THE PRIMEVAL HADRON: ORIGIN OF ROTATION AND MAGNETIC FIELDS IN THE UNIVERSE

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ABSTRACT. The problem of the origin of celestial bodies - stars, galaxies and their clusters - is discussed proceeding from the concept of superheavy strongly interacting elementary particles termed superhadrons.

Starting from generalized Regge law the universal relationship between mass and intrinsic angular momentum of cosmic objects has been established. Expressions are obtained for parameters of stars and Universe via fundamental constants. The prediction of the global rotation of the Universe is discussed and the problems of cosmic magnetic fields and energy problem in active galaxies are considered.

1. INTRODUCTION.

This review is written on the basis of author's works on hadronic cosmogony. The link between Ambartsumian's cosmogony and Regge law for angular momentum of cosmic bodies is emphasized.

2. REGGE LAW IN ASTROPHYSICS.

A generalized Regge-like formula, relating the spin (J) to the mass (m) for heavy superhadrons has been proposed (Muradian, 1975, 1980);

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

where m_p is the proton mass and $\hbar$ is the Plank constant. The number n = 1,2,3 characterizes the geometric shape of the hadrons: n=1 for one-dimensional string-like objects, n=2 for two-dimensional pancake objects and n=3 for three-dimensional spherical objects.

The Regge law (1) and identification of Ambartsumian's dense D-bodies with heavy superhadrons allows quantitati-

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vely explain the origin and magnitude of cosmic angular momenta and magnetic fields.

3. ROTATION OF CELESTIAL BODIES.

The analysis of the observational data on the rotation of cosmic objects has shown, that they can be classified into two groups:

a) The first group includes clusters of galaxies, single galaxies, globular and open star clusters and possibly stellar associations and superassociations. The angular momentum - mass distribution for those objects is described by the Regge law (1) at n=2:

$$J = \hbar \left(\frac{m}{m_p} \right)^{3/2} \qquad (2)$$

These formula possibly can be extrapolated for the description of the global rotation of the Metagalaxy or astronomical Universe.

b) The second group includes stars and planets. The angular momentum - mass distribution in this case is given by Regge law (1) at n=3:

$$J = \hbar \left(\frac{m}{m_p} \right)^{4/3} \qquad (3)$$

The available observational data on the rotation of various cosmic objects, along with theoretical straight lines, are presented in Figure 1. The data are in excellent agreement with theoretical predictions and in some sense Figure 1 represents Chew-Frautschi plot in astrophysics.

4. FUNDAMENTAL CONSTANTS AND PARAMETERS OF CELESTIAL BODIES.

Chandrasekhar's formula for the mass of typical star and Eddington-Dirac relation for the mass of the Universe may be obtained in a principally new way using the Regge law for angular momenta. Equating maximal Kerr spin $J = Gm^2/c$ to the expressions (2) and (3) we obtain parallel with Chandrasekhar and Eddington-Dirac relation (see first column of Table 1) a new expression for the corresponding angular momenta, displayed in the second column of Table 1.

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Table 1. The connection of masses and spins of cosmic objects with fundamental constants.

Object	Mass (m)	Spin ($\mathcal{J}$)
Stars	$m_p \left(\frac{\hbar c}{G m_p^2}\right)^{3/2}$	$\hbar \left(\frac{\hbar c}{G m_p^2}\right)^2$
Universe	$m_p \left(\frac{\hbar c}{G m_p^2}\right)^2$	$\hbar \left(\frac{\hbar c}{G m_p^2}\right)^3$

These results suggest an interesting graphic interpretation, shown on Figure 2.

In the paper entitled "Why are stars as they are?" Chandrasekhar suggested that "the stars are as they are, because $m_p\left(\frac{\hbar c}{G m_p^2}\right)^{3/2}$ provides a correct measure for their masses". As we see, this statement now can be supplemented by the words"... and $\hbar\left(\frac{\hbar c}{G m_p^2}\right)^2$ provides a correct measure for their angular momenta".

5. ROTATION OF THE UNIVERSE.

Substituting the accepted value of the mass of the observable Universe m = 10^{56} g into the relation (2) we can obtain the following estimate for the spin of the Universe, expressed in the units of Plank constant:

$$J_u = 10^{120}\,\hbar \qquad (4)$$

If this rotation, which is natural for hadronic cosmogony, will be confirmed, then attractive possibility is revealed: our Universe is a relic of the "Primeval Hadron" with the pancake shape, mass $m = 10^{80}\, m_p$ and spin $\mathcal{J} = 10^{120}\hbar$

6. COSMIC MAGNETIC FIELDS.

The problem of the origin of magnetic fields of galactic scale was discussed in the frame of hadronic cosmogony (Muradian, 1978, 1980, 1984). By means of the dimensional analysis and similarity method the following formulae for magnetic and electrical multipole moments of galaxies were deduced

$$\mu^{(k)} = \frac{\sqrt{G}}{c}\, \mathcal{J}\left(\frac{J}{mc}\right)^{k-1} \qquad k=1,3,5,\ldots (5a)$$

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$$\mathcal{E}^{(k)} = \sqrt{G}\, m \left(\frac{J}{mc}\right)^{k} \qquad k=0,2,4,\ldots \quad (5b)$$

For dipole (k=1) and octupole (k=3) magnetic moments of our Galaxy can be estimated by means of (5a) as follows: $\mu^{(1)} = 1{,}7 \times 10^{61}$ G cm^3 and $\mu^{(3)} = 10^{102}$ G cm^5 The octupole moment gives a vanishing contribution in the vicinity of the Solar system (10^{-11} G) and, thus, one may neglect it when compared with the dipole contribution (10^{-6} G). However, the contribution of the octupole may be comparable with that of the dipole at the distances of the order 1 kpc from the centre of the Galaxy. In immediate proximity to the galaxy nucleus the fields should have a fairly complex configuration determined by the contribution of higher multipole moments.

7. THE ENERGY PROBLEM.

The superhadron with the mass of 10^8 $m_\odot$, centered in the nucleus of an active galaxy, can provide energy output of the order 10^6 - 10^7 $m_\odot c^2$ = 10^{60} - 10^{61} erg in the forms of high energy particles and magnetic fields, confined in a very small volume. The efficiency of such a source can be much higher than the capabilities of the usual termonuclear and gravitational sources.

8. CONCLUSION.

The arguments presented here make probable the cosmic objects origin due to the decay of macroscopic quantum bodies such as superhadrons. The formation of galaxies and stars from the viewpoint of hadronic cosmogony was also considered by R.F.Sistero and I.N.Minin.

The basic difference between the approach based on the superhadron hypothesis and other cosmological theories is that our approach includes quite naturally the quantum mechanical parameters $\hbar$ and m_p along with the classical parameters c and G. Apparently, this condition should necessarily be satisfied in any future more fundamental theory of the origin of celestial bodies. Possibly, this new future theory will be substantially quantum mechanical unifying in a radical manner strong interactions with electromagnetism and gravitation.

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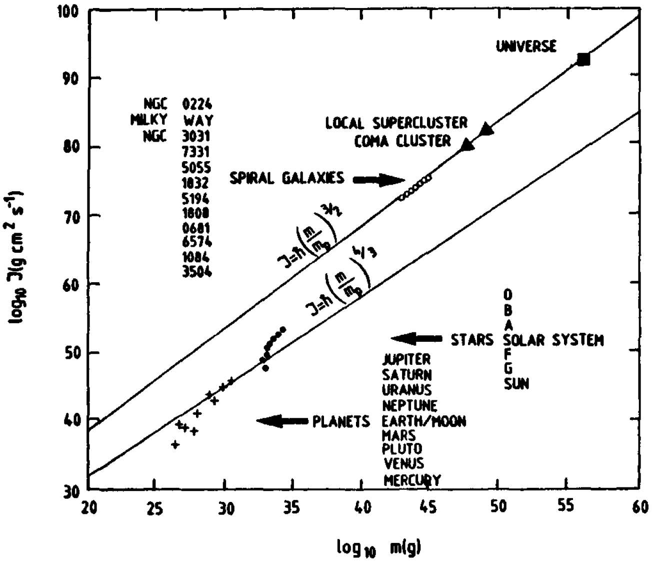

Figure 1. The angular momentum-mass distribution for cosmic objects. Straight lines correspond to the Regge-like relations (2) and (3).

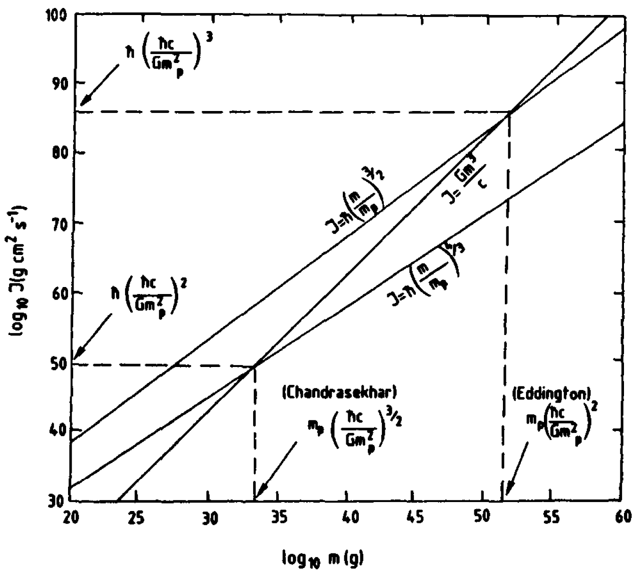

Figure 2. The graphic interpretation of the results in Table 1.

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