GRAVITY, GEOPHYSICS AND ASTRONOMY

With 2 tables

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SUMMARY

Author discusses the astronomical and geophysical aspects of the Dirac's cosmology. It is shown that the existence of the reversible high-pressure phases in a Dirac cosmology gives a very simple explanation for the origin and structure of Solar system, as well as a quantitative explanation for the expansion of the Earth. The expansion derived on the basis of this model is in a very surprising agreement with the different observational date derived from continental surface, decrease of water-covered continental areas (palaeogeographic maps) slowing down of the Earth's rotation (astronomical and paleontological observations), and energies. The most probable radius increase derived amount to 0,5 – 1,5 mm/year

At the time when Roland Eötvös began his research work on gravity, mass attraction was considered as a problem entirely solved. Nevertheless in such a situation Eötvös attacked the most delicate problems of gravity and his outstanding result was the high-precision prove of the proportionality of inertial and gravitative mass. Besides this prominent result, however, which became the basis of the theory of general relativity, he has carried out another measurement with a more modest result. He determined the value of the gravity constant. These two results of different character, however, met in a very interesting manner in one of Dirac's suggestions. Namely, in 1938, Dirac came to the conclusion that the gravity constant is a value decreasing in time proportionally with a time parameter of an order of magnitude comparable with the age of the Earth of the Solar System. Before analyzing the geophysical and cosmological consequences of this suggestion, let us emphasize its philosophical importance.

Our modern science is based on observations of only a few centuries old. In spite of this the physical laws are applied to geological, geophysical and astronomical problems for periods of several billion years. Now the question arises whether the supposition of the constancy of physical laws for such a

long period may be considered as correct ? As Newton's physics is not suitable for the description of phenomena of high velocity, moreover, the classical electromagnetic theory is not able to describe the phenomena of microsystems, it is probable that classical physics is not suitable to describe phenomena having a duration equal to the geological periods. Dirac's result proves that physical laws, if they refer to a time interval comparable with the age of the universe, may depend on a time parameter, too.

In the following it will be shown that the supposition of the validity of Dirac's cosmology, in addition to the existence of high pressure and degenerated phases, is suitable to give a general explanation for geological-geophysical phenomena of a long duration, as well as a consistent explanation for the origin of the Solar System.

The existence of Ramsey's high-pressure degeneration phases inside the Earth and the stars is equivalent, in the case of an Earth of homogeneous composition, to the establishment that the density inside the Earth is pressure dependent only. This conclusion together with Dirac's expression results in the expansion of the Earth and planets. The rate of expansion can be calculated from the known physical data of the Earth and its value depends only on the time parameters of Dirac's equation. Table I. contains the rate of radius increase in terms of the value the time parameter.

Table I.

Recent value of time parameter 10^9 years	Average rate of radius increase in mm/year		The average refers to a time-interval of (in million years)
	Bullen—Bullard model	Bullen—Jeffreys mode	
4,1	0,5	1,0	600
4,5	0,46	0,92	650
5,0	0,41	0,83	720
5,5	0,37	0,75	800
6,0	0,34	0,69	870
7,0	0,30	0,60	1000
8,0	0,26	0,52	1160
9,0	0,23	0,46	1300
10,0	0,21	0,42	1440

Only two of the geological-geophysical observations supporting these data may be mentioned. The first is the decrease of water-covered continental areas, a fact supporting the expansion of the Earth. The rate of decrease of water-covered continental areas can be determined from paleogeographic maps. On the basis of this the rate of expansion may be derived. It amounts to 0,5 to 1,6 mm/year, i. e. of the same order of magnitude as the theoretical value.

Another observation is connected with Middle-Devonian corals. On the basis of these fossils it has been shown that in the Middle-Devonian period the Earth made 400 rotations during a whole revolution around the Sun. Conform to the constancy of the momentum of inertiae this may be explained

only as an increase of the Earth's radius, with a yearly rate of 0,7 mm/year. Taking into account that the year itself was shorter, the rate of radius increase might have amounted to 1,5 mm/year.

The agreement between theoretical and observed values is shown in Table II.

Table II.

Rate of the annual radius increase

Means of Determination	Minimum mm/year	Maximum mm/year
Theoretical	0,5	1,0
Palaeogeographic maps	0,5	1,6
Continental surface	0,8	–
Slowing down of the Earth's rotation	0,6	1,5
Earthquakes and magmatic activity	~ 0,5	~ 1,0

According to a personal communication by Prof. P e t r o v a, K r a m o v has determined the rate of yearly radius increase of the Earth from paleomagnetic measurements by a method suggested formerly by me, (1960) and this determination resulted in a rate equal to the above data.

Concerning the problem of the origin of the Solar system the most delicate question arises in connection with the distribution of the angular momentum. If the constancy of the angular momentum is applied to any of the planets of the solar system, the following equation may be derived (J o r d a n, 1952):

$$fR_n = \text{const.}$$

where f is the gravity coefficient, R_n means the radius of the planetary orbit. If we accept the D i r a c-equation $f = x/t$ for the gravity coefficient where x is a constant and t a time parameter equivalent to the age of the solar system then the following equation may be written:

$$R_n = \lambda \cdot t \qquad (\lambda = \text{const.})$$

This equation has the consequences that, in the beginning, the Sun contained the mass of the planet. Namely, in the case of a corresponding small value of t, R_n may have become arbitrarily small. On the other hand, the planets could be originated from the Sun in the case of the validity of Dirac's equation only.

Moreover, if we accept the existence of highpressure degenerated phases – and the existence of white dwarfs are supporting this supposition – then Dirac's expression is suitable to give a very simple explanation for the origin of the solar system. It may be shown on the basis of the constancy of angular momentum of the system that – neglecting a common factor – the value of mass attraction exerted on the equator of the Sun has a form of B/t, while that of the centrifugal force the form of the function $A/r_0 + \alpha \cdot t$. Therefore, it is clear that there was an instant when the centrifugal force and the mass attraction on the equator of the Sun became equal and a weightless mass

ring has formed around it, and coagulated into a planet as a result of some smaller perturbations. On the residual mass of the Sun this phenomenon iterated but in longer and longer periods, while it ceased altogether in the interval where the decrease of mass attraction was small. According to this mechanism it is clear that the planets are orbiting around the Sun in a plane coinciding with the equator of the Sun and having the same direction of revolution. Moreover, this mechanism may be applied also to the planets in a time interval of strong decrease of mass attraction. Therefore, the outer planets must have several satellites, while the inner planets (except Mars which is the most external among the inner planets) possesses no satellites. Finally, the mass of the separated parts of the Sun (i. e. the mass of the planets) is relatively small in comparison with the mass of the Sun.

These theoretical consequences, however, are in good agreement with the regularities observed in the Solar system. Moreover, the formation of meteorites from small particles is a clear consequence of the above mechanism, as regards the possibility that, in case of the coagulation of rings into a planet, a dustlike residue could have remained is the surrounding space. Gravity showing in the beginning the characteristics of a strong interaction was suittable to collect this small particles by collision in meteorites or comets in a manner suggested by Urey, but carried out in a strong field. These accretion phenomenon was, however, a secondary one and not the primary process of planet formation.

The equation $fR_n = \text{const.}$ has the consequence that the duration of orbiting around the Sun, i. e. the lenght of a „year" is in connection with time parameter in the following way: $T = \mu \cdot t^2$. In this case the lenght of a „year" 400 million years ago, i. e. around the Middle-Devonian consisted of 303 contemporary days, consequently, the length of the day in the case of 400 rotations derived from corals had a duration of 65,500 sec instead of 86,400 sec, which corresponds to a very high angular velocity.

According to the theory sketched above the distribution of angular momentum in the planetary system may also be explained. At the formation of a planet the escaped mass had always the greatest specific angular momentum and, as a consequence of the high primaeval angular velocity of the Sun, the relativistic mass of the escaped material was very large.

This relativistic mass, however, became slowly equal to the statical mass as a consequence of the decrease of velocity following the increase of orbita ! radius, while the angular momentum did not change.

The above mechanism of the origin of the Solar system facilitates the comprehension of the high number of binary stars in our galaxy, too.

It may be concluded that phenomena having a duration comparable with the age of the universe may be explained only on the basis of laws similar to Dirac's hypothesis.

LITERATURE

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