of outlying galactic masses as the Universe grew, it would still gravitationally draw from this material albeit at a reduced rate. The resulting question as to the relative rate of growth of the physical and gravitational radii, is examined in the next Section. Prior to that however, to show how the gravitationally migrating galactic material would arrive at the location of the core in Phase I, consider the equation of motion applicable to celestial bodies in the vicinity. This is given by the rectilinear version of [2], Eq.(3.18), thus

$$\ddot{\sigma} = -c^2 u \frac{du}{d\sigma} + 2\frac{\dot{\sigma}^2}{u}\frac{du}{d\sigma} \tag{2.1}$$

Eq.(2.1) was obtained from [2], Eq.(3.18) by putting $\omega = 0$.
The first integral of (2.1) is obtained from [2], Eq.(B4), again by putting $\omega = \omega_0 = 0$, thus

$$\dot{\sigma} = cu\left(1 - \frac{u^2}{u_0^2}\right)^{1/2} \tag{2.2}$$

Substitution of (2.2) into (2.1) yields, after minor reduction

$$\ddot{\sigma} = -c^2 u \frac{du}{d\sigma}\left(2\frac{u^2}{u_0^2} - 1\right) \tag{2.3}$$

Here

u is the temporal rate at the location of the gravitationally migrating body.

u_0 is the temporal rate at the initial location of that body.

From (2.3) it is clear that while $2u^2 > u_0^2$, all such material bodies will continue to accelerate towards the core. However, when they reach the location where $2u^2 = u_0^2$, $\ddot{\sigma}$ in (2.3) becomes zero. At that location clearly

$$u = \frac{u_0}{\sqrt{2}} \tag{2.4}$$

Now, substitution of [2], Eq. (4.7) into (2.4), with the nomenclature selected to represent the Universe, gives after reduction

$$\sigma = \frac{4\alpha_u \sigma_0}{\sigma_0 + 2\alpha_u} \tag{2.5}$$

This is the distance from the centre of the core, at which the net acceleration towards that centre, of a random celestial body, becomes zero. It is at this distance that the positive acceleration produced by the velocity of the mass, as it moves through the spatial gradient of the Universe's temporal rate, exactly balances its negative Acceleration Potential. Clearly this distance will be different for each body depending upon σ_0. For the case where $\sigma_0 >> 2\alpha_u$ then (2.5) may be approximated by

$$\sigma = 4\alpha_u \tag{2.6}$$

and is thereby solely a function of the gravitational radius. The primary consequence of the above result is as follows.

Once a mass gravitating towards the core passes the point represented by (2.5), or as approximated by (2.6), it starts to be decelerated by the positive acceleration resulting from its velocity through the spatial gradient of the temporal rate generated by the core. This effect, at distances from the core below the value of σ in (2.5), is greater than the Acceleration Potential at such distances. Consequently, when such masses approach the core they will have been greatly decelerated and their arrival will be more of a "gentle congregation" rather than a violent collision. In this way the core will grow progressively but more as a close proximity of a large number of masses rather than one single large entity. In this latter stage, the normal individual gravitational field of each core mass will also become significant in this process.

To finalise the development of Phase I, it is necessary to analyse the dynamic relationship between the physical and gravitational radii. This will show that α_u will grow faster than σ_u, so that the $3\alpha_u$ criterion is subsequently realised.

2.2 In Phase I - The Dynamic Relationship Between the Physical and Gravitational Radii.

As the Universe begins to form, initially its gravitational radius will be very small. Subsequent to the emergence of the boundary, the gravitational radius can be expressed as

$$\alpha_u = \frac{\gamma m_u}{c^2} = \frac{4}{3}\pi\gamma\rho_u\frac{\sigma_u^3}{c^2} \tag{2.7}$$

where

ρ_u is the average density of the Universe

Although initially the average density could be quite high, the smallness of m_u coupled with the known values of γ and c, will ensure that $\alpha_u << \sigma_u$. As these parameters grow, as more and more material is accumulated, the relative rate of growth can be determined by taking the differential of (2.7) with respect to σ_u, thus

$$\frac{d\alpha_u}{d\sigma_u} = 4\pi\gamma\frac{\sigma_u^2}{c^2}\left(\rho_u + \frac{\sigma_u}{3}\frac{d\rho_u}{d\sigma_u}\right) \tag{2.8}$$

In (2.8) both σ_u and ρ_u must be positive, but the sign of the term $d\rho_{u/}d\sigma_u$ will depend upon the density of the matter continually being accumulated. Also, the manner of accumulation near the core as discussed in Section 2.1 above, will also affect the sign of $d\rho_{u/}d\sigma_u$. As the term involving $d\rho_{u/}d\sigma_u$ will predominate, the sign of (2.8) will therefore be primarily determined by it. Conjecture about this point can be resolved via reference to [3] Fig.1. There it is clear that as matter is accumulated and the mass of the Universe increases, the mass to radius relationship will eventually conform to [3], Eq.(2.3), and therefore using this equation, α_u can be empirically expressed as

$$\alpha_u = \frac{\gamma m_u}{c^2} = 5.36\,\mathbf{x}\,10^{17}\gamma\frac{\sigma_u^{1.38}}{c^2} \tag{2.9}$$

Consequently

$$\frac{d\alpha_u}{d\sigma_u} = 7.4\,\mathbf{x}\,10^{17}\gamma\frac{\sigma_u^{0.38}}{c^2} \tag{2.10}$$

Clearly here the change of α_u relative to σ_u is positive and therefore, as the Universe evolves in Phase I the physical radius and the gravitational radius slowly converge until, at the centre, the $3\alpha_u$ criterion is reached, and Phase II is initiated.
From (2.8) and (2.10), an empirical relationship for $d\rho_{u/}d\sigma_u$ can be expressed as

$$\frac{d\rho_u}{d\sigma_u} = \frac{3}{\sigma_u}\left(\frac{5.19\,\mathbf{x}\,10^{16}}{\sigma_u^{1.62}} - \rho_u\right) \tag{2.11}$$

So that for $d\rho_{u/}d\sigma_u$ to always be positive so that (2.8) is always positive

$$\rho_u < \frac{5.19 \text{ x } 10^{16}}{\sigma_u^{1.62}} \tag{2.12}$$

As one example, when $\sigma_u = 10^{10}$ L.Y., from (2.12)

$$\rho_u < 2.8 \text{ x } 10^{-29} grms/cm^3 \tag{2.13}$$

Compared with the estimates of ρ_u in [1], Section 2.3.4 for the home Universe, this inequality is certainly of the right order of magnitude.

The consequence of the above results, i.e. the faster growth rate of α_u compared to σ_u, is that the $3\alpha_u$ criterion will always eventually be realised. This will be so even if the galactic material in the surrounding space is near to inexhaustible. Of course, if this material is limited, the gravitational radius will become constant while the physical boundary of the Universe will start to shrink under the gravitational influence of the core. In this case the $3\alpha_u$ criterion will thereby be realised earlier.

The final significant question concerning the evolution of the Universe as depicted in [1], and this paper, is, once Phase II has started, to what radius does the boundary fall before expansion starts. i.e. what is the radius of the point of inflexion. This is the subject of the next Section.

2.3 In Phase II - The Radius of the Point of Inflexion.

After Phase II has been triggered via the $3\alpha_u$ criterion, the celestial bodies making up the boundary will continue to migrate towards the centre via momentum gained during Phase I.
The question analysed here is to what value does the physical radius fall at the point of inflexion. Subsequent to gravitational reversal, $(\sigma_u = 3\alpha_u)$, the spatial/temporal flows are as shown in Fig.2.1 below, (repeated from [1], Fig.3).

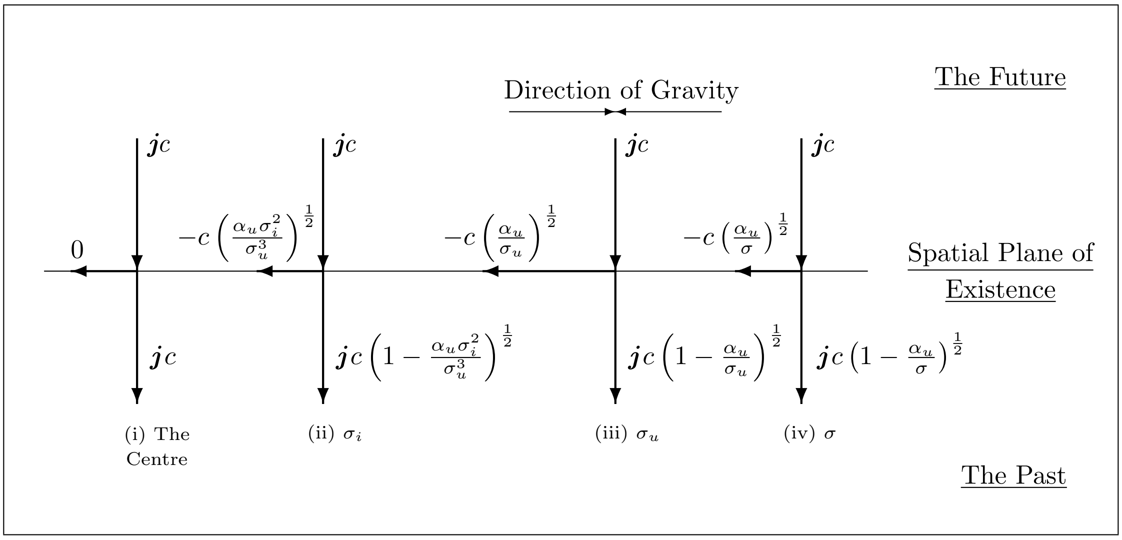

Fig.2.1 - Spatial/Temporal Flows Subsequent to Gravitational Reversal.

In Fig.2.1 the flows along the Spatial Plane of Existence are the linear contraction velocities of the now contracting spatial dimensions. The transverse terms, (the $\boldsymbol{j}$ terms), are the corresponding temporal flow velocities.

From Fig.2.1 it is clear that a new criterion at the boundary, ((iii) in the Figure), has become established due to the transformation from Phase I to Phase II. That criterion would be realised should σ_u shrink to become less than α_u. However, if the migration of all the matter towards the centre is arrested while $\sigma_u \geq \alpha_u$, then Phase II of the evolution, as described and developed in [1], will proceed normally. If not, and the collapse continues so that $\sigma_u < \alpha_u$, the Universe would not expand again. It is therefore very important to determine the radius of the Universe at the point of inflexion.

To investigate this question, it is necessary to first establish the velocity of the boundary in Phase I as it passes the critical point $3\alpha_u$.

In Phase I the velocity of a gravitating body is given by (2.2). Inserting [2], Eq. (4.7) into (2.2), i.e. expanding u and adopting the nomenclature to represent the Universe, gives

$$\dot{\sigma}_u = c\left(1 - \frac{2\alpha_u}{\sigma_u}\right)^{1/2}\left[1 - \frac{1 - \frac{2\alpha_u}{\sigma_u}}{u_0^2}\right]^{1/2} \tag{2.14}$$

and substitution of $\sigma_u = 3\alpha_u$ then reduces (2.14) to the initial condition at the boundary for the start of Phase II, call this $\dot{\sigma}_{0B}$, then

$$\dot{\sigma}_{0B} = \frac{c}{\sqrt{3}}\left(1 - \frac{1}{3u_0^2}\right)^{1/2} \tag{2.15}$$

The total contraction of σ_u can now be obtained as follows. The net acceleration experienced by a gravitating body in Phase II of a Relativistic Domain, is given by (2.1) with the sign of the Acceleration Potential term reversed. The solution of the resulting equation, with a non zero initial condition, for a gravitating mass on the boundary of the Universe, is then given by

$$\dot{\sigma}_u = cu\left(-1 + \frac{u^2}{u_{0B}^2} + \frac{\dot{\sigma}_{0B}^2 u^2}{c^2 u_{0B}^4}\right)^{1/2} \tag{2.16}$$

In (2.16) u is the temporal rate in Phase II for a gravitating mass at the boundary and is obtained from Fig.2.1(iii) as

$$u = \left(1 - \frac{\alpha_u}{\sigma_u}\right)^{1/2} \tag{2.17}$$

u_{0B} is the temporal rate in Phase II at the location of the boundary when $\sigma_u = 3\alpha_u$ and from (2.17) is

$$u_{0B} = \left(\frac{2}{3}\right)^{1/2} \tag{2.18}$$

$\dot{\sigma}_{0B}$ is the initial velocity of the gravitating mass in Phase II when $\sigma_u = 3\alpha_u$and is given by (2.15). Thus substitution of (2.15), (2.17) and (2.18) into (2.16) gives

$$\dot{\sigma}_u = c\left(1 - \frac{\alpha_u}{\sigma_u}\right)^{1/2}\left(\frac{5}{4}\left(1 - \frac{1}{5u_0^2}\right) - \frac{\alpha_u}{\sigma_u}\left(\frac{9}{4} - \frac{1}{4u_0^2}\right)\right)^{1/2} \tag{2.19}$$

The roots of (2.19) give the point of minimum radius of the boundary resulting from normal gravitational contraction in Phase I, and the deceleration in Phase II. Clearly the first root occurs when

$$\sigma_u = \alpha_u \tag{2.20}$$

and the second root occurs when

$$\sigma_u = \alpha_u \frac{(9u_0^2 - 1)}{(5u_0^2 - 1)} \tag{2.21}$$

The second root is larger than the first, and because u_0 must be close to unity, (2.21) is approximately $2\alpha_u$. This is the point of inflexion, and expansion in the remainder of Phase II starts from that radius.
The Acceleration Potential at the boundary in Phase II is, from [1], Eq.(2.12), with $\sigma_i = \sigma_u$

$$A_u = \frac{\gamma m_u}{\sigma_u^2} \tag{2.22}$$

and with $\sigma_u = 2\alpha_u = {}^{\gamma m_u}\!/_{c^2}$, this becomes at the point of inflexion

$$A_u = \frac{c^4}{4\gamma m_u} \tag{2.23}$$

This is the Acceleration Potential on all matter at the boundary of the Universe after it has contracted to the point of inflexion in Phase II. This is clearly positive and initiates the ensuing expansion as developed in [1].

3 Concluding Remarks.

The forming of a physical boundary during the evolution of the Universe is the most important aspect of the whole process. Moreso than even the $3\alpha_u$ criterion itself. This is because without a physical boundary the $3\alpha_u$ criterion could not be established. The formation of a definable boundary in Phase I, will be due simply to the gradual depletion of available material in the greater Cosmos, from which the Universe could be formed.

A very important aspect in the formation of the Universe in Phase I is the time dilatation effect. This positive acceleration reaction of motion through the spatial gradient of its temporal rate, ensures that celestial masses arriving at the core do so slowly, avoiding violent collisions. This results in a distributed nature of masses throughout the Universe including the core.

The second most important aspect in the evolution process is the $3\alpha_u$ criterion itself. Without this criterion the reversal of gravity would not occur. The $3\alpha_u$ criterion is another facet of the internal gravitational field of every source. It only becomes physically significant however, firstly in sources as large as the Universe, where there is sufficient mass to create a gravitational radius that is of the same order of magnitude as the physical radius. Secondly, the only other stellar objects where this criterion is possible significant, is Neutron stars where, as shown in [3], the criterion is reached when, under gravitational compression after the fusion process at the core runs out of fuel, the physical radius of a large star collapses to less than three times its gravitational radius.

The third significant parameter in the evolution process, the boundary radius at the point of inflexion, was shown to be equal to twice the gravitational radius. Had the collapse continued below the gravitational radius, the direction of internal gravity would have again reversed, and the gravitational collapse continued to create a single stellar entity with the radial dimension of many light years. However, from Section 2.3, the analysis shows that at the critical point of twice gravitational radius, where the inward motion of all stellar bodies is brought to a halt by the repulsive gravity field generated in Phase II, the magnitude of the field remains positive, thus ensuring that the subsequent expansion does indeed occur. Consequently, for the further collapse to the object described above, some extraneous influence that alters the process at the beginning of Phase II would have to be present. In view of the nature of Quasars, such a possibility cannot be entirely excluded.

Finally, the results of the development presented in this paper, together with those of [1], completes the overall characterisation of this new theory for the origin and existence of the Universe, as represented in the Relativistic Domain D_1. This new theory contains no anomalies of the type believed to exist in the "Big Bang", or modern Steady State models. This is largely due to an age of the Universe, as roughly estimated in [1], of some 45 billion years, and, in addition, the provision of a very good theoretical value of the Hubble "Constant", as also developed in [1].

APPENDIX A

Application to the Home Universe

If a Universe is formed from a near inexhaustible supply of celestial material, but with a well defined boundary, then at the $3\alpha_u$ criterion (2.7) will still apply, but, also α_u can be expressed as

$$\alpha_u = \frac{\sigma''_u}{3} \tag{A.1}$$

where now

σ''_u is the radius of the Universe at the $3\alpha_u$ criterion.

Substitution of (A.1) into (2.7) yields after minor reduction

$$\rho''_u = \frac{c^2}{4\pi\gamma\sigma''^2_u} \tag{A.2}$$

where

ρ''_u is the average density of the Universe with a boundary radius of σ''_u.

In [3] α_u for the home Universe was estimated at 1.22E27 cms. From (A.1), using this figure σ''_u works out to be 3.66E27 cms. Substitution of this figure into (A.2) then gives for ρ''_u the figure of 8.02E-29 gms/cm^3.

Now, using the above figures for ρ''_u and σ''_u in the standard formula for the mass of the Universe gives m_u = 1.65E55 gms. This value is the same as that estimated in [3] from a consideration of factors associated with the cosmological time of applicability of modern observations, i.e. τ_c= 9 billion years from the point of inflexion. In view of this comparative agreement, the consequence is that the home Universe was formed from a near inexhaustible supply of celestial material in the greater Cosmos.

The value of ρ''_u, the average density of the Universe at the $3\alpha_u$ criterion, is seen to be a little over 3½ times larger than that estimated in [3] at τ_c. Comparative radii and average densities are summarised in the following table.

Point of Measurement		**Phase**	**Radius**	**Average Density**
$3\alpha_u$ Criterion	$\sigma_u = 3\alpha_u$	I → II	3.66E27	8.02E-29
Point of Inflexion	$\sigma_u = 2\alpha_u$	II	2.44E27	2.71E-28
Cosmological Time of Modern Observation	τ_c	II	5.7E27	2.10E-29

Table A1 - Radius/Average Density Comparison for the Home Universe.

Table A1 shows that the expansion of the home Universe at τ_c in Phase II has now reached some 56% beyond the point where $\sigma_u = 3\alpha_u$.

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