БОЛГАРСКАЯ АКАДЕМИЯ НАУК . BULGARIAN ACADEMY OF SCIENCES

АСТРОФИЗИЧЕСКИЕ ИССЛЕДОВАНИЕ, 4 . ASTROPHYSICAL INVESTIGATIONS, 4

*София . 1985 . Sofia*

*In memory of the great scientific reformer Albert Einstein*

# Self-consistent Mega-Cosmology*

*Rashco G. Zaycoff*

*"Divinity is hidden within numbers"*

Pythagoras and Plato

## Part I. On the Present State oi the Universe

### *1. Introduction. Basic indications and relations, incl. Table 1 with legend. Explanation*

The available data on Mega-Cosmology, i. e. the cosmology of the galaxiee and their associations, are, regrettably, very poor and quite insufficient to evolvr a detailed dynamical picture of the present state and evolution of the matte, in the Universe. Therefore, a "sui generis" arithmetical modelling has been applied here, used intuitively by Gell-Mann for the description of some strange manifestations of the elementary particles. That modelling supposes the existence of some simple arithmetical relations between qualities with different numerical indications.

One supposes here simple arithmetical ratios between quantities with different richness *n*. The concept "richness" of a Galaxy-Association (GA) of the 1st order from 0 to 5 has been introduced by G. O. Abell [1]. The richness (—1) to GA of the 1st order has been added here, which consists of very disperse poor clusterings [2], massive and non-massive, incl. solitary galaxies [3]. The GA of the 1st order and richness (—1) has been noted with the common name "field galaxies" [4] as well, having in mind their great spatial dispersal. The GA of richness 0 to 5 have been named clusters (CL). The CL of richness 0 to 1 are disperse. The CL of richness 2 and 3 are compact and the CL of richness 4 and 5 are very compact, according to their classification of Zwicky [5], [6], Abell [7], [8] and others, e. g. [2].

* In this paper the author has used the units adopted in contemporary cosmology, as sideral year, unit distance A, megalight year, erg, the Hubble constant $H_0$; all dimensions are introduced in § 2 and 1 erg$=10^{-7}$ J.

The above-mentioned quantities are as follows;

1. $\overline{N}_{GA}^{SG(n)}$ = average number of GA of the 1st order and richness $n$ in a GA of the 2nd order, named Supergalaxy (SG) [9], since it has proper rotation like the ordinary galaxies;

2. $\overline{N}_{G}^{(n)}$ = average number of galaxies (G) in GA of the 1st order and richness $n$;

3. $\overline{N}^{SG(n)}$ = average number of G in all GA of the 1st order and richness $n$, including in a GA of the 2nd order;

4. $\overline{M}_{GA}^{(n)}$ = average mass (expressed in $10^{15}\, m_{\odot}$) of a GA of the 1st order and richness $n$, where $m_{\odot}$ is the solar mass;

5. $\overline{M}^{SG(n)}$ = average mass (expressed in $10^{15}\, m_{\odot}$) of all GA of the 1st order and richness $n$, including in a GA of the 2nd order;

6. $\overline{m}_{G}^{(n)}$ = average mass (expressed in $10^{11}\, m_{\odot}$) of a galaxy in a GA of the 1st order and richness $n$;

7. $m^{\max(n)}$ = maximum value of the mass (expressed in $10^{12}\, m_{\odot}$) among the masses of the galaxies in a GA of the 1st order and richness $n$. As it will be shown later, one can set from observations on galaxies in GA of the 1st order and richness $n=-1$, 1, 2.

$$(1.1)\qquad \overline{\mu}^{(n)} = m_{G}^{\max(n)} / \overline{m}_{G}^{(n)} = \begin{cases} 7.0 & n=-1 \\ 8.4 & n=0,1\,; \\ \quad\text{with} & \\ 10.5 & n=2,3 \\ 11.2 & n=4,5 \end{cases}$$

8. $\overline{T}_{G}^{(n)}$ = average kinetic temperature (expressed in $10^{6}$ (°K)) of the proper translational movement of the galaxies in a GA of the 1st order and richness $n$;

9. $\overline{Q}^{SG(n)}$ = average value of a quantity (expressed in $10^{6}$ (°K)$\times 10^{15}\, m_{\odot}$) which is proportional to the proper kinetic translational energy of all G in all GA of the 1st order and richness $n$, including in a GA of the 2nd order;

10. $\overline{v}_{G}^{(n)}$ = average proper velocity (expressed in km/s) of the G in a GA of the 1st order and richness $n$. As it will be shown later, between $\overline{v}_{G}^{(n)}$ and $\overline{T}_{G}^{(n)}$ holds the following approximate relation:

$$(1.2)\qquad (\overline{v}_{G}^{(n)})^2 \approx 2.494\times 10^{-2}\, \frac{\text{km}^2}{\text{s}^2(°\text{K})}\, \overline{T}_{G}^{(n)}\,;$$

11. $\overline{v}_{G||}^{(n)}$ = average proper radial velocity (expressed in km/s) within a GA of the 1st order and richness $n$. According to the astronomy's practice, the quantity $\overline{v}_{G||}$ is the arithemetical mean of $v_{G||}$. Hence, one holds the following relation:

$$(1.3)\qquad \overline{v}_{G||}^{(n)} = \overline{v}_{G}^{(n)} / \sqrt{8/\pi} \approx \overline{v}_{G}^{(n)}/1.60\,;$$

12. $\overline{N}_{CL}^{SG(tot)} = \sum_{n=0}^{5}{}' \overline{N}_{GA}^{SG(n)}$ = average number of clusters (CL) in all GA of the 1st order and richness $n=0$, 1, 2, 3, 4, 5 in a GA of the 2nd order. According to observations [10]:

$$(1.4)\qquad \overline{N}_{CL}^{SG(tot)} = 10 = \frac{1}{2}\,(N_{CL}^{SG(\min)} + N_{CL}^{SG(\max)}),$$

where

$$N_{CL}^{SG(min)} = N_{CL}^{Local\ SG} = 3; \quad N_{CL}^{SG(max)} = 17 \ [1]. \tag{1.5}$$

The clusters in the Local SG are: 1. The cluster-dumb-bell *Virgo* (*Virgo* E + *Virgo* S) [11] of richness 1; 2. The cluster *Fornax* (03211-3725) also of richness 1; 3. The cluster of Zwicky (1916.8+4855) of richness 0. On $N_{CL}^{SG(tot)}$ enters the number of the cluster-dumb-bells as, for example, *Virgo* and 3C129 (A2197) [12], both of richness 1, treated here as single clusters. If one considers the two parts of the cluster-dumb-bells as single clusters, one would get from observations [13]:

$$\overline{N}_{CL}^{SG(tot)'} = 11. \tag{1.6}$$

One gets from (1.4), (1.6) and $\overline{N}_{GA}^{SG(1)} = 4.48$ (Table 1, column 3) that the relative frequency of the cluster-dumb-bells among the clusters of richness 1 is

$$\frac{11-10}{4.48} \approx 0.21.$$

One gets further on the following basic relations between the quantities 1—9:

$$\begin{aligned} &\overline{N}^{SG(n)} = \overline{N}_{GA}^{SG(n)} \overline{N}_{G}^{(n)}; \quad \overline{N}_{GA}^{(n)} = \overline{N}_{G}^{(n)} \overline{m}_{G}^{(n)}; \\ &\overline{M}^{SG(n)} = \overline{N}_{GA}^{SG(n)} \overline{M}_{GA}^{(n)} = \overline{N}^{SG(n)} \overline{m}_{G}^{(n)}; \\ &\overline{Q}^{SG(n)} = \overline{M}^{SG(n)} \overline{T}_{G}^{(n)} = \overline{N}^{SG(n)} \overline{m}_{G}^{(n)} \overline{T}_{G}^{(n)}; \end{aligned} \tag{1.7}$$

and

$$\begin{cases} \overline{\mu}^{(0)} - \overline{\mu}^{(-1)} = 2\times 0.7; \ \overline{\mu}^{(1)} - \overline{\mu}^{(0)} = 0; \ \overline{\mu}^{(2)} - \overline{\mu}^{(1)} = 3\times 0.7; \\ \overline{\mu}^{(3)} - \overline{\mu}^{(2)} = 0: \ \overline{\mu}^{(4)} - \overline{\mu}^{(3)} = 1\times 0.7; \ \overline{\mu}^{(5)} - \overline{\mu}^{(4)} = 0. \end{cases} \tag{1.8}$$

Setting

$$\overline{x}^{(tot)} = \sum_{n=-1}^{s} \overline{x}^{(n)}, \tag{1.9}$$

one would get from (1.4), (1.7) and Table 1, Column 3

$$\begin{aligned} &\overline{N}_{GA}^{SG(tot)} = 20; \ \overline{N}^{SG(tot)}/20 = \overline{N}_G; \ \overline{M}^{SG(tot)}/20 = \overline{M}_{GA} = \overline{m}_G \overline{N}_G; \\ &\overline{M}^{SG(tot)}/\overline{N}^{SG(tot)} = \overline{m}_G; \ \overline{Q}^{SG(tot)}/\overline{M}^{SG(tot)} = \overline{T}_G; \\ &\overline{Q}^{SG(tot)}/\overline{N}^{SG(tot)} = \overline{m}_G \overline{T}_G. \end{aligned} \tag{1.10}$$

According to (1.2), (1.3)

$$(\overline{v}_G)^2 = 2.494\times 10^{-2}\times \frac{km^2}{s^2(°K)} \times \overline{T}_G; \ \overline{v}_{G||} = \overline{v}_G/\sqrt{8/\pi} \approx \overline{v}_G/1.60 \tag{1.11}$$

as well.

The simple arithmetical ratios, mentioned above, are the following:

$$\begin{aligned} &\overline{N}_G^{(n)} = 250(n+2)(n+3); \ \overline{T}_G^{(n)}/10^6(°K) = 7.5(n+2)(n+3), \\ &\overline{T}_G^{(n)}/\overline{N}_G^{(n)} = 0.03\times 10^6(°K). \end{aligned} \tag{1.12}$$

One has supposed that the average kinetic temperature of a GA is proportional to the density of its galaxy-population. With $n=-2$ one gets the case of an absolute cold Vacuum, since one gets from

$$\overline{N}_{\mathrm{G}}^{(-2)}=0\,;\ \overline{T}_{\mathrm{G}}^{(-2)}=0, \tag{1.12}$$

and from (1.7), (1.12)

$$\begin{cases} \overline{C}^{(n)}=\overline{M}_{\mathrm{GA}}^{(n)}\,\overline{T}_{\mathrm{G}}^{(2)}/\overline{M}_{\mathrm{GA}}^{(2)}\,\overline{T}_{\mathrm{G}}^{(n)}=\overline{m}_{\mathrm{G}}^{(n)}\,\overline{N}_{\mathrm{G}}^{(n)}\,\overline{T}_{\mathrm{G}}^{(2)}/\overline{m}_{\mathrm{G}}^{(2)}\,\overline{N}_{\mathrm{G}}^{(2)}\,\overline{T}_{\mathrm{G}}^{(n)} \\ =\overline{m}_{\mathrm{G}}^{(n)}/\overline{m}_{\mathrm{G}}^{(2)}. \end{cases} \tag{1.13}$$

Note: In the galaxy-mass $m_{\mathrm{G}}$ enter the masses of the:
1. Galaxy and its coronae; 2. Their rotational kinetic energy; 3. Their magnetic fields; 4. Cosmic rays of inert matter, which are exceptionless when retained by these magnetic fields.

Assuming the mass at rest of the neutrinos as zero in accordance with the united theory of electromagnetic and weak interactions of Salam-Weinberg, the kinetic mass (energy/$c^2$) do not enter in $m_{\mathrm{G}}$, $c$ being the velocity of light in vacuum, of the electromagnetic and neutrino-radiations and of the proper kinetic energy of the translational movement of the galaxies and their coronae, as well.

Table 1

| 1 | 1 | 3 | | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|
| Galaxy-Association GA | Richness $n$ | $\overline{N}_{\mathrm{GA}}^{\mathrm{SG}\,(n)\ (2)}$ value | ‰ | $\overline{M}_{\mathrm{GA}}^{(n)}$ / $10^{15}\,m_{\odot}$ | $40\,\overline{M}_{\mathrm{GA}}^{(n)}$ / $10^{15}\,m_{\odot}$ | $\overline{M}^{\mathrm{SG}(n)}$ / $10^{15}\,m_{\odot}$ | $\overline{m}_{\mathrm{G}}^{(n)}$ / $10^{11}\,m_{\odot}$ |
| Massive PCL[1] | — | — | — | — | — | — | — |
| Very disperse GA | —1 | 10.0 | 500 | 0.15 | 6 | 1.5 | 3 |
| Non-massive PCL[1] incl. SG[1] | — | — | — | — | — | — | — |
| Disperse | 0 | 3.86 | 193 | 0.50 | 20 | 1.9 | $\frac{10}{3}$ |
| clusters | 1 | 4.48 | 224[3] | 1.50[4] | 60 | 6.7 | 5 |
| Compact | 2 | 1.4 | 70[3] | 4.50[4] | 180 | 6.3 | 9 |
| clusters | 3 | 0.2 | 10[3] | 7.50 | 300 | 1.5 | 10 |
| Very compact | 4 | 0.04 | 2[3] | 11.25[4] | 450 | 0.4 | $\frac{75}{7}$ |
| clusters | 5 | 0.02 | 1[3] | 16.88 | 675 | 0.34 | $\frac{675}{56}$ |
| Sum | — | 20.0 | 1000 | — | — | 18.7 | — |
| Average value | — | — | — | 0.937 | 37.5 | — | ~5.6 |

Table 1 contains the values of the quantities 1—11 and (1—13). From Table 1 one gets the relations

$$(1.14) \qquad \overline{N}^{SG(-1)}/\overline{N}^{SG(tot)}=0.15$$

in accordance with the rough estimate 0.15 [4],

$$(1.15) \qquad \overline{N}^{SG\ (massive\ PCL)}/\overline{N}^{SG(0)}\approx 0.68,$$

in accordance with calculations on data [14] of Zwicky, where PCL denotes poor clusterings [2],

$$(1.16) \qquad \overline{N}^{SG(-1)}/\overline{N}^{SG(0)}\approx 0.86.$$

From (1.15), (1.16) one gets:

$$(1.17) \qquad \overline{N}^{SG\ (non\text{-}massive\ PCL,\ incl.\ SG)}\approx 0.86-0.68=0.18,$$

where SG denotes solitary galaxies [3],

$$\overline{M}^{(0)}_{GA}/\overline{M}^{(-1)}_{GA}=\frac{10}{3}; \quad \overline{M}^{(1)}_{GA}/\overline{M}^{(0)}_{GA}=\overline{M}^{(2)}_{GA}/\overline{M}^{(1)}_{GA}=3;$$

| 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
|---|---|---|---|---|---|---|---|
| $\frac{m^{max(n)}}{10^{12}\, m_{\odot}}$ | $\overline{N}_G^{(n)}$ | $\overline{N}^{SG\,(n)}$ | $\frac{\overline{T}_G^{(n)}}{10^6\,(^0K)}$ | $\frac{\overline{Q}^{SG\,(n)}}{10^6\,(^0K)\ 10^{15}\,m_{\odot}}$ | $\overline{V}^{(n)}_G$ km/s | $\overline{V}^{(n)}_{G\|\|}$ km/s | $\overline{C}^{(n)}$ [9] |
| — | (391.5) | (3915) | — | — | — | — | — |
| 2.10[5] | 500 | 5000 | 15 | 22.50 | 612[7] | 383 | $\frac{1}{3}$ |
| — | (108.5) | (1085) | — | — | — | — | — |
| 2.80 | 1500 | 5790 | 45 | 86.85 | 1059 | 664 | $\frac{10}{27}$ |
| 4.20[5] | 3000[6] | 13440 | 90 | 604.80 | 1498 | 939[8] | $\frac{5}{9}$ |
| 9.45[5] | 5000 | 7000 | 150 | 945.00 | 1934 | 1212[8] | 1[10] |
| 10.50 | 7500 | 1500 | 225 | 337.50 | 2369[7] | 1484 | $\frac{10}{9}$[10] |
| 12.00 | 10500 | 420 | 315 | 141.75 | 2803 | 1756 | $\frac{25}{21}$ |
| 13.50 | 14000 | 280 | 420 | 141.75 | 3236 | 2028 | $\frac{75}{56}$ |
| — | — | 33430 | — | 2280.15 | — | — | — |
| — | 1671.5 | — | 121.7 | — | 1742 | 1092 | — |

## Legend to Table 1

1) The nearest very massive PCL lies in the radial direction to the constellation Centaurus [2]. The nearest non-massive PCL are, except for our Local Group, the groups around NGC3031(M81) [15], around NGC253 [14] and many other groups, as well. There are also many SOG in our neighbourhood.

The nearest disperse CL are the three above-mentioned members of the Local SG. The nearest compact CL are: 1. The cluster Perseus (A426) of richness 3, instead of 2, as it will be shown later.

2. The cluster *Coma A* (A1656) of richness 2. The nearest very compact cluster is *Cygnus A*($Z=0.056$) of richness 4, where $z$ is the corresponding redshift parameter.

2) C=space-cell of Zwicky [5], [6] with equal average density of the inert matter at rest, where the lower index indicates the recent value of the cosmic time t, each C containing a SG [9], named supercluster as well [10].

3) According to the observations [13], [16] and [2].

4) $\overline{M}^{(1)}_{\mathrm{GA}}=M_{(Virgo)}=\frac{75}{50}(10^{15}\,m^{*}_{\odot})=1.5\times10^{15}\,m_{\odot}$.

The numerator and the dominator of the fraction indicate the earlier and the recent value of the Hubble constant $H_0$

$$M_{(Coma\ A)}=\frac{75}{50}(3.06\times10^{15}\,m_{\odot}\ [17])=4.59\times10^{15}\,m_{\odot}=1.02\,\overline{M}^{(2)}_{\mathrm{GA}},$$

$$M'_{(Coma\ A)}=4\times10^{15}\,m_{\odot}\ [18].$$

There are reasons to consider the former estimate of $M_{(Coma\ A)}$ as more reliable than the latter

$$M'_{(Cygnus\ A)}=10\times10^{15}\,m_{\odot}\ [18].$$

Since the estimate $M'_{(Cygnus\ A)}$ is performed through comparison with the estimate $M'_{(Coma\ A)}$ one can set:

$$M_{(Cygnus\ A)}=\overline{M}^{(4)}_{\mathrm{GA}}=\frac{10}{4}\,\overline{M}^{(2)}_{\mathrm{GA}}=11.25\times10^{15}\,m_{\odot},$$

where $\overline{M}^{(2)}_{\mathrm{GA}}$ is given in Table 1, column 4. Hence the cluster *Cygnus A* is of richness 4, instead of 3.

5) $M_{(our\ Galaxy)}=2\times10^{11}\,m_{\odot}$ [4]. The most massive of the observed spirals, situated in our GA of richness $(-1)$: NGC1961, shows shape irregularity, since very probably it is the result of the fusion of two spirals. Its mass is

$$10\times M_{(our\ Galaxy)}=2\times10^{12}\,m_{\odot}=\frac{20}{21}\,m_{\mathrm{G}}^{\max(-1)}=0.95\times m_{\mathrm{G}}^{\max(-1)}.$$

The giant very active elliptical NGC5128, lying within the very massive PCL in the radial direction to Centaurus [2], has the mass $m_{\mathrm{G}}^{\max(-1)}=2.1\times10^{12}\,m_{\odot}$.

$$m\{\mathrm{NGC4486\ (M87)\ in}\ Virgo\}=\frac{75}{50}(2.8\times10^{12}\,m_{\odot},\ [19]^{**})=4.2\times10^{12}\,m_{\odot}=m_{\mathrm{G}}^{\max(1)};$$

$$m\{\mathrm{4C31.04}\}=\frac{75}{50}(6.3\times10^{12}\,m_{\odot},\ [19])=9.45\times10^{12}\,m_{\odot}$$

$$=m\{\mathrm{NGC4889\ at\ the\ centre\ of}\ Coma\ A\}.$$

The mass of 4C31.04 has been estimated, using the motion of its sole satellites. Therefore, 4C31.04 belongs to a cluster of richness 2.

$$m\{\mathrm{NGC1275\ in}\ Perseus\}=m_{\mathrm{G}}^{\max(3)}=10.5\times10^{12}\,m_{\odot}=1.1\ m_{\mathrm{G}}^{\max(2)};$$

---

* Maximum value of $M_{(Virgo)}$ [16].

** New Scientist, **50**, 194 (1971).

$$m\{3C405 \text{ in } Cygnus\ A\} = m_G^{max(4)} = 12\times 10^{12}\, m_\odot = \frac{80}{63}\, m_G^{max(2)}$$

$$= 1.3\, m_G^{max(2)} = m\{3C295 \text{ in the cluster } 1410+5224 \text{ of richness } 4, [2]\};$$

$$m\,\{3C123 = m_G^{max(5)} = 13.5\times 10^{12}\, m_\odot = \frac{10}{7}\, m_G^{max(2)} = 1.4\, m_G^{max(2)}.$$

*Note*: The observations* show that among 20 quasars, i. e. extremely active nuclei of giant galaxies, with $0.1 \leqq Z \leqq 0.5$, 16 quasars are connected with ellipticals.

6) According to recent estimates $N_{G(Virgo)} = 3000 = \overline{N}_G^{(1)}$, accordance with the earlier relation $M_{(Virgo)} = \overline{M}_{GA}^{(1)}$.

7) $V_{(our\ Galaxy)} \approx 600$ km/s $\approx 0.98\ \overline{v}_G^{(-1)}$. Hence, the velocity of *our Galaxy* towards the frame connected with the residual cosmic electromagnetic radiation (RCR) does not surpass the average residual random velocity of the galaxies in the GA of richness $(-1)$; $V_{G(Perseus)}^{max} = 2500$ km/s ([20]) $= 1.05\ \overline{v}_G^{(3)}$. Hence, *Perseus* is a cluster of richness 3, as has been mentioned above.

8) There are two estimates of $\overline{v}_{G||(Virgo)}$: a) 706 km/s [21], b) 1091 km/s [22], calculated from the observed proper radial velocities of a sample of 54 massive galaxies (17 ellipticals, 20 lenticulars and 17 spirals). One gets:

$$\overline{v}_{G||(Virgo)} = \overline{v}_{G||}^{(1)} = 939 \text{ km/s} = 0.395\times 706 \text{ km/s} + 0.605\times 1091 \text{ km/s}.$$

The earlier estimate of $\overline{v}_{G||}$ (*Coma A*) $= 1060$ km/s with $\overline{T}_G$ (*Coma A*) $= 135\times 10^6$ (°K) and $\overline{v}_{G(Coma\ A)}/\overline{v}_{G||(Coma\ A)} = \sqrt{3}$ has been replaced with the recent (1978) in USA estimate — 1200 km/s $= 0.99\ \overline{v}_{G||}^{(2)}$ with $\overline{T}_{G(Coma\ A)} = \overline{T}_G^{(2)} = 150\times 10^6$ (°K) and $\overline{v}_{G(Coma\ A)}/\overline{v}_{G||(Coma\ A)} = \sqrt{8/\pi} \approx 1.6$.

9) One sets: $\overline{d}^{(n)} = \overline{D}_{GA}^{(n)}/\overline{D}_{GA}^{(2)}$, where $\overline{D}$ represents average diameter of a sphere with the same volume as the volume of the GA. If the stability of the GA of richness 2 was assumed, then one could get the condition of the stability of the GA of richness $n$, as follows:

$$\overline{r}^{(n)} \equiv \overline{d}^{(n)}/\overline{C}^{(n)} = \begin{cases} >1 & \text{with unstable GA} \\ \lesseqgtr & \text{with stable GA,} \end{cases} \tag{1.20}$$

where $\overline{C}^{(n)}$ is given by (1.13). Therefore, the relations (1.7), (1.12) which give (1.13) and (1.20) lead to the conclusion that the relative stability of the GA depends on the relative compactness of the GA and on the relative ratios of the average masses of their galaxies.

10) On the basis of the Virial Theorem Chandrasekhar has shown that *Coma A* of richness 2 is stable. One can suppose the stability of all GA of richness 2, as well.

The cluster *Perseus* of richness 3 shows a peripheral disruption [2], due, probably, to tidal influences between *Perseus* and neighbouring [2] GA of richness $(n=-1)$. That disruption can cause any disturbance of its compactness, which is, however, not so large to cause violation of its stability. The stability of compact $(n=2, 3)$ and very compact $(n=4, 5)$ clusters depends not only on inner tidal effects [23], on circular motions of the galaxies [24] and, probably, on inner relative strong magnetic fields. All these factors influence the factor $\overline{d}^{(n)}$ in (1.20).

*Explanation*: The assumed ratios (1.1), (1.12), (1.18) are not of a purely intuitive kind. They are accepted after many comparisons between different data available. In the references are pointed out only the most characteristic papers. The arithmetical modelling is carried out in a consistent and testable way and allows prediction of unknown data and relations within probable limits.

---

* La Recherche, 11, 822 (1980).

(1.18) $$\overline{M}^{(3)}_{GA}/\overline{M}^{(2)}_{GA}=\frac{5}{3};\quad \overline{M}^{(4)}_{GA}/\overline{M}^{(3)}_{GA}=\overline{M}^{(5)}_{GA}/\overline{M}^{(4)}_{GA}=\frac{3}{2},$$

and

(1.19) $$\overline{M}^{(5)}_{GA}/\overline{M}^{(-1)}_{GA}=112.5;\quad \overline{m}^{(5)}_{G}/\overline{m}^{(-1)}_{G}=\frac{225}{56}=4.018,$$
$$m^{\max(5)}_{G}/m^{\max(-1)}_{G}=\frac{45}{7}\approx 6;\quad \overline{N}^{(5)}_{G}/\overline{N}^{(-1)}_{G}=\overline{T}^{(5)}_{G}/\overline{T}^{(-1)}_{G}=2.8.$$

## *§ 2. Basic quantities and laws in astronomy*

The earlier value of the solar mass $m_\odot=1.9891\times10^{33}$g* with the gravitational constant $G=6.6732\times10^{-8}$ cm³/g s² is not consistent with the new value of $G$: $G=6.720\times10^{-8}$ cm³/g s² [25]. It must be replaced by the value:

(2.1) $$m_\odot=\frac{6.6732}{6.6720}\times1.9891\times10^{33}\,\text{g}\approx1.98946\,\text{g}\times10^{33}\,\text{g}.$$

Other basic astronomy's quantities are, as follows:

(2.2) $$\text{Y}=1\ \text{sideral year}=365.256\ \text{days}\approx3.15581\times10^{7}\ \text{s}\ (25);$$

(2.3) $$\text{A}=\text{unit distance}=1.49597875\times10^{8}\ \text{km},$$

which is the recent value of A.
It follows from (2.2), (2.3)

(2.4) $$\sin^{-1}\left(\frac{\text{A}}{\text{pc}}\right)=1''=\frac{\pi}{648000}\approx4.8481368\times10^{-6}$$

and from (2.3), (2.4)

(2.5) $$1\,\text{Mpc}=10^{6}\text{pc}=\frac{10^{6}\,\text{A}}{\sin\left(\frac{\pi}{648000}\right)}\approx3.085678\times10^{19}\ \text{km};$$

(2.6) $c$ = velocity of light in vacuum $=2.99792458\times10^{5}$ km/s [25].
One gets from the new value of $G$ [25] and from (2.2), (2.5), (2.6):

(2.7) $$\begin{cases} c^2=8.9875518\times10^{20}\ \text{cm}^2/\text{s}^2;\ \text{MlY}=\text{Mega-light year} \\ =10^{6}\text{CY}=9.460880\times10^{18}\ \text{km};\ \text{Mpc}\approx3.26151\,\text{MlY}; \\ (\text{Mpc})^3\approx2.938\times10^{58}\ \text{km}^3, \end{cases}$$

and

(2.8) $$\frac{8\pi G}{8}\approx5.58952\times10^{-7}\ \text{cm}^3/\text{gs}^2;$$

(2.9) $$1\ \text{eV}=1.6021892\times10^{-12}\ \text{erg}\ [25];$$

(2.10) $$\begin{cases} T\ \text{eV}=\text{temperature, associated with energy 1 eV} \\ =1.160450\times10^{4}\ (^\circ\text{K})\ [25]; \end{cases}$$

(2.11) $$\begin{cases} K=\text{Boltzmann Constant}=1.380662\times10^{-6}\ \text{erg}/^\circ\text{K}\ [25] \\ =8.61735\times10^{-5}\ \text{eV}/(^\circ\text{K})=\frac{1\ \text{eV}}{T\ \text{eV}}\ [25]; \end{cases}$$

---

* Inform. Bulletin, No 37, Jan. 1977, IAU.

(2.12) $1\ \text{GeV} = 10^9\ \text{eV} = 1.6021892 \times 10^{-3}\ \text{erg};$

(2.13) $N_A = \text{Number of Avogadro} = 6.022045 \times 10^{23}/\text{mole}$ [25];

(2.14) $\begin{cases} \hbar c = \text{energy moment} = 1.9732852 \times 10^{-5}\ \text{eV} \times \text{cm}\ [25] \\ = 3.1615772 \times 10^{-17}\ \text{erg} \times \text{cm}, \end{cases}$

where $\hbar = h/2\pi$ and $h$ is the Planck-constant of action.

The basic physical laws, used in Mega-Cosmology, are as follows:

a) The motion of the centers of inertia of the galaxies is referred to the frame, defined by the RCR, which is a black-body electromagnetic radiation and by other global non-RCR, and is considered here as motion of particles in a relativistic ideal gas under the action of randomly distributed local gravitational fields. The general relativistic form of the Clapeyron-Mendelejev's law of ideal gas is given by the following equation:

(2.15) $$\left(\frac{\overline{v}_G}{c}\right)^2 \times [M^0]_0 / \left\{1 - \left(\frac{\overline{v}_G}{c}\right)^2\right\} = 3KN_A\,\overline{T}_G/c^2 = \overline{T}_G/T = \overline{\xi}_G,$$

where $[M^0]_0$ is the recent value of the mass at rest, contained in a gramm of the energy of the substance, expressed by the ratio $\frac{1\ \text{erg}}{c^2}$.

If $[M^0]_0 \approx 1$ and $\left(\frac{\overline{v}_G}{c}\right)^2 \approx 0$, then one would get from (2.11), (2.13) and (2.15)

(2.16) $$(\overline{v}_G)^2 = 3KN_A\overline{T}_G = 2.49 \times 10^{-2} \frac{\text{km}^2}{(^\circ\text{K})\ \text{s}^2} \times \overline{T}_G.$$

One gets from (2.7), (2.12), (2.13)

(2.17) $$\frac{c^2}{N_A} \approx 1.492441820 \times 10^{-3}\ \text{erg} \approx 0.9315016\ \text{GeV}$$

and from (2.7), (2.11), (2.13), (2.15)

(2.18) $$T = \frac{c^2}{3KN_A} \approx 3.603203 \times 10^{12} (^\circ\text{K}).$$

It follows from Table 1, column 11 and (2.15), (2.18)

(2.19) $$\overline{T}_G \approx 12.2 \times 10^7 (^\circ\text{K});\quad \overline{\xi}_G = \frac{\overline{T}_G}{T} \approx 3.4 \times 10^{-5};$$

b) The RCR is a black-body electromagnetic radiation, as has been mentioned above. The form of the corresponding Stefan-Boltzmann's law is the following:

(2.20) $$\overline{\rho}_r^{RCR} = 3\overline{p}_r^{RCR} = \pi^2 K^4 (\overline{T}_r^{RCR})^4 / 15c^2(c\hbar)^3,$$

where $\overline{\rho}_r^{RCR}$ is the average mass-density of the RCR, $\overline{T}_r^{RCR}$ — its average temperature and

(2.21) $$\pi^2 \approx 9.86960440.$$

From (2.7), (2.11), (2.14), (2.20), (2.21) follows

(2.22) $$\bar{\rho}_r^{RCR} = 3\bar{p}_r^{RCR} \approx 8.4 \times 10^{-21} \frac{g}{km^3(°K)^4} \times (\bar{T}_r^{RCR})^4.$$

The basic quantities of Mega-Cosmology are the "Hubble Constant" $H_0$, the parameter of the deceleration $q$ and their functions. They depend on the cosmic time $t$. The recent value of $H_0$ is

(2.23) $$H_0 = \frac{1}{4}\{53 + 2 \times 50.3 + 46\} \text{ km/s Mps} \approx 50 \text{ km/s Mpc}.$$

The values 53 km/s Mpc [26], [27] and (46±19) km/s Mpc [27] are calculated from galaxies for which the distances are fixed from absolute magnitudes, estimated using cepheids and Type I Supernovae within these galaxies. The value 50.3 km/s/Mpc is relatively new [28]. The rounded off value 50 km/s/Mpc of $H_0$ [26], [29], [30] is considered currently as the most probable value of the "Hubble constant" $H_0$. One gets from (2.2), (2.5), (2.23)

(2.24) $H_0 = 1.64 \times 10^{-18}$ s; $1/H_0 = 19.4 \times 10^9$ Y; $2/3H_0 = 12.9 \times 10^9$ Y,

where the quantity $\frac{2}{3H_0}$ is the age of the Universe, if the proper translational movement of the galaxies and the electromagnetic and neutrino radiations were neglected and a global Euclidean structure of the expanding Universe was assumed. One gets from (2.8), (2.24)

(2.25) $$H_0^2 = 2.68 \times 10^{-36}/s^2; \quad \rho_{(cr)0} = \frac{3H_0^2}{8\pi G} \approx 4.79 \times 10^{-15} \text{ g/km}^3,$$

where $\rho_{(cr)0}$ is the recent critical value of the mass-density of matter (substance and radiation).

The approximate recent value of $q$ is:

(2.26) $$q_0 = \frac{1}{3}(2 \times 0.28 + 0.94) = 0.50.$$

The value 0.28 in (2.26) [31] is calculated from observations on very bright galaxies with red-shift parameter $z \leq 0.30$. The value 0.94 [26] is calculated from observations on quasars only. The former value has twice as large statistical weight than the latter value. The resulting weighted value $q_0 = 0.50$ [32] is calculated from observations of all available galaxies, including these with enormous activity of their central regions (quasars).

Taking into account the proper translational movement of the galaxies and the electromagnetic and neutrino-radiations, one would get the following relation:

(2.27) $$\lim_{t \to 0} q = 1 \geq q \geq \lim_{t \to \infty} q = 0.5.$$

The value $q_0$ is approximately $\approx 0.5$, as follows from (2.26), (2.27). One concludes with great probability hat the large scale homogeneous and isotropic Universe, expanding continuously from the initial moment $t = 0$ to $t \to \infty$ is Euclideah. Hence, one gets from (2.25)

(2.28) $$\bar{\rho}_0 = \rho_{(cr)0} \approx 4.79 \times 10^{-15} \text{ g/km}^3.$$

It follows from (2.6), (2.24) that the maximum of the momentary distance between in principle an observable object and the observer = the momentary distance of the horizon of the visibility is

(2.29) $$r_0^{max} = \frac{2c}{H_0} = 38730.8 \ \text{MlY} \approx 1187\rho \ \text{Mpc}.$$

Since there exists a horizon of visibility of the Expanding Euclidean Universe (EEU) which is also a horizon of the gravitational attraction, and that horizon tends at $t \to \infty$ to infinity, too, and simultaneously the average density $\overline{\rho}^0$ of the substantional mass at rest tends to zero, the gravitational and luminous paradoxes which appear in a static euclidean Universe with $\overline{\rho}^0 > 0$ do not exist any more. Hence, the EEU gives a natural explanation of the inertia of the substance.

## *§ 3. Average mass-densities of the kinetic energy and of the electromagnetic and neutrino radiational energy*

The average mass-density of the proper kinetic energy of the translational movement of the galaxies is $3\overline{p}_G$, where $\overline{p}_G$ is the average kinetic pressure, divided into the square $(c^2)$ of the velocity of light in vacuum. The common average mass-density of the electro-magnetic and neutrino radiations is $\overline{\rho}_r = 3\overline{p}_r$. The average mass-density of the RCR (residual cosmic electromagnetic radiaton) is $\overline{\rho}_r^{RCR} = 3\overline{p}_r^{RCR}$ given by (2.22). According to (2.15),

(3.1) $$3\overline{p}_G = \overline{\rho}_0^0 \left(\frac{\overline{v}_G}{c}\right)^2 / \left\{1 - \left(\frac{\overline{v}_G}{c}\right)^2\right\} = \overline{\rho}_0^0 \overline{\xi}_G / [M^0]_0,$$

where $\overline{\rho}_0^0$ is the recent value of the average mass-density $\overline{\rho}^0$ of the inert (substantial) matter at rest. Since at present $[M^0]_0 \approx 1$, one gets from (3.1)

(3.2) $$3\overline{p}_G \approx \overline{\rho}_0^0 \overline{\xi}_G.$$

One can, on the analogy of (3.1), write the relations

(3.3) $$3\overline{p}_r^{RCR} = \overline{\rho}_r^{RCR} = \overline{\rho}_0^0 \overline{\xi}_r^{RCR}, \quad 3\overline{p}_r = \overline{\rho}_r = \overline{\rho}_0^0 \overline{\xi}_r,$$

which are, however, exact. The quantities $\overline{\xi}_r^{RCR}$, $\overline{\xi}_r$ are defined through the relations

(3.4) $$\overline{\xi}_r^{RCR} = C_0^{RCR} \pi^2 \overline{\xi}_G, \quad \overline{\xi}_r = C_0 \pi^2 \overline{\xi}_G,$$

where $C_0^{RCR}$, $C_0$ are constants, $\overline{\xi}_G$ is given by (2.19) and $\pi^2$ — by (2.21). If one takes into account that, according to recent estimates [33]: $\overline{T}_r^{RCR} = 2.96\,(^\circ K)$, one would get from (2.19), (2.21), (2.22), assuming in the 1st approximation that $\overline{\rho}_0^0 = \overline{\rho}_0$, where $\overline{\rho}_0$ is given by (2.28)

(3.5) $$C_0^{RCR} = 0.4048.$$

One can assume that $\overline{\rho}_r$ is the average mass-density of the total radiation, including the electromagnetic (RCR, global non-RCR and other non-global and non-RCR) radiations and neutrino-radiation (which is only non-RCR). One sets further on

(3.6) $$C_0 = 0.4448.$$

One gets from (2.19), (2.21), (3.4), (3.5), (3.6)

(3.7) $$\overline{\xi}_r^{RCR} = C_0^{RCR}\pi^2\overline{\xi}_G \approx 13.49\times 10^{-5}$$

and

(3.8) $$\overline{\xi}_r = C_0\pi^2\overline{\xi}_G \approx 14.8\times 10^{-5}.$$

Since, obviously

(3.9) $$\overline{\rho}_0 = \overline{\rho}_0^0 + 3\overline{p}_G + \overline{\rho}_r,$$

one gets from (3.2), (3.3), (3.9)

(3.10) $$\overline{\rho}_0 = \overline{\rho}_0^0(1+\overline{\xi}_G+\overline{\xi}_r) = \overline{\rho}_0^0(1+\overline{\xi}),$$

where

(3.11) $$\overline{\xi} = \overline{\xi}_G + \overline{\xi}_r.$$

Therefore, it follows from (3.10)

(3.12) $$\overline{\rho}_0^0 = \frac{\overline{\rho}_0}{1+\overline{\xi}}.$$

It follows from (2.19), (3.8), (3.11), (3.12)

(3.13) $$\overline{\xi} = 1.82\times 10^{-4},$$

as well, and from (2.28), (3.12), (3.13)

(3.14) $$\overline{\rho}_0^0 \approx 4.79\times 10^{-15}\ \text{g/km}^3.$$

One gets further on from (2.19), (3.2), (3.3), (3.7), (3.8), (3.14)

(3.15) $$3\overline{p}_G = \overline{\rho}_0^0\overline{\xi}_G \approx 16.2\times 10^{-20}\ \text{g/km}^3;$$

(3.16) $$\overline{\rho}_r^{RCR} = \overline{\rho}_0^0\overline{\xi}_r^{RCR} \approx 64.6\times 10^{-20}\ \text{g/km}^3;$$

(3.17) $$\overline{\rho}_r = \overline{\rho}_0^0\overline{\xi}_r \approx 71.0\times 10^{-20}\ \text{g/km}^3$$

and from (2.22), (3.16)

(3.18) $$(\overline{T}_r^{RCR})^4 \approx 76.8(^0\text{K})^4; \quad \overline{T}_r^{RCR} \approx 2.96\ (^0\text{K}).$$

According to recent observations [33]*, the observed residual global electromagnetic radiation is with 5% greater than the estimated black-body RCR. According to (3.5), (3.6), the percentage of that non-black body electromagnetic radiation is:

(3.19) $$\frac{C_0^{RCR}}{C_0}\times 5.00\% = 4.55\%.$$

An interesting hypothesis [34] assumes that the same radiation is caused through the emission of the initial stars, its re-absorption and then re-emission by the interstellar, formerly very dense inert medium. The percentage of all

* Physics Today, 17, June, 1979.

non-black-body electromagnetic radiation, incl. the neutrino-radiation, is according to (3.5), (3.6), (3.19) (3.20)

$$100\left(1-\frac{C_0^{\mathrm{RCR}}}{C_0}\right)=9.00\,\%=4.55\,\%+1.20\,\%^{a)}+3.25\,\%^{b)},$$

where

a) electromagnetic radiation of the galactic stars, clouds and coronae [35], including the powerful X-rays, due to the inverse Compton scattering of microwave background radiation in the coronae of active galaxies by the relativistic electrons, escaping from nuclear regions [36];

b) non-residual neutrino-radiation with average mass-density $\bar{\rho}$ (neutrino) $=4.817\times10^{-6}\bar{\rho}_0$.

The percentage of the RCR (black-body electromagnetic radiation) is

(3.21) $$100\times C_0^{\mathrm{RCR}}/C_0=91\,\%.$$

## *§ 4. The size of the space-cells (C). The size and flatness of the Supergalaxy (SG). The average distance between galaxies in C and SG*

One gets from Table 1, column 6, (2.1), (2.7), (3.14)

(4.1) $$\begin{cases}\bar{M}^{\mathrm{SG(tot)}}=1.87\times10^{16}\,m_\odot=3.73\times10^{49}\,\mathrm{g};\\ \bar{M}\,(\mathrm{standard})=\bar{\rho}_0^0\,(\mathrm{Mpc})^3=1.41\times10^{44}\,\mathrm{g}.\end{cases}$$

Let us denote with $\bar{D}^{\mathrm{C}}$ the side-length of the space-cell C (cube). Bearing in mind that there is no inert matter outside the supergalaxies (SG), one gets

(4.2) $$\bar{M}^{\mathrm{C(tot)}}=\bar{\rho}_0^0(\bar{D}^{\mathrm{C}})^3=\bar{M}^{\mathrm{SG(tot)}}.$$

It follows from (2.5), (2.7), (4.1), (4.2)

(4.3) $$\bar{M}^{\mathrm{SG(tot)}}/\bar{M}\,(\mathrm{standard})=(\bar{D}^{\mathrm{C}}/\mathrm{Mpc})^3=2.65\times10^5$$

and from (2.5), (2.7), (4.3)

(4.4) $$\bar{D}^{\mathrm{C}}\approx 64.225\ \mathrm{Mpc}\approx1.98\times10^{21}\,\mathrm{km}\approx209\ \mathrm{MlY}.$$

There are two estimates of $\bar{D}^{\mathrm{C}}$

(4.5) $$\bar{D}^{\mathrm{C}\prime}=\frac{100}{50}\,(30\ \mathrm{Mpc}\ [5])=60\ \mathrm{Mpc};\ \bar{D}^{\mathrm{C}\prime\prime}=\frac{75}{50}\,(45.6\ \mathrm{Mpc}\ [10])=68.4\ \mathrm{Mpc}.$$

One gets from (4.4), (4.5)

(4.6) $$\bar{D}^{\mathrm{C}}=0.497\,\bar{D}^{\mathrm{C}\prime}+0.503\,\bar{D}^{\mathrm{C}\prime\prime};\ \frac{0.503}{0.497}\approx1.01.$$

Let $\bar{D}^{\mathrm{SG}}$ be the average diameter of a sphere with the same volume as that of the Supergalaxy (SG). There is the following estimate of the $\bar{D}^{\mathrm{SG}}$:

(4.7) $$\bar{D}^{\mathrm{SG}\prime\prime}=\frac{75}{50}\,(42\ \mathrm{Mpc}\ [10])=63\ \mathrm{Mpc}.$$

Setting

(4.8) $$\bar{\delta}=\bar{D}^{\mathrm{SG}}/\bar{D}^{\mathrm{C}},$$

one gets from (4.5), (4.7), (4.8):

(4.9) $$\bar{\delta}'' = \bar{D}^{SG''}/\bar{D}^{C''} = \frac{63 \text{ Mpc}}{68.4 \text{ Mpc}} = \frac{35}{38} \approx 0.92.$$

The previous estimate (4.9) of $\bar{\delta}$, based on $\bar{D}^{C'}$ [5], is

(4.10) $$\bar{\delta}' \approx 0.9.$$

One gets from (4.5), (4.8), (4.10)

(4.11) $$\bar{D}^{SG'} = \bar{D}^{C'}\bar{\delta}' = 54 \text{ Mpc}.$$

Setting, as in (4.6)

(4.12) $$\bar{D}^{SG} = 0.497\bar{D}^{SG'} + 0.503\,\bar{D}^{SG''},$$

one gets from (4.7), (4.11), (4.12)

(4.13) $$\bar{D}^{SG} = 58.5 \text{ Mpc}$$

and from (4.4), (4.8), (4.13)

(4.14) $$\bar{\delta} = 0.911 \approx 1.01\bar{\delta}' \approx 0.99\bar{\delta}''.$$

Let us introduce with $\bar{f}_{SG}$ the average flatness of the SG, defined by

(4.15) $$\bar{f}_{SG} = \bar{D}^{SG(major)}/\bar{D}^{SG(minor)}.$$

The volume of the SG is

(4.16) $$\begin{cases} \frac{\pi}{6}(\bar{D}^{SG})^3 = \frac{\pi}{6}\{(\bar{D}^{SG(major)})^2 \times \bar{D}^{SG(minor)}\} \\ = \frac{\pi}{6}\{\bar{D}^{SG(major)}\}^3 \times \bar{D}^{SG(minor)}/\bar{D}^{SG(major)}. \end{cases}$$

It follows from (4.15), (4.16)

(4.17) $$\bar{f}_{SG} = \bar{D}^{SG(major)}/\bar{D}^{SG(minor)} = (\bar{D}^{SG(major)}/\bar{D}^{SG})^3.$$

The maximum and minimum of $f_{SG}$ are given as follows:

(4.18) $$f_{SG}^{max} = f^{Local\ SG} = 5,\ [14];\ f_{SG}^{min} = 1.$$

Let us assume as well that

(4.19) $$\bar{f}_{SG} = (f_{SG}^{max} + 3f_{SG}^{min})/4 = 2.$$

It follows from (4.17), (4.19)

(4.20) $$\bar{D}^{SG(major)} = \bar{D}^{SG}\sqrt[3]{2} \approx \bar{D}^{SG} \times 1.26$$

and from (4.13), (4.20)

(4.21) $$\bar{D}^{SG(major)} = 73.7 \text{ Mpc}.$$

It follows from observations [4] and from (2.7)

(4.22) $$D^{Local\ SG\ (major)} = \frac{75}{50}\ 165 \text{ MlY} = 247 \text{ MlY} \approx 76 \text{ Mpc}$$

and from (4.21), (4.22)

$$(4.23)\qquad D^{\text{Local (SG (major)}}\approx 1.03\,\bar{D}^{\text{SG (major)}}.$$

One gets from (4.15), (4.19), (4.21)

$$(4.24)\qquad \bar{D}^{\text{SG(minor)}}=\bar{D}^{\text{SG (major)}}/\bar{f}_{\text{SG}}=36.9\text{ Mpc},$$

from (4.15), (4.18). (4.22)

$$(4.25)\qquad D^{\text{Local SG (minor)}}=15\text{ Mpc}$$

and from (4.13), (4.17), (4.18), (4.22)

$$(4.26)\qquad D^{\text{Local SG}}=D^{\text{Local SG (major)}}/\sqrt[3]{5}\approx 76/1.71\approx 44.4\text{ Mpc}\approx 0.76\bar{D}^{\text{SG}}.$$

It follows from Table 1, Column 10

$$(4.27)\qquad \bar{N}^{\text{SG (tot)}}=33.4\times 10^{3}.$$

The average distance between two galaxies in the space-cell C is

$$(4.28)\qquad \bar{\triangle}^{\text{C}}=\bar{D}^{\text{C}}(\bar{N}^{\text{SG (tot)}})^{-1/3}.$$

It follows from (2.7), (4.4), (4.27), (4.28)

$$(4.29)\qquad \bar{\triangle}^{\text{C}}\approx 1.99\text{ Mpc}\approx 6.5\text{ MlY}.$$

The average distance between two galaxies in the Supergalaxy SG is

$$(4.30)\qquad \bar{\triangle}^{\text{SG}}=\bar{D}^{\text{SG}}(6N^{\text{SG (tot)}}/\pi)^{-1/3}.$$

From (4.8), (4.14) follows

$$(4.31)\qquad \bar{D}^{\text{SG}}=\bar{D}^{\text{C}}\times\bar{\delta}=\bar{D}^{\text{C}}\times 0.91$$

and from (4.28), (4.29), (4.30), (4.31)

$$(4.32)\ \bar{\Delta}^{\text{SG}}=\bar{\Delta}^{\text{C}}\times\frac{\bar{\delta}}{\sqrt[3]{6/\pi}_{2\times 2.4}}\simeq\bar{\Delta}^{\text{C}}\times\frac{0.91}{1.24}=\bar{\Delta}^{\text{C}}\times 0.73\approx 1.46\text{ Mpc}\approx 4.78\text{ MlY}\approx 2\times 2.4\text{MlY}.$$

That result shows that the average distance between two galaxies in the SG is approximately twice as large the distance between the centres of *our Galaxy* and the *Galaxy Andromeda.*

## *§ 5. Horizon of visibility, expressed in* $\bar{D}^{\text{C}}$*. The recent values of q and t. Distant objects. Table 2*

One gets from (2.29), (4.4)

$$(5.1)\qquad r_0^{\max}/\bar{D}^{\text{C}}\simeq 185\ ;\ x_0^{\max}=\frac{4\pi}{3}(r_0^{\max}/\bar{D}^{\text{C}})^3\simeq 2.65\times 10^7$$

and from Table 1, columns 6 and 10, (2.1), (2.13), (4.1), (5.1)

$$(5.2)\qquad \begin{cases} M_0^{\max}=x_0^{\max}\bar{M}^{\text{SG(tot)}}=4.96\times 10^{23}m_{\odot}\simeq 9.87\times 10^{56}\text{g}\\ N_{0\text{G}}^{\max}=x_0^{\max}\bar{N}^{\text{SG(tot)}}\approx 8.85\times 10^{11}\ ;\ N_{\odot\,\text{(nucleons)}}^{\max}=M_{\odot}^{\max}N_A\\ \simeq 5.94\times 10^{80}\ ;\ \bar{N}_{0\,\text{(nucleons)}}^{\text{SG}}=\bar{M}^{\text{SG(tot)}}N_A\simeq 2.24\times 10^{73}.\end{cases}$$

According to (3.13),

(5.3) $$\bar{\xi}=1.82\times10^{-4}.$$

In Part III it will be shown that the recent values of $q$ and $t$ are expressed by the following relations:

(5.4) $$q_0=0.5+\frac{\bar{\xi}}{2(1+\bar{\xi})}=\frac{1+2\bar{\xi}}{2(1+\bar{\xi})}$$

and

(5.5) $$t_0=\frac{2}{3H_0}\{1-\bar{\xi}(1+\bar{\xi})+2\bar{\xi}(1+\bar{\xi})\sqrt{\bar{\xi}/(1+\bar{\xi})}\},$$

where $\frac{2}{3H_0}$ is given in (2.24). It follows from (2.24), (5.3), (5.4), (5.5)

(5.6) $$q_0\approx0.50$$

and

(5.7) $$t_0=12.9\times10^9\text{Y}.$$

The limits of the variable quantity $q$ are

(5.8) $$\lim_{t\to0} q=1\,;\quad \lim_{t\to\infty} q=0.5.$$

Rough estimates of the cosmic time $t_0$ are as follows:

(5.9) $$t\ (\text{nucleosynthesis})=13\times10^9\text{Y}^*$$

and

(5.10) $$t\ (\text{oldest stars in the Milky Way})=12\times10^9\text{Y}\ [37].$$

One sets

(5.11)
1. $t_0=t/z_0=0$ — recent value of the age of the EEU:
2. $t=t/z_0>0$ — value of the same age for distant objects ($z_0>0$)
3. $d=d/z_0$ — momentary distance of an object, for which $z_0>0$.
4. $Q=\sqrt{2q_{min}-1}$.

From the well-known relation of the Einstein-de Sitter model of the EEU one gets approximately from (5.7), (5.11)

(5.12) $$t=t_0(1+z_0)^{-3/2};\ \Delta t=t_0-t=t_0\{1-(1+z_0)^{-3/2}\}$$
$$=12.9\times10^9\text{Y}\times\{1-(1+z_0)^{-3/2}\}.$$

By considering euclidean space as a limit space ($q_{min}=0.5$) of the elliptic space, one gets from (2.29), (5.11):

(5.13) $$d=\frac{c}{H_0}\lim_{Q\to0}\left\{\frac{1}{Q}\sin^{-1}[2Q\{1-(1+z_0)^{-1/2}\}]\right\}$$
$$=\frac{2c}{H_0}\{1-(1+z_0)^{-1/2}\}=38.731\times10^9\,\text{lY}\{1-(1+z_0)^{-1/2}\}.$$

* Sciences et Avenir, No 355, 830 (1976).

Table 2

| Cluster 1410 + 5224 $z_0 = 0.461$ | | | Radiogalaxy 3C123 $z_0 = 0.637$ | | | The maximum visible G $z_0 = 1.70$ | | | The maximum visible OQ172 $z_0 = 3.53$ | | | The initial state of the Universe $z_0 = z_{in} = 3.68 \times 10^{12}$ | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $v_D = 1.08 \times 10^5$ km/s | | | $v_D = 1.3 \times 10^5$ km/s | | | $v_D = 2.3 \times 10^5$ km/s | | | $v_D = 2.8 \times 10^5$ km/s | | | $v_D = c$ | | |
| $\frac{d}{10^9 \text{ lY}}$ | $\frac{\Delta t}{10^9 \text{ Y}}$ | $\frac{t}{10^9 \text{ Y}}$ | $\frac{d}{10^9 \text{ lY}}$ | $\frac{\Delta t}{10^9 \text{ Y}}$ | $\frac{t}{10^9 \text{ Y}}$ | $\frac{d}{10^9 \text{ lY}}$ | $\frac{\Delta t}{10^9 \text{ Y}}$ | $\frac{t}{10^9 \text{ Y}}$ | $\frac{d}{10^9 \text{ lY}}$ | $\frac{\Delta t}{10^9 \text{ Y}}$ | $\frac{t}{10^9 \text{ Y}}$ | $\frac{d}{10^9 \text{ lY}}$ | $\frac{\Delta t}{10^9 \text{ Y}}$ | $\frac{i}{10^9 \text{ Y}}$ |
| 6.7 | 5.6 | 7.3 | 8.5 | 6.7 | 6.2 | 16.6 | 10 | 2.9 | 20.5 | 11.6 | 1.3 | 38.7 | 12.9 | 0 |

Since as it will be shown in Part II

(5.14) $$(z_0)\ \text{initial} = z_{\text{in}} = 3.68 \times 10^{12} = x,$$

one gets from (2.29), (5.14)

(5.15) $$\lim_{z_0 \to \infty} d = d_0^{\max} = r_0^{\max} = 38730.8 \text{ MlY}$$

and

(5.16) $$\lim_{t_0 \to \infty} r_0^{\max} = \infty; \quad \lim_{t_0 \to \infty} t_0^{\max \text{ with (visible objects)}} = \infty.$$

Let $D$ denote the "Doppler value." Then

(5.17) $$\left\{ v_D = c\,\frac{(1+z_0)^2 - 1}{(1+z_0)^2 + 1};\ \lim_{z_0 \to \infty} v_D = c; \quad 1 + z_0 = \sqrt{(c+v_D)\,(c-v_D)} \right.$$

$$= \left(1 + \frac{v_D}{c}\right) \Big/ \sqrt{1 - \left(\frac{v_D}{c}\right)^2}.$$

Table 2 contains the values of $z_0$, $v_D$, $d$, $\Delta t$, $t$ of the following 5 very distant objects:
1. The cluster 1410+5224 of richness 4, 2, the Radiogalaxy 3C123, probably in a cluster of richness 5, 3. The maximum visible galaxy (CalTech, USA, 1981), probably in a cluster of richness 5, 4. The maximum visible quasar OQ 172 [38]; 5. The initial state of the Universe.

## Part II. On the Initial State of the Universe

### *§6. The number of neutrons in a gramm. Initial temperature. Initial average densities. The minimum distance between two initial particles*

Let $\mu$ be the mass of the neutron $= m_n$. According to [39],

(6.1) $$\mu c^2 = 0.9395731 \text{ GeV} = C_n \times \frac{c^2}{N_A}.$$

One gets from (2.17), (6.1)

(6.2) $$C_n = 1.009$$

and from (2.13), (6.2) for the number $N_n$ of the neutrons in a gramm (g)

(6.3) $$N_n = \frac{N_A}{C_n} = \frac{1}{\mu} \approx 5.97 \times 10^{23}/\text{g}.$$

It follows from (2.7), (2.14), (6.3)

(6.4) $$N_n \hbar c / c^2 = N_A\, \hbar c / C_n c^2 \approx 2.1 \times 10^{-14} \text{ cm}$$

and

(6.5) $$(c^2/N_n \hbar c)^3 \approx 1.08 \times 10^{41}/\text{cm}^3; \quad 1/N_n (c^2/N_n \hbar c)^3 \approx 1.81 \times 10^{17} \text{ g/cm}^3.$$

As a result of the initial (in) neutralization of the electric charges and the action of the subnuclear induction, the initial substance ($s$) consists of neutrons ($n$) and antineutrons ($\tilde{n}$), mutually compact and adjoining with very small superiority of neutrons, the contents of $n$ and $\tilde{n}$ being of pure kinetic nature, like the radiation in a black-body. More completely expressed, these contents consist of quarks and virtually gluons, moving with the initial velocity $v=c$. Therefore, the masses at rest of the initial particles (ip) in $n$ and $\tilde{n}$ are zero. Their total kinetic mass, however, coincides with $\mu=m_n$ and their total kinetic energy with $\mu c^2$ in (6.1).

One gets from (2.11), (2.18), (6.1), (6.3)

$$\text{(6.6)}\qquad \mu c^2=c^2/N_n=c^2C_n/N_A=K(\overline{T}_s)_{in}=c^2/3N_A T\times(\overline{T}_s)_{in}$$

and from (2.18), (6.2), (6.3), (6.6)

$$\text{(6.7)}\qquad (\overline{T}_s)_{in}=3C_nT=\mu c^2/K\approx 1.09\times 10^{13}(^0K).$$

The same value follows if one multiplies $T$ eV in (2.10) with $\mu c^2=m_nc^2$ in (6.1). Let us assume further on that

1. There exists also initial light radiation with initial mass-density

$$\text{(6.8)}\qquad (\overline{\rho}_r)_{in}\equiv(3\overline{p}_r)_{in}=C_0^{RCR}\pi^2(\overline{\rho}_s)_{in}=C_0^{RCR}\pi^2(3\,\overline{p}_s)_{in},$$

where $\pi^2$ is given in (2.21), $C_0^{RCR}$ in (3.5) and

$$\text{(6.9)}\qquad (\overline{\rho}_s)_{in}=(3\,\overline{p}_s)_{in}$$

is the initial average mass-density of the substance;

2. The initial substance and the initial light radiation are in a thermodynamical equilibrium. Therefore

$$\text{(6.10)}\qquad (\overline{T}_s)_{in}=(\overline{T}_r)_{in}=T_{in}=(1+z_{in})\overline{T}_r^{RCR},$$

where $z_{in}$ is the initial value of the red-shift parameter and $\overline{T}_r^{RCR}$ has the value in (3.18). The quantity $1+z_{in}=\alpha_0\approx z_{in}$ is the recent value of the spatial scale-factor $\alpha$ which satisfies the inequality

$$\text{(6.11)}\qquad \lim_{t\to 0}\alpha=1<\alpha_0<\lim_{t\to\infty}\alpha=\infty.$$

The quantity $\alpha_0$ has the following value

$$\text{(6.12)}\qquad \alpha_0=1+z_{in}=T_{in}/\overline{T}_r^{RCR},$$

which follows from (6.10). One gets from (3.18), (6.7), (6.10),

$$\text{(6.13)}\qquad \alpha_0=\frac{10.90\times 10^{12}(^0K)}{2.96\ (^0K)}\approx 3.68\times 10^{12},$$

coinciding with (5.14). Let $[M^0]$ be the quantity = mass at rest, containing in a gramm (Energy/$c^2$) of the substance. One sets [40]

$$\text{(6.14)}\qquad [M^0]=\sqrt{1-1/\alpha^2}$$

with $\alpha<1$ the quantity $[M^0]$ is imaginary. With $\alpha=1$ (at $t=0$): $[M^0]=0$, in accordance with (6.11) and the assumption that the initial substance is of pure kinetic nature. With $\alpha\to\infty$ (at $t\to\infty$) $[M^0]=1$. One gets from (6.13), (6.14)

$$\text{(6.15)}\qquad 1-[M^0]_0\approx\frac{1}{2\alpha_0^2}\approx 3.685\times 10^{-26}\approx 0;\ [M^0]_0\simeq 1.$$

It follows from (2.15), (2.19), (6.12), (6.13)

$$\text{(6.16)}\qquad C_s=\alpha_0\overline{\xi}_G=\alpha_0\overline{T}_G/T=(1+z_{in})\overline{T}_G/T\approx 1.24\times 10^8$$

and from (6.2), (6.16)

(6.17) $$C_s/C_n \approx 1.23\times10^8;\ \frac{\pi}{2C_s}\approx 4.26\times10^{-8}\approx 0.$$

One gets from (2.18), (2.20), (6.3), (6.7), (6.8), (6.9), (6.10)

$$(\bar{\rho}_r)_{\text{in}} = C_0^{\text{RCR}}\pi^2(\bar{\rho}_s)_{\text{in}} = \pi^2 \text{K}^4\, T^4_{\text{in}}/15\ c^2(c\hbar)^3$$

(6.18) $$\pi^2\{\text{K}\times 3C_n T\}^4/15c^2(c\hbar)^3 = \frac{\pi^2}{2}\{\text{K}\,T\times 3C_n\}^4/15c^2(c\hbar)^3$$

$$\pi^2\left\{\frac{c^2}{N_{\text{A}}}\times 3C_n\right\}^4/15c^2\ (c\hbar)^3 = \pi^2\left(\frac{c^2}{N_n}\right)^4/15\,c^2\ (c\hbar)^3 = \pi^2/15\,N_n\times(c^2/N_n c\hbar)^3$$

and from (6.8), (6.18)

(6.19) $$(\bar{\rho}_s)_{\text{in}} = 1/15\,C_0^{\text{RCR}} N_n\times(c^2/N_n c\hbar)^3.$$

It follows from (3.5)

(6.20) $$15\times C_0^{\text{RCR}} = 6.07$$

and from (6.5), (6.19), (6.20)

(6.21) $$(\bar{\rho}_s)_{\text{in}} = 2.98\times10^{16}\ \text{g/cm}^3.$$

Since

(6.22) $$(\bar{\rho})_{\text{in}} = (\bar{\rho}_s)_{\text{in}} + (\bar{\rho}_r)_{\text{in}},$$

one gets from (6.8), (6.22)

(6.23) $$(\bar{\rho})_{\text{in}} = (1 + C_0^{\text{RCR}}\pi^2)\,(\bar{\rho}_s)_{\text{in}}$$ and

from (2.20), (3.5)

(6.24) $$1 + C_0^{\text{RCR}}\pi^2 = 4.99,$$

from (6.21), (6.23), (6.24)

(6.25) $$(\bar{\rho})_{\text{in}} \approx 14.87\times10^{16}\ \text{g/cm}^3$$

and from (6.21), (6.22), (6.25)

(6.26) $$(\bar{\rho}_r)_{\text{in}} = (\bar{\rho})_{\text{in}} - (\bar{\rho}_s)_{\text{in}} = 11.90\times10^{16}\ \text{g/cm}^3,$$

in accordance with the expression for $(\bar{\rho}_r)_{\text{in}}$ in (6.18). Let us denote with *ns* a "neutron-star". Since [41]

(6.27) $$\rho_{ns}^{\max} = 6\times10^{15}\ \text{g/cm}^3,$$

and with $\rho > \rho_{ns}^{\max}$ one gets the mass-density of the hyperon stars. It follows from (6.25) and (6.27)

(6.28) $$\sqrt[3]{(\bar{\rho})_{\text{in}}/\rho_{ns}^{\max}} \approx 2.91 < 3.$$

That is the state of a white hole. One gets from (2.15), (2.18), (6.7), (6.10), (6.16), (6.17)

(6.29) $$C_s T = \bar{\xi}_{\text{G}}\alpha_0 T = \alpha_0 \bar{T}_{\text{G}} = C_s T_{\text{in}}/3C_n \approx 4.48\times10^{20}(^0\text{K}).$$

It follows from the definition of $\alpha_0$ as the recent value of the spatial scale-factor and from (2.3), (4.4), (6.13)

$$(6.30)\qquad \{(\bar{D}^{C})^3\}_{in}=(\bar{D}^{C})^3/\alpha_0^3;\ (\bar{D}^{C})_{in}=\bar{D}^{C}/\alpha_0=5.38\times10^{8}\ \mathrm{km}=3.60\ \mathrm{A}.$$

One gets from (2.20), (6.8), (6.9), (6.10), (6.12)

$$(6.31)\qquad (\bar{\rho}_s)_{in}=3\,\bar{p}_G\alpha_0^4,$$

from (3 2), (4.1), (4.2), (6.16), (6.30), (6.31)

$$(6.32)\qquad \begin{aligned}\{\bar{M}_s^{C\,(tot)}\}_{in}&=(\bar{\rho}_s)_{in}\{(\bar{D}^{C})^3\}_{in}=3\,\bar{p}_G\alpha_0^4(\bar{D}^{C})^3/\alpha_0^3=3\,\bar{p}_G\alpha_0(\bar{D}^{C})^3\\ &\approx\bar{\rho}_0^0\xi_G\alpha_0(\bar{D}^{C})^3=\bar{\xi}_G\alpha_0\bar{\rho}_0^0(\bar{D}^{C})^3=C_s\bar{M}^{SG\,(tot)}\approx4.64\times10^{57}\ \mathrm{g}\end{aligned}$$

and from (6.32)

$$(6.33)\qquad \{\bar{M}_s^{C\,(tot)}\}_{in}/\bar{M}^{SG\,(tot)}=C_s.$$

It follows from (5.2), (6.6), (6.29), (6.33)

$$(6.34)\qquad \begin{aligned}C_sT&=C_sT_{in}/3C_n=\{\bar{M}_s^{C\,(tot)}\}_{in}T_{in}/3C_n\bar{M}^{SG\,(tot)}\approx\frac{C_n}{N_A}\{\bar{N}^{C}_{n,\,\tilde{n}}\}_{in}\\ &\times T_{in}/3C_n\times\frac{1}{N_A}(\bar{N}^{SG}_{nucleons})=\{\bar{N}^{C}_{n,\tilde{n}}\}_{in}T_{in}/3\{\bar{N}^{SG}_{nucleons}\}\end{aligned}$$

and from (6.17), (6.34)

$$(6.35)\qquad \{\bar{N}^{C}_{n,\,\tilde{n}}\}_{in}/\bar{N}^{SG}_{nucleons}=C_s/C_n\approx1.23\times10^{8}.$$

The colossal value of the ratio in (6.35), of the order $10^8$, shows the initial enormously copious production of neutron-antineutron pairs. One gets from (5.2), (6.33), (6.35)

$$(6.36)\ \{\bar{N}^{C}_{n,\tilde{n}}\}_{in}\approx\frac{C_s}{C_n}N_A\bar{M}^{SG\,(tot)}=C_sN_n\bar{M}^{SG\,(tot)}=N_n\{\bar{M}_s^{C\,(tot)}\}_{in}=N_n(\bar{\rho}_s)_{in}\{(\bar{D}^{C})^3\}_{in}.$$

The minimum distance between the centers of the initial $n$ and $\tilde{n}$ is

$$(6.37)\qquad (\bar{d}_{n,\tilde{n}})_{in}=\sqrt[3]{\{\bar{D}^{C}\}^3_{in}/\{\bar{N}^{C}_{n,\tilde{n}}\}_{in}}.$$

One gets from (6.4), (6.19), (6.20), (6.36), (6.37)

$$(6.38)\ \{\bar{d}_{n,\,\tilde{n}}\}_{in}=\frac{1}{\sqrt[3]{N_n(\bar{\rho}_s)_{in}}}=\sqrt[3]{15C_0^{RCR}}\times\frac{N_n\hbar c}{c^2}\approx1.82\times\frac{N_n\hbar c}{c^2}\approx3.83\times10^{-14}\ \mathrm{cm}$$

and from (6.38)

$$(6.39)\qquad (\bar{r}_n)_{in}=\frac{1}{2}(\bar{d}_{n,\,\tilde{n}})_{in}\approx1.92\times10^{-14}\ \mathrm{cm}.$$

The quantity $(\bar{r}_n)_{in}$ is the average radius of the initial neutron or the initial antineutron. The interaction between two initial neutrons (antineutrons) is realized through virtually gluons with kinetic mass $\bar{m}_{gl}$, defined by

$$(6.40)\qquad (\bar{d}_{n,\tilde{n}})_{in}=\frac{c\hbar}{\bar{m}_{gl}c^2}\approx\frac{19.73\times10^{-6}}{\bar{m}_{gl}c^2/\mathrm{ev}}\,.$$

One gets from (6.1), (6.38), (6.40)

(6.41) $$\bar{m}_{g1}c^2 = 0.515 \text{ GeV} = 0.548\, mc^2.$$

*§7. The maximum of the average density of the inert matter at rest $\bar{\rho}^0$. The minimum of the horizon of visibility $\frac{2c}{H}$*

One sets

(7.1) $$C^0 \equiv \bar{\rho}_0^0 \alpha_0^3 = \bar{\rho}_0^0 \times \bar{\xi}_G \alpha_0^4 / \bar{\xi}_G \alpha_0 = 3\bar{p}_G \alpha_0^4 / C_s$$

and gets from (3.2), (6.16), (6.21), (6.31), (7.1)

(7.2) $$C^0 \approx (\bar{\rho}_s)_{in} / C_s \approx 2.39 \times 10^8 \text{g/cm}^3.$$

One gets further on

(7.3) $$(\bar{\rho}^0)^{max} = \lim_{\alpha \to \alpha_1} \bar{\rho}^0 = \frac{3\sqrt{3}}{16} C^0 \approx 0.325 C^0 \approx 7.77 \times 10^7 \text{g/cm}^3,$$

where (7.2) has been used and $\alpha_1$ is given with

(7.4) $$\alpha_1 = \frac{2}{3}\sqrt{3} = 1.15.$$

It follows from (6.14), (7.4)

(7.5) $$\lim_{\alpha \to \alpha_1} [M^0] = \sqrt{1 - 1/\alpha_1^2} = 0.5.$$

One gets from (2.8) and (7.1)

(7.6) $$(C_1)^2 \equiv \frac{8\pi G}{3} C^0 \approx 1.34 \times 10^2/\text{s}^2,$$

from (6.16), (6.24)

(7.7) $$C_2 \equiv (1 + C_0^{RCR}\pi^2) C_s \approx 6.21 \times 10^8,$$

from (2.8), (6.23), (6.25), (7.2), (7.6), (7.7)

(7.8) $$(C_H)^2 \equiv (H_{in})^2 = (C_1)^2 C_2 = \frac{8\pi G}{3} (\bar{\rho})_{in} \approx 8.31 \times 10^{10}/\text{s}^2$$

and from (7.8)

(7.9) $$C_H \equiv H_{in} \cong 2.88 \times 10^5/\text{s}.$$

It follows from (2.6), (2.29), (7.9)

(7.10) $$(r^{max})_{in} = \frac{2c}{H_{in}} \approx 2.08 \text{ km}.$$

# Part III. Einstein-de Sitter Model of the EEU and the Extended Principle of Inertia

## *§ 8. The relativistic discrepances of the generalized Einstein-de Sitter model with the classical principle of inertia*

The Einstein - de Sitter model of the Expanding Euclidean Universe (EEU) holds good with the immobile substance ($s$) and the abcence of radiation ($r$) — electromagnetic radiation and neutrinos. It contains an initial singular state associated, as it will be shown later, with striking relativistic discrepances, if the motion of the substance and the radiations were taken into account. For their removal it is necessary to reformulate the above-mentioned model on the basis of a generalized principle of inertia with respect to the substance. This reformulation gives a mathematical form of the well-known concepts of E. Mach within the framework of the EEU and should be valid for the moving substantial particles ($sp$) in the presence of radiation ($r$). Simultaneously, the motion of the $sp$ should be considered as non-free, since it is influenced by large-scale randomly distributed local gravitational fields. Hence, this motion should be treated as a large-scale chaotic like the molecular relativistic motion within an ideal gas. Like the substance, the radiations are also large-scale homogeneously and isotropically distributed. However, a great part of $r$, according to (3.21): 91 % is RCR, i. e. black-body electromagnetic radiation which defines a preferable frame to which the expansion time $t$ and the motion of the $sp$ can be measured. The translational velocity of Our Galaxy (c. 600 km/s) has been established recently in that way. At present one can consider as large-scale $sp$ the galaxies, including their coronae, which are spatially extended hot plasma, heated mainly through explosions from the galactic nuclei. The recent observations support the assertion that there is no substance outside the galaxy-coronae. However, the initial $sp$ are the initial quarks, moving with the velocity of light $c$. The initial $\bar{\rho}^0$ is zero. There is also initial electromagnetic radiation, the average mass-density of which, according (6.8) and (6.24), is 4-times greater than the average mass-density of the initial substance. There are no initial leptons, incl. neutrinos. They appeared in the next moment $\Delta t>0$, together with the mutual annihilation of the enormously large number of initial neutrons and antineutrons ($n$ and $\tilde{n}$).

The line element of the EEU is defined by the simple quadratic form

$$ds^2 = c^2 dt^2 - \alpha^2\{(du^1)^2 + (du^2)^2 + (du^3)^2\}, \tag{8.1}$$

where $\alpha$ is the spatial scale-factor, depending on $t$. At a given moment $t=t_0$ the Cartesian coordinates of the EEU are

$$x_0^1 = \alpha_0 u^1, \quad x_0^2 = \alpha_0 u^2, \quad x_0^3 = \alpha_0 u^3, \tag{8.2}$$

where $\alpha_0 = \alpha(t_0)$. One gets, further on

$$v_s^2 = \alpha^2\left\{\left(\frac{du^1}{dt}\right)^2 + \left(\frac{du^2}{dt}\right)^2 + \left(\frac{du^3}{dt}\right)^2\right\}, \tag{8.3}$$

where $v_s$ is the local velocity of a substance particle ($sp$). Setting

$$w_s = \frac{v_s}{c}, \tag{8.4}$$

one gets

(8.5) $$ds^2 = c^2 dt^2 \times (1 - w_s^2).$$

Let $\overline{v}_s$ be the large-scale average of $v_s$. It can be easily demonstrated that the mixed average tensor-components $\overline{M}_i^{\cdot k}$ of the moving substance in the absence of non-kinetic pressures have the following non-vanishing large-scale values:

(8.6) $$\overline{M}_0^{\cdot 0} = \frac{\overline{\rho}_s^0}{1-\overline{w}_s^2} = \overline{\rho}_s^0 + 3\overline{p}_s; \quad \overline{M}_1^{\cdot 1} = \overline{M}_2^{\cdot 2} = \overline{M}_3^{\cdot 3} = -\frac{1}{3}\rho_s^0 \times \frac{\overline{w}_s^2}{1-\overline{w}_s^2} = -\overline{p}_s.$$

It can be demonstrated that the mixed average tensor-components $\overline{E}_i^{\cdot k}$ of the residual cosmic electromagnetic radiation (RCR) have the following non-vanishing large-scale values:

(8.7) $$\{\overline{E}_0^{\cdot 0} = \overline{\rho}_r = 3\overline{p}_r; \quad \overline{E}_1^{\cdot 1} = \overline{E}_2^{\cdot 2} = \overline{E}_3^{\cdot 3} = -\overline{p}_r.$$

One sets now

(8.8) $$\overline{\rho} = \overline{\rho}_s + \overline{\rho}_r = \overline{\rho}_s^0 + 3\overline{p},$$

where $\overline{\rho}$ is the average total mass-density of matter (inert and RCR) and

(8.9) $$\overline{p}c^2 = (\overline{p}_s + \overline{p}_r)c^2 = \left(\overline{p}_s + \frac{1}{3}\overline{\rho}_r\right)c^2$$

is the average total pressure of matter. One gets from (3.1)

(8.10) $$3\overline{p}_s = \overline{\rho}_s^0 \, \xi_s / [M^0];$$

with $[M^0] = 1$ the relation (8.10) coincides with (3.2). It follows on the analogy of (3.3)

(8.11) $$3\overline{p}_r = \overline{\rho}_r = \overline{\rho}_s^0 \, \overline{\xi}_r.$$

One gets from (8.8), (8.9), (8.10), (8.11), setting

(8.12) $$\overline{\xi} = \overline{\xi}_s / [M^0] + \overline{\xi}_r,$$

the following relation

(8.13) $$\overline{\rho} = \overline{\rho}_s^0 (1 + \overline{\xi})$$

and

(8.14) $$3\overline{p} = \overline{\rho}_s^0 \, \overline{\xi}.$$

With $[M^0] = 1$ the relation (8.12) coincides with (3.11).

The generalization of the Einstein-de Sitter cosmological equations (with $\overline{\xi} \neq 0$ and $\overline{p} \neq 0$) is rewritten in the following form:

(8.15) $$\dot{\alpha}^2 = K_0 \overline{\rho} \alpha^2; \quad -2\alpha \ddot{\alpha} = K_0 (\overline{\rho} + 3\overline{p}) \alpha^2,$$

where the dot signifies the 1st derivative and the colon the 2nd derivative with respect to the cosmic time $t$, and according to (2.8)

(8.16) $$K_0 = \frac{8\pi G}{3} \approx 5.6 \times 10^{-7} \, \mathrm{cm^3/gs^2}.$$

One gets from (8.8), (8.15)

$$(8.17) \qquad H^2 = \left(\frac{\dot{\alpha}}{\alpha}\right)^2 = K_0\bar{\rho} = K_0(\bar{\rho}_s^0 + 3\bar{p}); \quad q = -\frac{\alpha\ddot{\alpha}}{(\dot{\alpha})^2} = \frac{\bar{\rho}_s^0 + 6\bar{p}}{2(\bar{\rho}_s^0 + 3\bar{p})},$$

where $H$ is the variable Hubble recession parameter and $q$ is the variable deceleration parameter. From (8.15) follows the isentropic relation

$$(8.18) \qquad \frac{d}{d\alpha}(\bar{\rho}\alpha^3) + 3\bar{p}\alpha^2 = 0.$$

One gets from (8.13), (8.14), (8.18)

$$(8.19) \qquad \begin{cases} \alpha\frac{d}{d\alpha}(\bar{\rho}_s^0\alpha^3) + \frac{d}{d\alpha}(3\bar{p}\alpha^4) = \alpha\frac{d}{d\alpha}(\bar{\rho}_s^0\alpha^3) + \frac{d}{d\alpha}(\bar{\rho}_s^0\alpha^4\bar{\xi}) \\ = \alpha\frac{d}{d\alpha}(\bar{y}) + \frac{d}{d\alpha}(\bar{y}\alpha\bar{\xi}) = 0, \end{cases}$$

where

$$(8.20) \qquad \bar{y} = \bar{\rho}_s^0\alpha^3.$$

Since equation (8.19) holds good for the inert (ponderable) matter, i. e. for the substance and for the radiation separately, one gets from (8.12), (8.19) the two equations

$$(8.21) \qquad \alpha\frac{d}{d\alpha}(\bar{y}) + \frac{d}{d\alpha}(\bar{y}\alpha\bar{\xi}_s/[M^0]) = 0; \frac{d}{d\alpha}(\bar{y}\alpha\bar{\xi}_r) = 0.$$

According to (8.20), the quantity $y$ is proportional to the average mass at rest of the substance contained within an arbitrary volume of the EEU, for example, within the volume $(\bar{D}^C)^3$, where $\bar{D}^C$ is given in (4.4).

In the usual formulation of the principle of inertia the following relations hold

$$(8.22) \qquad 0 \leqq \alpha \leqq \infty; \quad [M^0] = 1; \quad \bar{y} = C^0[M^0] = C^0 = \text{Constant}.$$

The third of these relations corresponds to the independence of $3\bar{p}_G$ and $\bar{\xi}_G$ in (2.15), (3.1) from $[M^0]$. The constant $C^0$ can coincide with the quantity $C^0$ in (7.2). One gets, further on, from (8.21), (8.22)

$$(8.23) \qquad \bar{\xi}_s = \frac{C_s}{\alpha},$$

where $C_s$ is the constant (6.16), and from (3.4), (8.23)

$$(8.24) \qquad \bar{\xi}_r = C_0'\pi^2\bar{\xi}_s = C_0'\pi^2\frac{C_s}{\alpha},$$

where $C_0'$ can, or does not coincide with its value $C_0^{RCR}$ in (3.5). It follows from (8.20), (8.22)

$$(8.25) \qquad \bar{\rho}_s^0 = \frac{C^0}{\alpha^3}$$

and from (8.10), (8.11), (8.12), (8.22), (8.23), (8.24)

$$(8.26) \qquad \bar{\xi} = \bar{\xi}_s + \bar{\xi}_r = \frac{C_s(1 + C_0'\pi^2)}{\alpha}.$$

At $\alpha=0$ one gets the initial singular state of the EEU, for which the quantities $\overline{\xi}_s$, $\overline{\xi}_r$, $3\overline{\rho}_s$, $\overline{\rho}_r$, $\overline{\rho}_s^0$ become infinitely large. At $\alpha\to\infty$ one gets the final state of the EEU, for which the above-mentioned quantities become zero. It follows from (2.15), (8.4), (8.22), (8.23)

$$\frac{\overline{w}_s^2}{1-\overline{w}_s^2}=\overline{\xi}_s=\frac{C_s}{\alpha} \tag{8.27}$$

and from (8.27)

$$\overline{w}_s^2=\frac{C_s}{C_s+\alpha}. \tag{8.28}$$

One gets from (8.4), (8.28)

$$\lim_{\alpha\to 0}\overline{w}_s=1;\quad \lim_{\alpha\to 0}\overline{v}_s=c;\quad \lim_{\alpha\to 0}\overline{w}_s=0;\quad \lim_{\alpha\to\infty}\overline{v}_s=0 \tag{8.29}$$

and from (8.10), (8.11), (8.22), (8.23), (8.24)

$$\begin{gathered}\lim_{\alpha\to 0}\frac{3\overline{p}_s}{\overline{\rho}_s^0}=\lim_{\alpha\to 0}\frac{C_s}{\alpha}=\infty;\quad \lim_{\alpha\to 0}\frac{\overline{\rho}_r}{\overline{\rho}_s^0}=(C_0'\pi^2C_s)/\alpha=\infty;\\ \lim_{\alpha\to\infty}\frac{3\overline{p}_G}{\overline{\rho}_G^0}=\lim_{\alpha\to\infty}\frac{C_s}{\alpha}=0;\quad \lim_{\alpha\to\infty}\frac{\overline{\rho}_r}{\overline{\rho}_G^0}=\lim_{\alpha\to\infty}(C_0'\pi^2C_s/\alpha)=0.\end{gathered} \tag{8.30}$$

Therefore, in the vicinity of the singular state of the EEU the average velocity of the substance-particles (*sp*) converge to the velocity of light in vacuum $C$. The average mass-densities of the kinetic and radiative energy predominate unlimitedly over the average mass-density at rest $\overline{\rho}_s^0$. Inversely, ad infinitum, the average mass-density at rest $\overline{\rho}_{(G)}^0$ predominates unlimitedly over the average mass-densities of the kinetic and of the radiative energy, the velocities of the galaxies tending simultaneously to zero. Since according to (8.22) the total mass at rest, contained in a given volume of the EEU, is proportional to $\overline{y}=C^0$ and does not depend on the expansion of the Universe and in the singular state of the EEU the *sp* reaches the velocity $c$ while its mass at rest remains its finite value, one gets a discrepancy with the theory of relativity, which predicts that the particles moving with the boundary velocity have zero mass at rest, for example, the protons, gluons and neutrinos. Moreover, the gravitational forces in the neighbourhood of the initial state of the Universe, which are colossal, cannot detain the initial *sp* which move with velocities of the order of $c$, instead to tend to zero, and according to the predictions of the general theory of relativity, one gets another discrepancy. To remove these two striking contradictions, one must replace the classical principle of inertia by an extended principle of inertia for which the initial singular state of the EEU does not exist anymore.

One gets from (8.13), (8.22), (8.25), (8.26)

$$3\overline{p}=\overline{\rho}_s^0\,\overline{\xi}=\frac{C^0C_s(1+C_0'\pi^2)}{\alpha^4}, \tag{8.31}$$

then from (8.13), (8.14), (8.16), (8.17), (8.22), (8.31)

$$\overline{\rho}=\frac{3H^2}{8\pi G}=\rho_{\text{critical}}=\overline{\rho}_s^0(1+\overline{\xi});\quad \overline{\rho}_s^0=\frac{\rho_{\text{critical}}}{1+\overline{\xi}} \tag{8.32}$$

and from (8.13), (8.14), (8.17), (8.22), (8.31)

(8.33) $$2q=\frac{1+2\bar{\xi}}{1+\bar{\xi}}=1+\frac{\bar{\xi}}{1+\bar{\xi}},$$

i. e. the relation (5.4). It follows from (8.32), (8.33)

(8.34) $$\bar{\rho}_s^0=2(1-q)\rho_{\text{critical}}.$$

One gets through complicated calculations from (8.13), (8.14), (8.15), (8.22), (8.25), (8.26), (8.31), supposing that

(8.35) $$\lim_{\alpha\to 0} t=0,$$

the following expression of the cosmic time $t$:

(8.36) $$\begin{cases} t=\frac{2}{3H}\left\{1-\bar{\xi}+2\bar{\xi}\sqrt{\bar{\xi}(1+\bar{\xi})}-2(\bar{\xi})^2\right\} \\ =\frac{2}{3H}\left\{1-\bar{\xi}(1+\bar{\xi})+2\bar{\xi}(1+\bar{\xi})\sqrt{\bar{\xi}/(1+\bar{\xi})}\right\}, \end{cases}$$

which for

(8.37) $$H=H_0,\quad \bar{\xi}=\frac{C_s(1+C_0'\pi^2)}{\alpha_0}$$

coincides with (5.5). From (8.16), (8.17), (8.25), (8.26), (8.31), (8.33)

(8.38) $$\begin{cases} H^2=\frac{8\pi G C^0}{3\alpha^3}\left\{1+\frac{C_s(1+C_0'\pi^2)}{\alpha}\right\}. \\ 2q=\frac{1+2C_s(1+C_0'\pi^2)/\alpha}{1+C_s(1+C_0'\pi^2)/\alpha}. \end{cases}$$

It follows from (8.38)

(8.39) $$\lim_{\alpha\to 0} H=\infty;\quad \lim_{\alpha\to 0} q=1;\quad \lim_{\alpha\to\infty} H=0;\quad \lim_{\alpha\to\infty} q=0.5.$$

## *§ 9. A generalized Einstein - de Sitter model with an extended principle of inertia, excluding the initial discrepances and singularity*

Instead of the relations (8.22), one introduces now the following relations:

(9.1) $$1\leq\alpha\leq\infty;\quad [M^0]=\sqrt{1-1/\alpha^2};\quad \bar{y}=C^0[M^0]=C^0\sqrt{1-1/\alpha^2},$$

where the constant $C^0$ coincides with the quantity $C^0$ in (7.2). The relations (9.1) correspond to the extended principle of inertia. It follows from (9.1)

(9.2) $$\lim_{\alpha\to 1}[M^0]=0;\quad \lim_{\alpha\to 1}\bar{y}=0;\quad \lim_{\alpha\to\infty}[M^0]=1;\quad \lim_{\alpha\to\infty}\bar{y}=C^0.$$

Therefore, the final (at $t\to\infty$) values of $[M^0]$ and $\bar{y}$ coincide with their values in (8.22). Since for very large values of $\alpha$ the relations (9.2) coincide approximately with the relations (8.22), one can apply (8.33) and (8.36) for these values of $\alpha$. One gets from (8.21), (9.1)

$$\overline{\rho}_s^0 = C^0\sqrt{1-1/\alpha^2};\quad \overline{\xi}_s = \{C_s + \sin^{-1}(1/\alpha)\}/\alpha;\quad \overline{\xi}_r = \frac{C_s C_0' \pi^2}{\alpha\sqrt{1-1/\alpha^2}} \tag{9.3}$$
$$= C_s C_0' \pi^2/\sqrt{\alpha^2-1};\quad C_0' = C_0^{\mathrm{RCR}} \text{ or } \mp C_0^{\mathrm{RCR}}, \text{ as in § 8,}$$

from (8.10), (8.11), (9.3)

$$3\overline{p}_s = C^0\{C_s + \sin^{-1}(1/\alpha)\}/\alpha^4:\quad 3\overline{p}_r = \overline{\rho}_r = C^0 C_s C_0' \pi^2/\alpha^4 \tag{9.4}$$

and from (8.9), (9.4)

$$3\overline{p} = C^0\{C_s(1+C_0'\pi^2) + \sin^{-1}(1/\alpha)\}/\alpha^4 \tag{9.5}$$
$$= C^0 C_s\left\{1 + C_0'\pi^2 + \frac{1}{C_s}\sin^{-1}(1/\alpha)\right\}/\alpha^4.$$

It follows from (3.1), (8.4)

$$3\overline{p}_s = \overline{\rho}_s^0 \frac{\overline{w}_s^2}{1-\overline{w}_s^2} \tag{9.6}$$

and from (9.4), (9.6)

$$\overline{w}_s^2 = \frac{C_s + \sin^{-1}(1/\alpha)}{\sqrt{\alpha^2-1} + C_s + \sin^{-1}(1/\alpha)}. \tag{9.7}$$

Let $x_{\mathrm{in}}$, $x_{\mathrm{fin}}$ be the denotations

$$x_{\mathrm{in}} = \lim_{\alpha\to 1} x;\quad x_{\mathrm{fin}} = \lim_{\alpha\to\infty} x. \tag{9.8}$$

One gets from (9.1), (9.3), (9.4), (9.5), (9.7), (9.8)

$$(9.9)\begin{cases} (\overline{\rho}_s^0)_{\mathrm{in}} = 0;\quad (3\overline{p}_s)_{\mathrm{in}} = C^0 C_s\left(1 + \frac{\pi}{2C_s}\right);\quad (3\overline{p}_r)_{\mathrm{in}} = (\overline{\rho}_r)_{\mathrm{in}} \\ = C^0 C_s C_0^{\mathrm{RCR}}\pi^2;\quad (\overline{w}_s)_{\mathrm{in}} = 1;\quad (\overline{v}_s)_{\mathrm{in}} = c;\quad \frac{(\overline{\rho}_r)_{\mathrm{in}}}{(3\overline{p}_s)_{\mathrm{in}}} \\ = \frac{C_0^{\mathrm{RCR}}\pi^2}{1+\frac{\pi}{2C_s}};\quad (\overline{\rho}_{(G)}^0)_{\mathrm{fin}} = 0;\quad (3\overline{p}_G)_{\mathrm{fin}} = 0;\quad (\overline{\rho}_r)_{\mathrm{fin}} = 0;\quad (\overline{w}_G)_{\mathrm{fin}} = 0;\quad (\overline{v}_G)_{\mathrm{fin}} = 0. \end{cases}$$

Therefore, the extended principle of inertia removes the initial singular state of the EEU and the discrepances mentioned in § 8.

One gets further on from (9.3), (9.5)

$$\frac{3\overline{p}}{\overline{\rho}_s^0} = \frac{C_s\left\{1 + C_0'\pi^2 + \frac{1}{C_s}\sin^{-1}(1/\alpha)\right\}}{\sqrt{\alpha^2-1}};\quad (3\overline{p}/\overline{\rho}_s^0)_{\mathrm{in}} = \infty;\quad (3\overline{p}/\overline{\rho}_s^0)_{\mathrm{fin}} = 0 \tag{9.10}$$

and from (8.16), (8.17), (9.3), (9.5)

$$H^2 = \frac{8\pi G C^0}{3\alpha^4}\left\{\sqrt{\alpha^2-1} + C_s\left[1 + C_0'\pi^2 + \frac{1}{C_s}\sin^{-1}(1/\alpha)\right]\right\} \tag{9.11}$$

and

(9.12)
$$2q=1+\frac{C_s\left\{1+C_0'\pi^2+\frac{1}{C_s}\sin^{-1}(1/\alpha)\right\}}{\sqrt{\alpha^2-1}+C_s\left\{1+C_0'\pi^2+\frac{1}{C_s}\sin^{-1}(1/\alpha)\right\}}.$$

It follows from (9.8), (9.11), (9.12)

(9.13)
$$\begin{cases}(H^2)_{\text{in}}\equiv C_H^2=\frac{8\pi GC^0C_s}{3}\left\{1+C_0^{\text{RCR}}\pi^2+\frac{\pi}{2C_s}\right\}; \quad (q)_{\text{in}}=1;\\ (H^2)_{\text{fin}}=0; \quad (q)_{\text{fin}}=0.5,\end{cases}$$

where $C_H=\text{const}>0$ is the initial value of the Hubble recession parameter. One gets for very large (finite) value of $\alpha$, for example $\alpha_0$ in (6.13), and with $\bar{v}_s=\bar{v}_G$; $\bar{\rho}_s^0=\bar{\rho}_{(G)}^0$

(9.14)
$$\begin{cases}[M^0]\approx 1; \quad \bar{\rho}_{(G)}^0\approx\frac{C^0}{\alpha^3}; \quad \xi_G\approx\frac{C_s}{\alpha}; \quad \xi_r=\frac{C_sC_0'\pi^2}{\alpha}; \quad 3\bar{p}_G\approx\bar{\rho}_{(G)}^0\bar{\xi}_G;\\ 3\bar{p}_r\equiv\bar{\rho}_r\approx\frac{C^0C_sC_0'\pi^2}{\alpha^4}\approx C_0'\pi^2\times 3\bar{p}_G; \quad \bar{w}_G=\frac{C_s}{C_s+\alpha}; \quad \bar{\rho}=\rho_{\text{critical}}\\ \approx C^0\{1+(1+C_0'\pi^2)\bar{\xi}_G\}/\alpha^3\approx\bar{\rho}_{(G)}^0(1+\bar{\xi}); \quad 3\bar{p}_r\equiv\bar{\rho}_r\approx\bar{\rho}_{(G)}^0\bar{\xi}_r;\\ \bar{\rho}_r/3\bar{p}_G\approx\bar{\xi}_r/\bar{\xi}_G=C_0'\pi^2.\end{cases}$$

One gets from (8.17), (9.9), (9.14)

(9.15)
$$\begin{cases}\frac{(\bar{\xi}_s)_{\text{in}}}{\bar{\xi}_G}=\left(1+\frac{\pi}{2C_s}\right)\alpha^4; \quad \frac{(\bar{\rho}_r)_{\text{in}}}{\bar{\rho}_r}=\frac{C_0^{\text{RCR}}}{C_0'}\alpha^4<\alpha^4;\\ \frac{\bar{\rho}^0}{\bar{\rho}}=\frac{\bar{\rho}_0}{\rho_{\text{critical}}}\approx\frac{1}{1+\{1+C_0'\pi^2\}\xi_G}=\frac{1}{1+\bar{\xi}};\\ \bar{\rho}^0=\frac{\rho_{\text{critical}}}{1+\bar{\xi}}; \quad 2q\approx\frac{1+2\bar{\xi}}{1+\xi}.\end{cases}$$

It follows from (8.8), (8.9), (8.15), (9.3), (9.4), (9.5)

(9.16)
$$C_1t=\int_1^{\alpha>1}\frac{\alpha\,d\alpha}{\sqrt{C_s(1+C_0^{\text{RCR}}\pi^2)+\sqrt{\alpha^2-1}+\sin^{-1}(1/\alpha)}},$$

where, according to (7.6)

(9.17)
$$C_1=\sqrt{\frac{8\pi G}{3}C^0}$$

and $C_s$ is given by (6.16). Setting

(9.18)
$$\alpha=\alpha_0,$$

where $\alpha_0$ is given by (6.13), one gets from (8.4), (9.14)

(9.19)
$$C_s\approx\alpha_0\bar{\xi}_G; \quad \bar{v}_G^2=\frac{C_sc^2}{C_s+\alpha_0}.$$

From $c^2$ in (2.7), $\alpha_0$ in (6.13), $C_s$ in (6.16) and from (9.19) one can calculate exactly the value of $\overline{v}_G$ in Table 1, Column 13. One can, further on suppose that the constant $C_s$ is very large in comparison with $\frac{\pi}{2}$, i. e. that

$$\frac{\pi}{2C_s} \approx 0, \tag{9.20}$$

in accordance with (6.17). In that case one gets from (9.3), (9.14), (9.15) and (9.20)

$$(\overline{\xi}_s)_{in} \approx C_s \approx \alpha_0 \overline{\xi}_G; \quad (\overline{\rho}_s)_{in} = (3\overline{p}_s)_{in} \approx C^0 C_s \approx 3\overline{p}_G \alpha_0^4;$$
$$(\overline{\rho}_r)_{in} \approx C^0 C_s C_0^{RCR} \pi^2 \approx (\overline{\rho}_r)_0 \alpha_0^4 \approx C_0^{RCR} \pi^2 (\overline{\rho}_s)_{in}, \tag{9.21}$$

in accordance with (6.8), (6.16), (6.31), (7.2), (9.9). As has been mentioned above the initial mass-density of the radiation $(\overline{\rho}_r)_{in}$ concerns only the initial black-body electromagnetic radiation. The rest recent radiation of 9% according to, (3.20) are the results of the disintegration of the successive products of the mutual annihilation of the initial $n$, $\tilde{n}$. The assumptions (6.8), (6.9) are contained in (9.21).

Let $z_{in}$ be the red-shift parameter, which corresponds to the initial state of the EEU, for which the spatial factor $\alpha$ is 1. Obviously, one gets from (2.20):

$$\alpha_0 = 1 + z_{in} = \frac{(\overline{T}_r)_{in}}{T_r^{RCR}} = \sqrt{(\overline{\rho}_r)_{in}/(\overline{\rho}_r)_0} \tag{9.22}$$

and in accordance with (6.10)

$$(\overline{T}_s)_{in} = (\overline{T}_r)_{in} = T_{in}. \tag{9.23}$$

Setting as in (7.7)

$$C_2 = (1 + C_0^{RCR} \pi^2) C_s, \tag{9.24}$$

one gets from (7.6), (9.13), (9.20), (9.24)

$$(H_{in})^2 = C_1^2 C_2. \tag{9.25}$$

## References


1. Abell, G. O. 1961. Astron. J., **66**, 607.
2. Mathews, F. R., W. W. Morgan, M. Schmidt. 1964. Astrophys. J., **140**, 35.
3. Sandage, A. R. 1961. Astrophys. J., **133**, 355.
4. Kohler, D. 1974. Sciences et Avenir, **333**, 1046.
5. Zwicky, F. 1957. Publ. Astronom. Soc. Pacific., **69**, 518.
6. Zwicky, F. 1957. Morphological Astronomy, Berlin, 156.
7. Abell, G. O. 1958. Astrophys. J. Suppl., **3**, 211.
8. Abell, G. O. 1965. Ann. Rev. Astron. Astrophys., **3**, 1.
9. de Vaucouleurs, G. 1959. Astr. Zu. (russian), **36**, 974.
10. Karachentsev, I. D. 1966. Astrofizica, **2**, 159.
11. Pskovskii, Y. P., G. B. Sholomnitskii (ed). 1965. — In: Observational Foundations of Cosmology, 353, M. (in Russian).
12. Peterson, B. A. 1970. Nature, **227**, 54.
13. Abell, G. O. 1975. Galaxies and the Universe (Stars and Stellar Systems, vol. IX), Chicago, 601.
14. Agekyan, P. A. 1970. Stars, Galaxies, Metagalaxy, M. (in Russian).
15. Peebles, P. J. E. 1971. Physical Cosmology, New Jersey.

16. Abell, G. O. 1962. Membership of Clusters of Galaxies. Problems of Extragalactic Research (IAU Symp. No 15), N. Y., 213.
17. Rood, H. J., T. L. Page, E. C. Kintner, I. R. King. 1972. Astrophys. J., **175**, 627.
18. Gull, S. F., J. E. Northhover. 1973. Nature, **244**, 80.
19. Van den Bergh, S. 1968. Comm. David Dunlop Obs., No **195**.
20. Miley, G. R., G. C. Perola, P. C. Van Kruit, Van der Laan. 1972. Nature, **237**, 269.
21. Hunt, B., D. V. Sciama. 1972. Nature, **238**, 320.
22. de Vaucouleurs, G., A. de Vaucouleurs. 1972. Nature, **236**, 166.
23. Bahcall, J., R. Hills. 1972. Astrophys. J., **179**, 699.
24. Kalinkov, M. 1968. Compt. Rend. Acad. Bulg. Sci., **21**, 621.
25. Taylor, B. N. 1980. Rev. Mod. Phys., **52**, No 2, Part II, 33.
26. Sandage, A. R. 1972. Astrophys. J., **173**, 485.
27. Branch, D., B. Pachett. 1973. M. N. R. A. S., **161**, 71.
28. Rowan-Robinson, M. 1976. Nature, **264**, 603.
29. Sandage, A. R. 1971. Mayal Symp. Tucson.
30. Peach, I. V., D. S. Evans (ed), 1972. — In: External Galaxies and Quasi-stellar Objects, 314.
31. Sandage, A. R. 1975. Astrophys. J., **202**, 563.
32. Silk, J. 1974. Astrophys. J., **193**, 525.
33. Woody, D., P. Richards. 1979. Physical Review, Letters, **42**, No 14, 925.
34. Paget, J. L, J. Heylsaerts. 1980. Astronomy and Astrophysics, **83**, L. 10.
35. Weinberg, S. 1972. Gravitation and Cosmology, John Wiley.
36. Friedmann, H. 1973. Science, **181**, 395.
37. Allen, C. W. 1973. Astrophysical Quantities, 3rd ed. Univ. London
38. Wampler, E. J., L. B. Robinson, J. A. Baldwin, E. M. Burbidge. 1973. Nature, **243**, 336.
39. Rosenfeld, A. H., G. P. Jost, N. Barash-Schmidt, G. Brieman, R. J. Hemingway, M. J. Lostry, M. Ross, V. Chaloupka, B. Armstrong. 1973. Rev. Mod. Phys., **45**, 29.
40. Zaycoff, R. G. 1980. Expanding Universe with Moving Inert Matter and Light Radiation, Sofia, 81.
41. Gerlach, U. H. 1968. Phys. Rev., **172 II**, 1325.

## Самосогласованная мега-космология

*Р. Г. Зайков**

(Резюме)

В данной работе рассматривается настоящее и начальное состояние Вселенной, как и космологические модели.

Первая часть посвящена нынешнему состоянию Вселенной. В ней приводятся основные величины и реляции между ними. Обсуждаются различные аспекты распределения масс и излучения во Вселенной, характеристические размеры скоплений и сверхскоплений галактик, а также и средние расстояния между ними. Приводятся рабочие формулы о горизонте видимости и

* Prof. Rashco Gavrilov Zaycoff (Dec. 10, 1901 — Nov. 25, 1982) is an eminent Bulgarian physicist-theoretician, a known author in the general theory of relativity, quantum mechanics, elementary particles, cosmology, the theory of probability, and mathematical statistics. His first studies were published during the thirties in *Zeitschrift für Physik, Zeitschrift für Astrophysik, Annalen der Physik . . .* He is an author of the monograph *Expanding Universe with Moving Inert Matter* and *Light Radiation* (Bulg. Acad. Sci., 1980) and of a series of widely cited papers on astronomy. The present article is the last completed writing by Prof. R. Zaycoff.

параметре замедления. Вводятся новые классы богатства скоплений галактик, следуя Эйбелу. Разработана новая классификация по массам и определены основные характеристики возможных скучиваний галактик.

Во второй части рассмотрено начальное состояние Вселенной. Определены температура, плотность, число нейтронов, минимальное расстояние между начальными частицами и минимальный радиус горизонта.

Последняя часть посвящена модели Эйнштейна — де Ситтера расширяющейся евклидовой Вселенной. Рассмотрена также обобщенная модель, основанная как на классическом, так и на расширенном принципе инерции, притом без сингулярности.

*Institute of Nuclear Research and Nuclear Energetics,*
*Bulgarian Academy of Sciences*

## Contents