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Первичный адрон: происхождение звезд, галактик и астрономической Вселенной

Проанализировано соотношение между массой и угловым моментом для известных космических объектов и показано, что все они обладают обобщенным реджевским поведением вида $J = (\frac{m}{m_p})^{1+1/n} \hbar$, где $n = 2$ для галактик, их скоплений и сверхскоплений и $n = 3$ для астероидов, планет и звезд. Это позволяет предположить, что сверхплотная прото-материя Амбарцумяна должна иметь адронную природу. Исходя из этого дано реалистическое и количественное объяснение происхождению космических вращательных моментов, космических магнитных полей и показано, что имеются возможности для дальнейших космогонических применений. Предложенный подход естественным путем позволяет включить в рассмотрение фундаментальные квантово-механические параметры $\hbar$ и m_p, наряду с классическими параметрами G и c, и приводит к выражениям для масс и спинов космических объектов через фундаментальные постоянные. Некоторые из этих выражений совпадают с соотношениями "Больших чисел" Эддингтона-Дирака.

Работа выполнена в Лаборатории теоретической физики ОИЯИ и в Бюраканской астрофизической обсерватории.

Препринт Объединенного института ядерных исследований. Дубна 1979

Muradian R.M. **E2 - 12467**

The Primeval Hadron: Origin of Stars, Galaxies and Astronomical Universe

The relationship between mass and angular momentum for the known cosmic objects has been examined, and it is shown that they are described by the generalized Regge-like dependence of the form $J = (\frac{m}{m_p})^{1+1/n} \hbar$, where $n = 2$ for galaxies, their clusters and superclusters, and $n = 3$ for asteroids, planets and stars. It offers the possibility, that Ambartsumian's superdense proto-matter has hadronic nature. This allows us to give a realistic and quantitative explanation with a minimum number of arbitrary assumptions for the origin of cosmic angular momenta, cosmic magnetic fields and offers the framework for other cosmogonic implications. This approach incorporates in a natural way the fundamental quantum-mechanical parameters $\hbar$ and m_p besides the classical parameters G and c and allows us to derive simple expressions for masses and spins of cosmic objects through fundamental constants, some of which coincide with Eddington-Dirac's "Large Number" relations.

The investigation has been performed at the Laboratory of Theoretical Physics, JINR and in Byurakan Astrophysical Observatory.

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1. INTRODUCTION

Cosmic objects - the Sun and the solar system, the stars, interstellar matter, galaxies and their clusters, and the whole astronomical Universe itself - evolve during time. This means that in the past these objects probably existed in some other form, different from their present state.

The central problem of cosmogony is to find the initial conditions, hopefully simple, from which the characteristic features of present-day astrophysical objects may be deduced in a self-consistent manner.

There are two different approaches to the problem of the initial conditions in cosmogony.

The first is connected with the names of Kant, Laplace, Jeans, Weizsäcker and is known as classical cosmogony.

The second can be termed as Ambartsumian's non-classical cosmogony, developed by him in several papers[1-6].

Many aspects of this approach are in violent opposition to the hypothesis of condensation of celestial bodies from the diffuse medium. Ambartsumian's method, based on careful investigation and subsequent generalization of diverse astrophysical facts and phenomena, provides deeper and more realistic framework for understanding of the fundamental cosmogonic processes. The foundation of his theory is based on the idea that primordial material, with nearly nuclear density, fragments and subsequently developes to bring about the formation of all celestial objects, such as galaxies, stars, diffuse matter and their systems. Starting from very general features of these superdense bodies, and without concern for their physical nature, Ambartsumian gives a comprehensive explanation for the formation and evolutionary processes in young stellar systems, for the origin of spiral structure, for the connection between activity of galactic nuclei and the formation of radio sources, Seyfert and Markarian galaxies and other remarkable astrophysical phenomena. (See, for example, ref.[7]).

The questions naturally arising are: What is the physical nature of superdense pregalactic and prestellar matter? Is it possible in the framework of the accepted physical laws to put forward a definite model for this matter, based on the cardinal laws of conservation of energy and of linear and angular momenta?

An important clue to these questions has been found in the analysis of observational data regarding the angular momentum of galaxies and other celestial objects, which result in understanding of Regge-like behaviour of cosmic objects and their systems/8-11/.

2. THE ROTATION OF COSMIC OBJECTS AND THE SPIN OF HADRONS

The mass and angular momentum (spin) of our Galaxy according to Nordsiek's/12/estimate are

$$m_G = (3.38 \pm 0.80) \times 10^{44}\,\mathrm{g}$$

$$J_G = (1.92 \pm 0.62) \times 10^{75}\,\frac{\mathrm{g \cdot cm^2}}{\mathrm{sec}}$$

There is no hope that classical cosmogony can explain even the order of magnitude of galactic angular momentum. On the other hand, it has been pointed out by Ambartsumian/1/ that the angular momentum problem is one of the unsolved difficulties in the framework of his superdense cosmogony. (For a review of different approaches in this line see Harrison/13,14/, where also an interesting attempt is undertaken to unify Ambartsumian's and Weizsäcker's cosmogony). The understanding of the possible rotation of clusters and superclusters of galaxies presents more problems/15/.

It has been shown/8/ that the difficulties in the angular momentum problem can be overcome if we accept that Ambartsumian's superdense pregalactic matter has a hadronic nature. Indeed, recent developments in high energy physics clearly indicate that there is a deep connection between the spins and masses of strongly interacting elementary particles, hadrons. The spin angular momentum of all known baryons and mesons appears to be nearly proportional to the square of their mass. The correlation between spin and mass of experimentally known low mass hadron is represented by a straight line Regge trajectory in a Chew-Frautschi/16/plot.

The general formula which connects the maximal spin J and mass m of heavy hadrons reads/8/:

$$J = \left(\frac{m}{m_p}\right)^{1+\frac{1}{n}} \hbar, \qquad (1)$$

where $m_p = 1.67 \times 10^{-24}$ g is the proton mass and $\hbar = 1.05 \times 10^{-27}$ g cm^2/sec is Plank's constant. The number n in the exponent takes values $n = 1,2,3$ and characterize the spatial dimensionality of hadrons.

The case $n=1$ describes the one dimensional "string-like" hadrons and corresponds to the well-known straight line Regge trajectory for ordinary hadrons and hadronic resonances/16/.

The other case $n=2$ corresponds to the two-dimensional "disk-like" hadrons, for which

$$J = \left(\frac{m}{m_p}\right)^{3/2} \hbar = 4.87 \times 10^{8}\, m^{3/2} \ \text{(CGS units)}. \qquad (2)$$

Finally, $n=3$ corresponds to the case of three-dimensional or spherical hadrons, with

$$J = \left(\frac{m}{m_p}\right)^{4/3} \hbar = 5.31 \times 10^{4}\, m^{4/3} \ \text{(CGS units)}. \qquad (3)$$

The analysis of observational data on the rotation of cosmic objects has shown that all of them can be classified into two groups, in which spin-mass relations are given by formulae (2) and (3) respectively.

1) The first one includes clusters of galaxies, single galaxies, globular and open star clusters and perhaps, stellar associations and superassociations. The angular momentum-mass distribution for these objects is described by formula (2).

2) The second group of objects, which is described by formula (3) includes stars, planets and asteroids.

The observational data for masses and spins of different cosmic objects and the comparison with theoretical predictions are given in Tables 1 and 2 and displayed in the Figure.

In some sense this plot represents a generalized Chew-Frautschi plot for cosmic objects. The plot of $\log J$ against $\log m$ shows a remarkable regularity, and the theoretical lines describe not only the shape, but also the absolute values in tremendous mass and spin intervals without invoking arbitrary parameters.

The cosmogonic deduction which can be made from a consideration of the data in Table 1 and the upper half of the Figure, is that corresponding objects are products of desintegration of disk-like massive superhadrons, the mass of the superhadron is nearly equal to the mass of the ensueing object and spin given by formula (2). The baryon

Table 1

Masses and spins of clusters of galaxies, spiral galaxies and globular clusters

Object	Mass, m	Spin, J $(\frac{g.cm^2}{sec})$ Observed*)	Spin, J $(\frac{g.cm^2}{sec})$ Computed from: $(\frac{m}{m_p})^{3/2}\hbar$
Clusters of galaxies a)			
Virgo	$2\times10^{13}\ m_\odot$	2.6×10^{78}	3.9×10^{78}
A 1656 (Coma)	2×10^{14}	0.9×10^{80}	1.2×10^{80}
A 2199	1×10^{14}	2.2×10^{79}	1.5×10^{79}
Shakhabazian I	1.2×10^{13}	1.4×10^{77}	1.8×10^{78}
Local Supercluster	2.5×10^{15}	$6\ \times10^{81}$	5.4×10^{81}
Spiral Galaxies b)			
Our Galaxy	3.38×10^{44} g	$1,92\times10^{75}$	3.02×10^{75}
NGC 224 (M31)	3.78×10^{44}	2.36×10^{75}	3.58×10^{75}
681	7.76×10^{43}	1.67×10^{74}	3.33×10^{74}
1084	4.97×10^{43}	7.44×10^{73}	1.71×10^{74}
1808	9.55×10^{43}	2.11×10^{74}	4.54×10^{74}
1832	1.11×10^{44}	2.85×10^{74}	5.70×10^{74}
3031 (M81)	2.78×10^{44}	1.30×10^{75}	2.26×10^{75}
3504	2.19×10^{43}	1.61×10^{73}	4.99×10^{73}
5005	1.98×10^{44}	6.82×10^{74}	1.36×10^{75}
5055 (M63)	1.31×10^{44}	2.91×10^{74}	7.30×10^{74}
5194 (M51)	9.54×10^{43}	2.48×10^{74}	4.54×10^{74}
6574	8.15×10^{43}	1.18×10^{74}	3.58×10^{74}
7331	1.86×10^{44}	6.82×10^{74}	1.24×10^{75}
Globular clusters			
NGC 104 (47 Tuc)	$5.3\times10^{5}\ m_\odot$	1.3×10^{65}	1.7×10^{67}
362 (Δ 62)	1.8×10^{5}	2.4×10^{64}	3.3×10^{66}

a) Rood /17/.

b) Nordseik /12/.

* For clusters of galaxies and globular clusters the "observed" spin is estimated from the data on velocity dispersion and linear size.

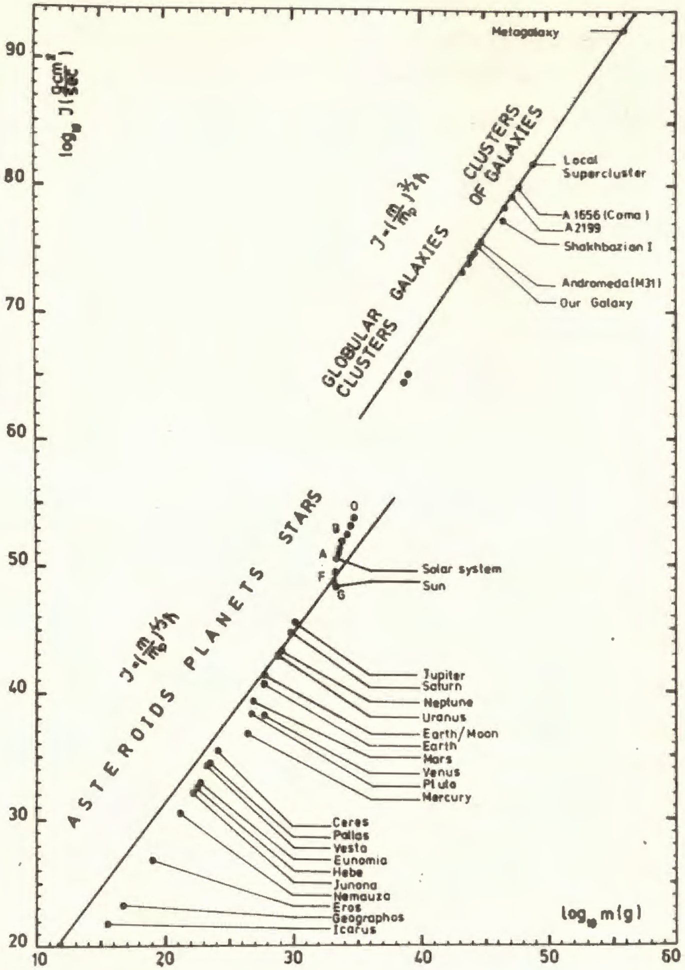
Table 2

Masses and spins of stars, planets and asteroids

Object	Mass, m(g)	Spin, J $(\frac{g.cm^2}{sec})$ Observed	Spin, J $(\frac{g.cm^2}{sec})$ Computed from: $(\frac{m}{m_p})^{4/3}\hbar$
Main Sequence Stars a)			
O5	7.92×10^{34}	7.07×10^{53}	1.81×10^{51}
B0	3.54×10^{34}	1.46×10^{53}	6.17×10^{50}
B5	1.28×10^{34}	3.12×10^{52}	1.60×10^{50}
A0	6.44×10^{33}	8.56×10^{51}	6.36×10^{49}
A5	4.16×10^{33}	3.02×10^{51}	3.55×10^{49}
F0	3.38×10^{33}	1.27×10^{51}	2.70×10^{49}
F5	2.56×10^{33}	2.57×10^{50}	1.85×10^{49}
G0	2.18×10^{33}	2.54×10^{49}	1.50×10^{49}
Sun (G2)	1.99×10^{33}	1.63×10^{48}	1.33×10^{49}
Solar System	1.99×10^{33}	3.15×10^{50}	1.33×10^{49}
K0	1.54×10^{33}	$< 3.65\times10^{48}$	9.42×10^{48}
M0	9.31×10^{32}	$< 1.63\times10^{48}$	4.83×10^{48}
Planets b)			
Mercury	3.33×10^{26}	6.5×10^{36}	1.23×10^{40}
Venus	4.87×10^{27}	1.8×10^{38}	4.38×10^{41}
Earth	5.97×10^{27}	5.91×10^{40}	5.75×10^{41}
Earth/Moon	5.97×10^{27}	2.81×10^{41}	5.75×10^{41}
Mars	6.42×10^{26}	2.05×10^{39}	2.94×10^{40}
Jupiter	1.90×10^{30}	4.32×10^{45}	1.25×10^{45}
Saturn	5.68×10^{29}	7.68×10^{44}	2.50×10^{44}
Uranus	8.72×10^{28}	2.09×10^{43}	2.05×10^{43}
Neptune	1.02×10^{29}	2.10×10^{43}	2.53×10^{43}
Pluto	6.6×10^{26}	2.3×10^{38}	3.04×10^{40}
Asteroids b)			
1. Ceres	1.2×10^{24}	2.96×10^{35}	6.77×10^{36}
2. Pallas	3.0×10^{23}	2.57×10^{34}	1.06×10^{36}
3. Juno	1.4×10^{22}	1.30×10^{32}	1.79×10^{34}
4. Vesta	2.4×10^{23}	2.55×10^{34}	7.91×10^{35}
6. Hebe	2.4×10^{22}	2.92×10^{32}	3.61×10^{34}
15. Eunomia	$4.\ \times10^{22}$	9.23×10^{32}	7.38×10^{34}

a) Allen /18/.

b) Alfvén and Arrenius. /19/



The angular momentum-mass distribution for cosmic objects. Straight lines represent the theoretical predictions from formulae (2) and (3). Data are taken from Tables 1 and 2.

number of the superhadron must be equal to the ratio $\frac{m}{m_p}$ and, for example, in the case of a typical galaxy this number is nearly 10^{68}. The proto-galaxy-superbaryon may result from the decay of the more massive superbaryon whose mass nearly equals the mass of a typical cluster of galaxies, say $\approx 10^{15} m_{\odot}$, baryon number $\approx 10^{72}$ and spin $\approx 10^{80}$ g cm^2/sec, or it may originate directly from the "Primeval hadron", from which the whole astronomical Universe or Metagalaxy is formed This primeval superbaryon should have the mass of Metagalaxy $m_{MG} = 10^{56}$ g, baryon number equal to the Eddington number $N_E = \frac{m_{MG}}{m_p} = 10^{80}$ and a spin $J_{MG} = 5 \times 10^{92}$ g cm^2/sec given by (2). The possible angular momentum of the Metagalaxy can also be estimated by means of the generalized dimensional analysis, developed by Huntley to be[9]

$$J_{MG} = G^{-1/2} m_{MG}^{1/2} c^2 r_{MG}^{3/2} \equiv \frac{G m_{MG}^2}{c} \left(\frac{r_{MG} c^2}{G m_{MG}} \right)^{3/2} \qquad (4)$$

which gives the same number. Here $r_{MG} = c/H_0$ is Hubble's radiu and H_0 is Hubble's constant. One of the possible ways to detect the spin of the Metagalaxy is based on the detection of the large angular-scale anisotropies in the 3°K microwave radiation[20].

The picture described above has some external resemblance to Lemaître's "Primeval atom" hypothesis[21] which says that "... we could conceive the beginning of the Universe in the form of a unique atom, the atomic weight of which is the total mass of the Universe. This highly unstable atom would divide into smaller and smaller atoms by a kind of superradioactive process". The term "beginning of the Universe", of course, has a sense of transformation of the state of matter, which has brought to the formation of the present day astronomical Universe.

Assuming that the "Primeval atom" is not an "atom" but is a massive disk-like superbaryon with Regge-like spin-mass connection (2), the main difference rests with the fact that in our picture galaxies, clusters of galaxies and other cosmic objects and their systems are formed from the decay products of the corresponding superhadrons, but not condensed from diffuse matter. This offers an explanation of the rotational hierarchy of cosmic objects in the scale of galaxies, their clusters, etc.

Now let us turn to the stars, planets and asteroids, represented in Table 2. It has been pointed out above that their rotation is approximately described by the relation (3), corresponding to the spin-mass correlation for three-dimensional or spherical hadrons. For example the mass of the Sun is $m_{\odot}=1,99\times10^{33}$ g. Substituting this mass into (3) we obtain the following theoretical value for the spin angular momentum of the Sun $J_{\odot}=1,33\times10^{49}$g cm^2/sec, which must be compared with the observed value $J_{\odot}=1,63\times10^{48}$g cm^2/sec (or may be with the angular momentum of the solar system $J_{sol.sys}=3,15\times10^{50}$g cm^2/sec). The inspection of Table 2 shows that the agreement between theory and observation is reasonably satisfactory.

It is necessary to point out that the less massive and less isolated objects, like asteroids, planets and stars, are subject to stronger external interactions, which can change the rotational momenta, than more massive objects like galaxies and their clusters. In other words, the bigger the cosmic object or system, the better their memory of primordial initial conditions.

3. EVOLUTION OF THE SUPERDENSE MATTER

From the point of view of modern physics, matter can exist in three qualitatively different forms, such as:

1) The usual atomic-molecular matter, which consists of atoms and molecules with a density $\rho\approx$ few grams per cm^3.

2) The nuclear (or baryonic) matter with density $\rho\approx3\times10^{14}$g/cm^3 which represents a tightly bound system of baryons (neutrons, protons and hyperons), from which is constituted the ordinary nuclei of chemical elements. Neutron stars are example of superdense objects of astrophysical dimensions, which consist of gravitationaly bound nuclear matter (see, for example,[22,23]).

3) The hadronic (or quark) matter, from which the ordinary hadrons, mesons, baryons and their resonances are constituted has a density $\rho\gtrsim6,5\times10^{14}$g/cm^3, higher than the density of nuclear matter. There are many theoretical investigations concerning the properties of hadronic matter in astrophysical situations[24-29]. The main result of these investigations, based on different model theories of strong interactions (the "bag" model, quantum chromodynamics, etc.) is that nuclear matter undergoes phase transition at densities above $\approx7\times10^{15}$g/cm^3 to a state of hadronic or quark matter, that is the baryon-quark phase transition occurs at a density 10-60 times that in atomic nuclei and neutron stars.

The cosmogonic picture, developed above, strongly suggests that evolutionary changes in the forms of matter during the formation of celestial bodies take place according to the following scheme:

$$\begin{matrix}\text{hadronic} & \rightarrow & \text{nuclear} & \rightarrow & \text{ordinary atomic -}\\ \text{matter} & & \text{matter} & & \text{molecular matter.}\end{matrix}$$

in accordance with Ambartsumian's general point of view.

4. THE ORIGIN OF MAGNETIC FIELDS

The cosmic magnetic fields play an important role in astrophysics, as was recognized by H.Alfvén, E.Fermi and others. The problem of the origin of large-scale magnetic fields was considered in ref.[11] starting with the hypothesis of hadronic cosmogony. It has been argued that the dipole magnetic field of galactic scale can be the remnant of the magnetic field of the protogalaxy-superhadron having dipole moment

$$\mu=\frac{Q^*}{mc}J, \qquad (5)$$

where Q^* is some effective charge, and J and m are spin and mass of the superhadron.

The effective charge Q^* cannot be calculated theoretically, but can be estimated by dimensional considerations. If we suppose that this charge is due to mainly gravitational interactions then

$$Q^*=\sqrt{G}\,m\equiv\sqrt{\frac{Gm_p^2}{e^2}}\,\frac{m}{m_p}\,e=10^{-37}\frac{m}{m_p}\ \text{coulomb}, \qquad (6)$$

where $e=4,8\times10^{-10}$ CGSE $=1,6\times10^{-19}$ coulomb, and the dimensionless quantity $\sqrt{\frac{Gm_p^2}{e^2}}\approx10^{-18}$ is the ratio of the proton's gravitational charge to its electric charge. For example, for the Galaxy $Q^*_G=2\times10^{31}$ coulomb, and for Earth $Q^*_{\oplus}=3,6\times10^{14}$ coulomb.

The substitution of (6) into (5) results in the Blackett[30] formula for the dipole magnetic moment of rotating body

$$\mu=\frac{\sqrt{G}}{c}J. \qquad (7)$$

Although this formula is not correct for laboratory size bodies, nevertheless it is possible that this formula estimates approximately the right order of magnitude for large self-graviting systems like massive superhadrons.

It is known that electrically neutral particles and bodies can have nonzero effective charges. The electric charges inside the neutral body can be separated by some (known or unknown) mechanism. Then such a body will have a net effective charge. For example, if in a rotating electrically neutral sphere positive charges are concentrated in the center and an equal amount of negative charge is distributed on the surface, then resulting magnetization is provided by the effective negative charge. It is not difficult to understand that even a charged body can have an effective charge of opposite sign. Eddington[31] has shown that stars must have positive electric charges, nearly equal to 100 coulomb/$m_{\odot}$. But nevertheless they may effectively behave as negatively charged objects, with respect to magnetization by rotation.

In the case of the Galaxy, the dipole magnetic moment, calculated from (7) results in $\mu_G = 1.7\mathrm{x}10^{61}\,\mathrm{G\cdot cm}^3$, and the corresponding field strength in the vicinity of the solar system is $H = \frac{\mu}{r_0^3} \approx 10^{-6}\,\mathrm{G}$ ($r_0 = 9\,\mathrm{kpc}$) which does not contradict the observed value. The protogalaxy-superhadron can also have higher multipole moments. For example, the possible octupole magnetic moment in the case of the Galaxy can be estimates as $\mu_G^{(3)} \approx \frac{\sqrt{G}}{c}\left(\frac{J}{mc}\right)^2 J \approx 10^{102}\,\mathrm{G\cdot cm}^5$ which may give an observable contribution only near the center of the Galaxy.

It must be noted that due to high conductivity and self-induction of the galactic medium, the magnetic moment is almost conserved and the comparatively small changes in the configuration of the fields may be caused by the motions of ionized interstellar matter, in which the magnetic field is "frozen-in".

A dipole magnetic field of galactic dimensions has been observed, for example, in the active "radio-tail" galaxy NGC 1265, moving in the Perseis cluster[32,33].

More detailed conclusions on the evolution of the primordial field can probably be obtained only after the construction of a fundamental theory of superhadrons, taking into account gravitational effects.

5. THE ENERGY PROBLEM

The fundamental assumption has been put forward first by Ambartsumian[3] that nuclei of galaxies can contain a highly condensed object, the remnant of the primordial

superdense material from which they were formed. According to him, such superdense matter in a metastable configuration may serve as the energy source for different forms of activity in the galactic nuclei and quasars.

Many exotic and non-exotic sources of energy have been proposed for explaining the activity of galactic nuclei. There are speculations on massive magnetized rotating objects - spinars[34], magnetoids[35], and electrified black holes[36], situated in the center of galactic nuclei.

From the point of view of hadronic cosmogony it is natural to accept that the superdense object in galactic nuclei postulated by Ambartsumian is a remnant of the protogalaxy-superhadron with mass of the remnant being of the order $\approx 10^8 m_{\odot}$ or more, and spin given by the relation (2). The magnetic field near this object is given by relation (7). It follows that the magnetic field configuration very near the nucleus must be complicated and contain not only the dipole component but also contributions from higher multipole moments. Energy output of the order $10^{60} - 10^{61}$ erg $= \approx 10^6 - 10^7 m_{\odot} c^2$ confined in a very small volume, in the forms of high energy particles and magnetic fields, can be, in principle, provided by a massive superbaryon, centered in the nucleus of a galaxy. The efficiency of such a source depends on the mass and conserved baryon number of the superhadron and can be much higher than the capabilities of the usual thermonuclear or gravitational sources.

If the spin axis of the superbaryon which remains still in the nucleus of a galaxy does not coincide with the spin axis of the galaxy (like in the case of M31 and NGC 3672), then the resulting precession can bring periodical intensity variations in luminosity of quasars and active nuclei.

The necessity for the existence of a new, non-thermonuclear energy source in galaxies and stars has been repeatedly stressed by Ambartsumian[3,4,5].

6. FUNDAMENTAL CONSTANTS AND PARAMETERS OF COSMIC OBJECTS

The Regge-like relations (2) and (3) allow us to give a simple derivation for the expression of masses and spins of cosmic objects through fundamental constants. As is well known the spin angular momentum of the Sun (and approximately of other stars) is close to the maximal Kerr value

$$J = \frac{Gm^2}{c}.$$

Equating this value to the relation (3) $\frac{Gm^2}{c} = (\frac{m}{m_p})^{4/3}\hbar$ and solving for m, we obtain that $m = (\frac{\hbar c}{Gm_p^2})^{3/2} m_p$ which is a familiar Chandrasekhar[37] relationship for the mass of stars from the theory of stellar structure.

Equating maximal Kerr value for spin to the relation (2) $\frac{Gm^2}{c} = (\frac{m}{m_p})^{3/2}\hbar$ we obtain $m = (\frac{\hbar c}{Gm_p^2})^2 m_p$ which is the well known Eddington-Dirac relation for the mass of the Metagalaxy[38]. It will be desirable to obtain a similar expression for typical galactic masses. The mass of a typical galaxy can be taken as $10^{11} m_\odot$ which is nearly the mean geometric value between mass of typical star $m_{star} \approx 10^{33}$ g and mass of Metagalaxy $m_{MG} \approx 10^{56}$g. From this coincidence we can deduce that $m_{gal} \approx \sqrt{m_{star}\ m_{MG}} = (\frac{\hbar c}{Gm_p^2})^{7/4} m_p$. The same relation (except the substitution $m_p \to m_\pi$ where m_π is pion mass) was obtained by Harrison from other considerations[39].

Now it is easy to obtain expressions for the spin angular momenta, substituting the derived expressions for mass into relation (3) for stars and relation (2) for galaxies and the Metagalaxy. The values obtained for spins together with masses are shown in Table 3. There exist other "large number" relations, which can be found in ref.[40] and in ref.[9] Of course, the relations of such type cannot be considered as exact, and as noted by G.Gamow, here one may put 10=100= = 1! On the other side these relations show that there is a deep interconnection between quantum-mechanical and macroscopic gravitational phenomena.

7. CONCLUDING REMARKS

The hadronic cosmogony, discussed above, allows one to obtain in a theoretically self-consistent manner, without any arbitrary parameters, reasonable values for the rotational momenta of cosmic objects and their systems, from asteroids to the Metagalaxy. It must be stressed that in this way a large mass interval, of about 34 orders of magnitude (from 10^{22}g asteroids to 10^{56} g Metagalaxy) is covered. The corresponding interval for angular momenta covers about 60 orders of magnitude (from 10^{33}g·cm^2/sec till 10^{93}g·cm^2/sec). The law of conservation of angular momentum is fulfilled, and rotational momentum calculated for nearly all the cosmic objects seems to agree with observations. These results, together with the possibility of explaining the origin of cosmic magnetic fields and other implications[41,42] suggest that the hadronic approach is realistic and sensible.

Table 3

The connection of masses and spins of different cosmic objects with fundamental constants. Dimensionless combination of the fundamental constants $\hbar c/Gm_p^2 = 1{,}69 \times 10^{38}$ is the inverse of the "gravitational fine structure constant"

Object	Mass, m		Spin, J	
Stars	$(\frac{\hbar c}{Gm_p^2})^{3/2} m_p$	a)	$(\frac{\hbar c}{Gm_p^2})^2\hbar$	
Galaxies	$(\frac{\hbar c}{Gm_p^2})^{7/4} m_p$	b)	$(\frac{\hbar c}{Gm_p^2})^{21/8}\hbar$	
Metagalaxy	$(\frac{\hbar c}{Gm_p^2})^2 m_p$	c)	$(\frac{\hbar c}{Gm_p^2})^3\hbar$	d)

a) Chandrasekhar[37]; b) Harrison[39]; c) Dirac[38]; d) Muradian[8,9].

The main difference with other types of cosmogony lies in the fact that hadronic cosmogony incorporates in a natural way fundamental quantum-mechanical parameters $\hbar$ and m_p, besides the classical parameters G and c. This seems to be a compulsory condition for any realistic cosmogonic theory. It seems highly probable that a more complete future hadronic cosmogony must be based on essentially quantum-mechanical theory, unifying the theory of strong interactions with gravity and electromagnetism. Probably, in this sense Ambartsumian's conjecture, that new physics is needed to explain the origin and evolution of cosmic objects may be understood.

Perhaps only such a theory, starting with as simple initial condition, as a "Primeval Hadron" can explain the existence of the observed present-day cosmic bodies with their whole complexity and diversity. Rephrasing Lemaître's sentence, we can say that it seems difficult to conceive of conditions which are simpler than those which existed when all matter was unified in one superhadron.

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