АСТРОФИЗИКА

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THE NEEDNES OF THE HIGH PRECISION MEASUREMENTS IN THE FUNDAMENTAL CONSTANTS BRANCH

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The possibility of the variation of the gravitational constant with the space coordinates is considered.

It was suggested by Sinha et al. [1, 2] that in Nature there is not one value of the gravitational constant. It is consistent with the idea of the variation of Newtonian gravitational constant G_N proposed in this paper.

Now we suggest that the gravitational constant can be changed throughout the space (not in time). Recently such changes were "reported" with respect to the nuclear matter. Inside nuclear matter, instead of Newtonian G_N we have

$$G_f >> G_N \ .$$

It is found by Ikaunieks [3] and others that red giant variables have slightly longer period in the hemisphere centred on $l = 325^o$ than in the hemisphere centred on $l = 325^o + 180^o$ (see Table 1 in [2]).

Table 1

The type of red giant variables	Average period	
	$l = 60^o - 240^o$	$l = 240^o - 60^o$
Ce	400^d	396^d
Se	378	365

This law was known as very mysterious since the second decade of our century, and was confirmed in 1957 by Hoffleit and 1963 by Plaut.

If the gravitational constant changes delicately with the distance from the centre of the Milky Way, i.e. *increases toward the centre,* then the red giant variables of the *same chronological* age should be expected more advanced in the evolution as we are going from peripheral regions toward the centre of the Milky Way. Really, the luminosity L changes as

$$L \sim G^7 \text{ or } G^8.$$

The effect can be easily seen if we have statistically *significant* sample — the local perturbations of the potential mask the effect. According to theoretical considerations the variables which are more advanced in their *evolution* will have shorter periods [4]. Then, since a variation of G play an important role in stellar evolution it may lead to a serious discrepancies (as reported in the Table 1) in the age of stars at different directions (centre and anti–centre of the Milky Way) if we allow the variation of fundamental constant G with space coordinates (not with time as Dirac have done in his papers written between 1937 — 1980).

Permitting the extremely small *increasing* of the Planetary System orbit around the centre of the Milky Way another interesting effect can be associated with the concept of decreasing value of G as we go from central to peripheral regions. With

$$\delta G/G \approx 10^{-11}/\text{year} ,$$

the Earth would be expected to expand — as the gravitational force gets weaker with scale — by approximatelly 100 km in 10^9 years. Similar considerations imply the Moon's expansion at the rate not greater than 1 km per 10^9 years. The small increasing of the Planetary System orbit around the core of the Milky Way can be an effect of the neutrino decay process

$$\nu_{heavy} \rightarrow \nu_{light} + X .$$

Note that the expansion of the Milky Way was reported by Tifft in a whole chain of his papers. Moreover it is quite possible that the Solar System is going toward his apogalacticum; the circular orbit of the Sun seems to be only an idealization, of course.

Is our hypothesis ad hoc or not? Ad–hocness can be de fined as a relation between two theories T_1 and T_2. Essentially our theory, T_2, with the variation of the fundamental constants [$G \neq \text{const}, G = G(r)$] is formulated within the same astronomical research programme as the theory T_1 with $G = \text{const}$. In this

programme we can define, after Lakatos [5], a hard core and a heuristic, where the hard core contains unfalsifiable statements. Our theory T_2, as well as the standard theory T_1, is a conjunction of the standard hard core and of the different auxiliary hypotheses. If anomalies appear we can use the modus tollens to the auxiliary hypotheses, *only*. This tactic is *forbidden* with respect of the *hard core*.

Now, some comments on the hard core. Hard core of T_1 and T_2 consists of equations of stellar interior, i.e.

$$dP/dr = -\rho G M_r/r^2 \text{ , (eqs. of structure)} \qquad \text{(S)}$$

etc.;

associated with the eqs. of structure theories such as: radioactive energy transport or convective energy transport theories, hydrostatic and thermal theories, theory of atomic absorption, theory of nuclear reaction, theory of homologous contraction etc.

The *heuristic* of this programme is given by the principle of the Kantian mode of the evolution of stars. Applications of this heuristic generate the sequence of theories $T_1, T_2, \ldots$. So T_1 and T_2 belong to classical (so-called standard approach) programme [4] on the origin and evolution of celestial bodies. We claim that the shift from T_1 to T_2 is not ad hoc.

A theory is not *ad hoc*, if it has novel consequences as compared with its predecessor and it accords with the spirit of the heuristic. But T_2 seems to be able to explain Earth's expansion.

Let's consider the sequence of theories — T_1, T_2, where T_1 faces two anomalies $-a_1$ and a_2 and T_2 arises in order to explain for a_1. If T_2 explains also a_2 then a_2 can be taken as a novel fact in contradiction to a_1. Anomaly a_i is showed in Table 1. Anomaly a_2 is a long standing problem of the Earth's expansion. (It was suggested by Lakatos [5, 6] that novelty in the methodology is not simply temporal novelty).

At the first look it might be not clear that the assumption of variation of G does not change the hard core definied above. We should stress however, that the parameter G in the eqs. of structure (S) plays only the role of a proportionality factor and its numerical value is not fixed theoretically. The meaning of the above equation is very limited — it informs only about the equality between the pressure and gravitational force and is completely independent is $G = \text{const}$ or not. So our assumption about the variation of G does not contradict the concept of the classical hard core.

Our assumption that $G = G(r)$ bases on the classical (standard) approach to the evolution of stars, so it does not contradict the heuristic of the programme that stars originated and evolved due to the Kantian mode.

It is noted that in the Kantian mode [7] there is no specific relation between the part and the whole, the star and the Universe. In the Hegelian-like mode of the origin

of stars — which is possible only in the evolving Universe — the cosmological level would not be separated from the local astrophysical phenomena [8, 9]. In the Kantian (and pre–Hegelian–like) approach the cosmological laws have been defined irrespective of whether astrophysical granularity of matter exists, or not [10, 11].

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НЕОБХОДИМОСТЬ ИЗМЕРЕНИЙ ВЫСОКОЙ ТОЧНОСТИ ФУНДАМЕНТАЛЬНЫХ ПОСТОЯННЫХ

М. ЗАБИЕРОВСКИЙ

Обсуждается возможность изменения гравитационной постоянной с пространственными координатами.

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