

## 11. The physical space.

In Chapter 9 we have seen that the physical space must exist of immense quantities of energons, moving into each direction with velocities between  $\frac{1}{2}c$  and  $1\frac{1}{2}c$ .

An astonishing possibility urged itself while evaluating the ideas:

*The potential density of space and the density of the ec's are equal.*

Now the question is: which mechanisms rule those densities?

Before trying to find the answer, some data are repeated here:

### Stabilisation of ec's.

In the paragraphs 6.3.1, 9.6 and 9.8.1 some equations have been used for the calculation of the equatorial spin-velocity of ec's ( $V_r$ ), the radius of pp's ( $r_{pp}$ ) and the pp-content inside the ec's ( $C_1$ ).

ec-weight	$m_e = 0.9109534 \times 10^{-30} \text{ kg}$
ec-radius	$r_e = 6.6979 \times 10^{-18} \text{ m}$
quantity of Spp's of an ec:	$N_{es} = 3.277 \times 10^{30}$
pp-radius	$r_{pp} = 7.4 \times 10^{-33} \text{ m}$
pp-production-factor	$N_{cr} = 1.8618 \times 10^{-12} \text{ t}_0^{-1}$
pp-content of space	$C_{pp} = 2.73 \times 10^{81} \text{ pp's.m}^{-3}$
average potential density	$D_{ec} = 7.24 \times 10^{20} \text{ kg.m}^{-3}$
absolute period of time	$t_0 = r_{pp}/c = 2.468 \times 10^{-41} \text{ s}$
Equat.spin-velocity ec's	$V_r = 1.1744 \times 10^{-7} \text{ m.s}^{-1}$

$$V_r = p^2 \cdot h / (2\pi^2 \cdot m_e \cdot r_e \cdot K_r^{1/2}) = 1.1744 \times 10^{-7} \text{ m.s}^{-1}$$

$$r_{pp} = V_r \cdot 2r_e \cdot \sqrt{2}/c = 7.4 \times 10^{-33} \text{ m}$$

$$C_1 = 1368 \times C_{pp}; C_{pp} \times \text{ec-vol.} \times 0.955 = 3.28 \times 10^{30} = N_{es}.$$

The value of  $C_1$  looks doubtfully: it is much higher than  $C_{pp}$ , which has shown itself as being the value for a stable energon density, but there can be a reason (see next page). From the next calculations the conclusion can be drawn that there is a connection between the pp-production-factor ( $N_{cr}$ ) and the spin-velocity of the elementary charges, besides the connection between this velocity and pp-dimension.

The value  $\tan(0.034^0) = 5.9341 \times 10^{-4}$  attracts the attention:

$$r_{pp} / \{\tan(0.034^0) \times r_e\} = 1.8618 \times 10^{-12} = N_{cr}.$$

The equation can be written as  $N_{cr} = (\tan 0.034^0)^{-1} \times (r_{pp} / r_e) / t_0$ , and because

$$\tan(0.034^0) \times 360^0 / 2\pi = 0.034 \text{ radian, we can say:}$$

$$(\tan 0.034^0)^{-1} = 360^0 \times 1 / (0.034 \times 2\pi) \text{ [degr/rad]} = 1685.17 \text{ [degr/rad]} \times (r_{pp} / r_e) / t_0 [t_0] = 1.8618 \times 10^{-12} \text{ [degr/rad/t}_0\text{= angular velocity]}.$$

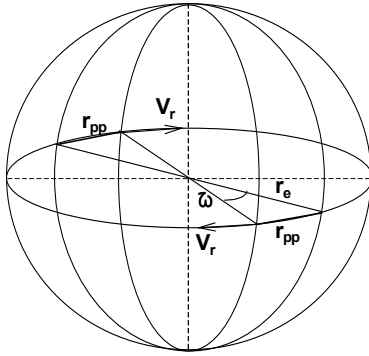
From  $N_{cr}$  the **angular velocity** for  $2 \cdot r_e$  can be derived, see **Fig. 67**:

$$\bar{\omega}_{cr} = 1.8618 \times 10^{-12} \times 2 \cdot r_e / t_0 = 1.8618 \times 10^{-12} \times 2 \cdot r_e \cdot c / r_{pp} = 1.0104 \times 10^{12} \text{ [degr/s]},$$

$$\text{or } \bar{\omega}_{cr} = (\tan 0.034^0)^{-1} \times 2 \times c = 1.0104 \times 10^{12} \text{ [degr/s]}.$$

Multiplication of this outcome by  $2\pi r_e / 360$  gives  $1.18 \times 10^{-7} \text{ m.s}^{-1} \approx V_r$ .

Figure 67



This value may be justified by multiplication with  $(7.38/7.4)^2$ , giving  $1.174 \times 10^{-7} \text{ m.s}^{-1}$  (see § 9.6 about correction of *ec*-puls)

The relationship between spin-rotation ( $V_r$ ) and the *pp*-creation in *ec*'s ( $N_{cr}$ ) is also conceivable directly from the supposed cause of *ec*-spin (see § 2.3): from the ejected *pp*'s into one direction only a very small part has a track perpendicular to the *ec*-surface.

All the other tracks have oblique angles with that surface. As this is valid for each direction, *ec-spin has an important influence on the character of pp's, working on one object.*

If the inside *pp*-emission of an *ec* should be equally to that of the outside, then the inside emission in the period of *pp*-presence should be  $(2/\pi)^2 \times 2r_e/c \times N_{cr} \times N_{es} \times 1/t_0 = 4.477 \times 10^{33}$  *pp*'s, which is 1366 times  $N_{es}$ . Possibly a reduction-factor, proportionally to the amount of *pp*-layers ( $x$ ) of the *pp*-mantle must be used, thus  $1/x$ . On page 134 that amount has been estimated on 1280 (94% of 1366), thus if the assumption is true, we have to use a reduction-factor of  $1/1366$  to find the inside emission in the period of *pp*-presence:  $1/1366 \times (2/\pi)^2 \times 2r_e/c \times N_{cr} \times N_{es} \times 1/t_0 = 3.277 \times 10^{30} = N_{es}$ .

**De-stabilisation** occurs with collision between *ec*'s within a period of  $10^{-25}$  s, which must cause a dramatic disturbance of the equilibrium of the *ec*'s: a kind of *super-ec* is formed and is inflating itself with velocity  $c$  until its density has become normal again ( $D_{ec}$ ). Then it decays into multiple normal *ec*'s with an identical total weight (see § 9.8.2).

#### **Stabilisation of the density of the physical space.**

The stabilisation of the *pp*-density of space seems to be unconceivable, but this problem may perhaps be approached by the thought that the *pp*'s in space will frequently collide. These collisions must differ very much from the annihilating collapse with the *ec*-mantle.

In the energon hypothesis it is thought that *pp*'s with unusual velocities (too high or too low) will pass the *ec* unchanged. Therefore it seems that it has to be accepted that colliding *pp*'s in space can neither be changed because a partly loss of angular

momentum is unthinkable. However, the necessity of a mutual *pp*-influence looks inevitable. That will be discussed after an analysis of the frequency of *pp*-collision.

The situation in *ec*'s as well as in space is thought to be stabilised on an equal density. This leads to the presumption that there must be an equal chance on collision between *pp*'s and *pp*'s versus *Spp*'s. With equal densities is meant the density of *pp*'s, emitted to the *ec*-inside, the density of the *Spp*'s of the active *ec*-mantle with respect to the *ec*-capacity, and the average *pp*-density of space (*except the neighbourhood of large masses, see below*).

According to the energon-hypothesis free space contents:

$$C'_{pp} = 3 / (\pi \cdot r_e \cdot r_{pp}^2) = 2.604 \times 10^{81} \text{ } pp's \cdot m^{-3}; \quad (C_{pp} = 2.73 \times 10^{81}; \text{ § 9.8.1})^*$$

If  $1 \text{ } m^3$  is seen as a sphere, then its diameter measures:  $d_s = 2 \cdot \{3/(4 \cdot \pi)\}^{1/3} = 1.2407 \text{ } m$ .

The number of *pp*'s that can maximally be present along this diameter amounts to:

$$n_d = 2 \times (3 \times 2.60 \times 10^{81} / 4 \cdot \pi)^{1/3} = 1.7068 \times 10^{27} \text{ } pp's.$$

Therefore the average distance between *pp*'s in space is:

$$a_{pp} = d_s / n_d = 7.2690 \times 10^{-28} \text{ } m.$$

The period needed to cover  $a_{pp}$  measures  $a_{pp}/c = 2.4247 \times 10^{-36} \text{ } s$ .

The central section of a *pp* amounts to:  $\sigma = \pi \cdot (r_{pp})^2 = 1.7203 \times 10^{-64} \text{ } m^2$ , and the area of a sphere with radius  $a_{pp}$ :  $O_A = 4\pi \times (7.2690 \times 10^{-28})^2 = 6.640 \times 10^{-54} \text{ } m^2$ , thus

$$(\sigma/O_A)' = 2.59081 \times 10^{-11}, \text{ that gives the chance on collision between two } pp's.$$

As one *pp* is surrounded by 10.39 other *pp*'s,  $(\sigma/O_A)'$  must be multiplied, see page 154:

$$(\sigma/O_A) = (\sigma/O_A)' \times 10.39 = 2.69185 \times 10^{-10} \text{ in } a_{pp}/c \text{ seconds.}$$

The frequency of *pp*-collisions per  $N_{es}$  *pp*'s per second can now be described by:

$$v_{coll/Nes} = (\sigma/O_A) \times (c/a_{pp}) \times N_{es} = \mathbf{3.6381 \times 10^{56} \text{ } s^{-1}}.$$

*As the pp-concentration inside ec's ( $C_1'$ ) is equal to that of free space ( $N_{es}/ec$ -volume), the amount of pp-collisions must also be equal.*

The amount of *pp*-collisions, in the mean period for a *pp* to cross the *ec*-volume, can be calculated according to:  $v_{coll/Nes} \times 2 \cdot (2/\pi)^2 \cdot r_e/c = 6.5884 \times 10^{30}$ . Dividing this by  $N_{es}$  gives the number of collisions for each *pp* within that crossing period, rounded off :

$$v_{coll/ec} \approx \mathbf{2.0} \text{ per } 1.81095 \times 10^{-26} \text{ } s.$$

An other approach to the frequency of *pp*-collision in space is the calculation of the amount of collisions per *pp* per  $t_0$ , using a cubic measurement:

$$v_{coll/t_0} = v_{coll/Nes} \times t_0 \times 1.612 / N_{es} \approx \mathbf{4.42 \times 10^{-15}} \text{ (space-factor),}$$

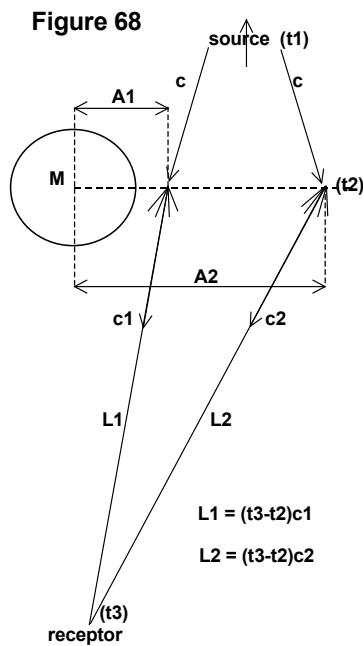
in which 1.612 gives the ratio between the edge of a cube and the radius of an equal spherical volume (§ 5.3). The result approaches the ratio between the total *pp*-volume

and the volume of space, as aspected.

The value  $v_{coll/ec}$  is an unique number, suitable to express the condition for the equilibrium between the diverse  $pp$ -phantoms: one collision per  $pp$ -pair between the entrance (emergence) and leaving (annihilation) the system.

The problem of equilibrium can be comprised by the following statement:

*The creative emission by ec's into the in- and outside space is just enough to maintain the necessary  $pp$ -density on  $N_{es}$   $pp$ 's per ec-volume.*



**The bending of light by heavy masses**, described by Einstein and regarded as a result of gravitation, may probably be understood as a local influence of energon-density in the neighbourhood of a heavy mass  $M$  on the velocity of  $pp$ -waves, forming a potential signal, see **figure 68**.

These waves belong to one point in time on their source ( $t_1$ ) and form a diverging front with respect to that source. If this front passes (at time  $t_2$ ) the heavy mass  $M$  (a star for example), it meets different  $pp$ -densities. These densities, caused by  $pp$ 's that are sent transversally to the direction of the wave by mass  $M$ , must be inversely proportional to the square of distance  $A$  to the mass.

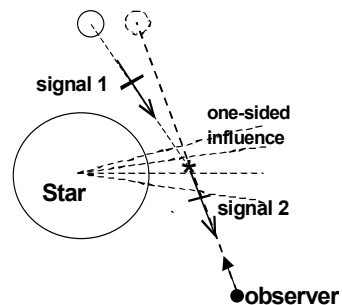
*In analogy with waves in gases, parts of the signal-waves, scattered by  $pp$ -collisions, will move at lower velocities in regions with higher  $pp$ -densities.*

The two parts can only transfer a signal to a receptor by converging into that receptor (at time  $t_3$ ). That can happen if the initial direction of the wave will be bent a little towards the mass  $M$ . In that case the different tracks can be covered in an equal period of time:

$$L_1/c_1 = L_2/c_2 = t_3 - t_2$$

*That gives an effect as gravitation should do!*

**Figure 69. Bending of signals**



Thus the influence of the  $pp$ -emission of a heavy mass (star) on passing  $pp$ 's, forming an  $EM$ -signal, will cause a bending of the working direction of the signal, which is in accordance of Einstein's General Theory of Relativity (**Figure 69**).

#### **The volumetric condition for free energons.**

The problem of the volumetric behaviour of free  $pp$ -masses may be approached by using the space factor  $4.42 \times 10^{-15}$ .

On page 103 (§ 9.8.1) was found that  $4.42 \times 10^{-15} = 4.r_{pp} / r_e$ , thus being dependent of a ratio between the unchangeable radii of energons and elementary charges. As indicated, that ratio is equal to the ratio of the capacity of the outer  $S_{pp}$ -mantle of an  $ec$  and that of the  $ec$  itself. The reason why  $pp$ 's in  $ec$ 's need the same volume as free  $pp$ 's do must be identical. Probably this problem must be brought back to the movement of the  $pp$ 's.

On page 131 the amount of  $pp$ -collisions during the mean crossing-period for an  $ec$ , is found to be 2 (4  $pp$ 's!). That means a meeting of 2  $pp$ 's for half of that period ( $\sim r_e$ ) giving the ratio 4  $pp$ -radii against 1  $r_e$ . That is just the ratio for the space factor ( $4.r_{pp}/r_e$ ). Other periods do not change this ratio (see also pages 103 and 143).

*Possibly, the condition for the need of space by free  $pp$ 's is just one  $pp$ -collision (4  $r_{pp}$ 's) in the period to cover a mean hemisphere with radius  $r_e$ .*

#### **The inevitable birth of $ec$ 's from high-density $pp$ -clouds.**

High-energy events can damage the fundamental structure of matter, as has been mentioned in § 9.8.2. The  $pp$ -clouds, that arise from those events, have a density higher than that of  $ec$ 's ( $D_{ec} = 7.2 \times 10^{20} \text{ kg.m}^{-3}$ ). Immediately after the disturbance, the  $pp$ -cloud starts to expand with velocity  $c$  under the influence of  $pp$ -creation ( $N_{cr}$ ), until the density has reached its normal value  $D_{ec}$ .

It can be reasoned that, at that moment, the  $pp$ -cloud must break up into a proportional number of normal  $ec$ 's, gluing together a surplus of actually meeting  $pp$ 's in the region of the settling mantles.

For an explanation the following approach has been chosen.

An  $ec$  takes a distinct place and volume in space, so that an  $ec$ -in being must be seen as build up from a distinct point in space, possibly liberated  $P_A$ 's (see page 3).

An amount of  $N_{es}$   $pp$ 's will be created in a period  $t_0/N_{cr} = 1.236 \times 10^{-29} \text{ s}$ .

The period of convergence for distance  $r_e$  must be  $\Delta t_{re} = r_e \cdot \sqrt{2}/c = 3.16 \times 10^{-26} \text{ s}$ ,

which means that  $\Delta t_{re} \times N_{cr}/t_0 \times N_{es} \approx 2560 \times N_{es}$   $pp$ 's will be created in  $\Delta t_{re}$  s, thus

reaching simultaneously the *ec*-mantle in-being. Correction for the *pp*-rotation will cause a factor  $\frac{1}{2}$ , which is leading to a thickness of 1280  $S_{pp}$ 's. Calculations on page 130 suggest however, that the real amount of  $S_{pp}$ -layers has to be 1366, thus:

**$1.366 \times 10^3$   $S_{pp}$ -layers are forming the *ec*-mantle.**

The weight of the *ec*, however, is determined by the  $N_{es}$  active  $S_{pp}$ 's.

We have to conclude that the given picture of the *ec*-rise from high-density *pp*-clouds is only possible *on the condition* that a layer of about  **$1.366 \times 10^3$   $S_{pp}$ 's** is needed for a proper functionality of the *ec*. An other *ec*-radius, say  $x.r_e$ , is impossible then because it leads to another amount. The creation can probably only happen at the moment that

**$N_{\text{mantle}}/N_{es} \approx 1.366 \times 10^3$**  , not sooner and not later. (See page 159).

If an identical reasoning is applied to the universe as a whole, an interesting and astonishing result is got:

*the universe may be bordered by a regulating energetic film.*

The necessary formula must have the following shape, giving the at-once offer of *pp*'s to the extreme regions of the universe in our time ( see  $N_{\text{mantle}}$  above ) :

$$N_U = 0.955 \cdot \sqrt{2} \cdot R_U \cdot 10^{83} \cdot N_{es} \cdot N_{cr} \cdot t_0^{-1} \cdot c^{-1} \approx \mathbf{1.6 \times 10^{160}}$$

(with 4.5 % annihilation and no difference of *pp*-rotation;  $R_U = 1.42 \times 10^{26} m$ ).

A loss by efficiency, as above, may lead to:

$$N_U \approx \mathbf{1.3 \times 10^{160}}.$$

One single layer of touching  $S_{pp}$ 's in this region would contain

$$4 \cdot R_U^2 / r_{pp}^2 = \mathbf{1.61 \times 10^{117}} \text{ } S_{pp}'\text{s,}$$

so that the energetic film around the universe must consist of

$$\mathbf{8 \times 10^{42} \text{ } } S_{pp}\text{-layers, with an overall thickness of } \mathbf{6 \times 10^7 \text{ km.}}$$

*This relative thin  $S_{pp}$ -film should be seen as the regulator of the constant *pp*-density of the universe ( $C_{pp}' = 2.61 \times 10^{81} m^{-3}$ ) and as a complete isolator.*

There exists a difference between the mantle of *ec*'s and that of the universe. In the mantle of the universe both kinds of *pp*'s are active and no new *pp*'s are formed and emitted into the outside. The inside activity of *ec*'s can be replaced by reflection of arriving *pp*'s (signals, gravitational quanta) at the universal mantle.

An argument in favour of the behaviour of the *pp*-mass near the universal mantle can be found in the derivation of the fourth equation of the gravitational constant  $G$  (see the pages 154/5 and 163/4). In this reasoning the velocity of light must be coupled to the

amount of  $pp$ 's along a distance,  $c' = c \cdot n_{pp} \text{ s}^{-1}$ , causing the loss of the length-dimension. It can be imagined that the amount of  $pp$ 's per meter, into the direction of the borders of the universe, increases (increase of  $pp$ -density). Because we can say  $c = c'/n_{pp}$ , an increase of  $n_{pp}$  diminishes the "constant  $c$ ", if  $c'$  is the real constant.

This vision is in agreement with the black-hole state of the universe (see pages 159/160). The formula  $R_U = (G/c^2) \cdot M_U$ , valid for this state, tells that  $R_U/M_U$  is a constant. On page 160 is shown that the ratio almost reaches the right value  $7.4239 \times 10^{-28}$  by using  $G/c^2$ .

As the increase of  $M_U$  is explained by the creating *cosmological constant*:

$$C_c \cdot M_U \cdot T_U \approx 4/3 \cdot \pi \cdot R_U^3 \approx 10^{79} \text{ m}^3, \text{ or } M_U/R_U \approx (4/3 \cdot \pi \cdot R_U^2)/(C_c \cdot T_U) \approx 1.71 \times 10^{27}$$

the difference between  $1 / 1.71 \times 10^{27} = 5.85 \times 10^{-28}$  and  $7.42 \times 10^{-28}$  may be explained by the release of the length-dimension conforme  $c = c' / n_{pp}$  (see above).

There are resting some other intriguing questions.

Until now, cosmological problems have been handled in this work as taking place in a spherical space in which time has its own place. The often used metaphor of a spherical bent space, embracing a four-dimensional entity, as a parallel of a two-dimensional spherical bent plane embracing a three-dimensional spherical space, does not reach our imaginative faculty. We can conclude that there are real borders. But how can an observer near the border of a spherical universe have the same impression of that universe into all directions? Even the bending of light by gravity cannot give an acceptable image of equal information, coming from all directions.

However, the presumable existence of an energetic film, mentioned above, as an isolating and regulating border of the universe, may give a possible solution. This border must constantly interact with arriving energons, containing information. *As this information probably cannot get lost, it will be reflected and so offer a sight at the universe into the opposite direction.*

Another problem concerns the question how the universe can react as a whole on disturbances of density at distant places? That problem remind us of the period of fast inflation that must have existed in the beginning of time. Something in space must happen much faster than the velocity of light allows.

A third question is whether the energons must be seen as energy or not. If they are the

cause of the expansion of the universe, they must have the power to move the immense masses, but they themselves must possess mass, according to the famous equation of Einstein. On the other hand, the dual character of energons, emerging from the two opposite poles, leads to the supposition of the existence of positive- and negative energy with a sum of zero. Therefore, it seems better to see the energons according to their second name: *power-particles*, having the power to do something. An energon has the power to *exert* a mass in combination with another energon (see § 2.2).

It seems obviously that the power of creation has been restricted to the material structure of the elementary charges. An exception occurs with the energetic destruction of those charges. In that case the induced, highly concentrated, energon clouds continue with the creation until the density of normal *ec*'s has been reached and the condensation of the *ec*'s can take place. An unique *ec*-destruction forms the enormous explosion of the instable black hole.

A smooth development to the present end-state is not likely: a state of continual *pp*-density, higher than that of *ec*'s seems to be impossible.

The combination of findings in § 5.3 (density of *ec*'s in nucleons), chapter 6 (emergence of gravity in nucleonic structures) and in § 9.8.1 (the need to accept inflation of the primeval universe) leads to the insight that the period, immediately following on the creation of *ec*'s, must have been a very dramatic one: an *inflation* of the universe must have happened *with* the forming of nucleons, at the moment that the *ec*-density was big enough, *thus with the choice between matter and antimatter*.

What was the role of this choice on the next development of the universe?

The choice between matter and antimatter probably could not have been made. Possibly both structures must have been realised at once. It is thinkable that the emergence of nucleons and anti-nucleons from the same compressed *ec*-plasma must have lead to a compression of time-space, because the reversed passing of the energy-threshold into free *ec*'s was not possible anymore("annihilation").

The compression of time-space would have its advantages, seen from the energons: while the angular momentum of *pp*'s decreases:  $M_x = m.(xl).(xr)/(xt)$ , energy and momentum do not change:  $e_x = m.(xl)^2/(xt)^2$ ,  $m_v = m.(xl)/(xt)$ , the forces and power would increase with x-values between 1 and 0:  $f_x = m.(xl)/(xt)^2$ ,  $e_x/t = m.(xl)^2/(xt)^3$

From § 3.3.2 (page 24) can be seen that transversally moving *ec*'s with velocities higher than 0.866.c cause forces that increase very fast till infinity at velocity c. The above mentioned equation for  $f_x$  shows that an increasing  $f_x$  is accompanied by a value x, that is shrinking below 1, thus by a fast reduction of time and also by a reduction of distance.

The concentrations of matter and antimatter could have expelled each other then into separated proto-universes, after which normalisation of time-space could have taken place. An new approach to the problem, using the exchange of potential- and normal energy, is given in *pages 155/158 (proto universe)*, in which diverse quantitative links with other considerations in this work could be found. After reaching its equilibrium, the volume of the universe probably expanded with the constant, newly-formed volume of energons. Some consequences with respect to the black-hole state of the universe have been mentioned above.

What will be the the further development ? If there is a drift of energons into the direction of the border, accompanied by an increasing density and annihilation, will matter be dragged with it ?

A new insight in universal development came during the preceding decennium with measurements on the Ia-supernova as a standard-candle at very large distances. Combination with measurements of the red-shift of these 'candle-lights' seem to suggest that the expansion of the universe accelerates. That conclusion seems to be unrealistic and the energon-hypothesis confirms that vision.

In the hypothesis the (very early) inflation is seen as a too large offer of *pp*'s in the time of creation. That must have caused a temporary increase of *pp*-density with a *reduction of light-velocity* because the coupling between time and length was violated at that event ( $C_c \text{ m}^3 \cdot \text{kg}^{-1} \cdot \text{s}^{-1}$ , § 9.8.6). As the red-shift  $1+z = \{(c+v)/(c-v)\}^{1/2}$  will increase with this *c*-reduction, the measurements of luminosity and real red-shift (with *c'*, if known) could be brought into equilibrium.

Looking to the formula for the calculation of the amount of *pp*-layers of the universal mantle, it may be clear that this amount is inversely proportional to the radius of the universe:  $0.955 \cdot \sqrt{2} \cdot 10^{83} \cdot N_{\text{es}} \cdot N_{\text{cr}} \cdot r_{\text{pp}}^2 / (4 \cdot R_U \cdot t_0 \cdot c) \approx 10^{43}$  (amount of *pp*-layers).

It is thinkable that the thickness of the mantle will be a measure of the end of our universe. The critical value is unknown, but an example is possible:

let it be that the critical amount of *pp*-layers per mantle is  $0.1 \times 10^{43}$ , with a universal radius of  $x \cdot R_U$ . Then we will find  $x \approx 10$ . Because the growing-velocity of  $R_U$  depends on that of the universal capacity conform  $I_U \cdot t = (4\pi/3) \cdot (R_U \cdot t^{1/3})^3$ , or  $R_U \propto t^{1/3}$ , a tenfold of the radius means that the factor of time-growth becomes  $10^3$ , or  $10^3 \cdot T_U \approx 15 \times 10^{12}$  years.

If the universe collapses, the existing black holes will be the longest 'living' structures. The start of a pair of new universes must then wait till the evaporation and concentration of mass (!) of a lonely and small black-hole will cause its critical density (see page 160).