LETTERS TO PROGRESS IN PHYSICS

A Few Remarks on "The Length of Day: A Cosmological Perspective"

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An interesting hypothesis concerning the varying length of day has been formulated in this edition, proposed by A.I. Arbab, based on a proposition of varying gravitational constant, G. The main ideas are pointed out, and alternative frameworks are also discussed in particular with respect to the present common beliefs in astrophysics. Further observation is of course recommended in order to refute or verify this proposition.

1 Introduction

An interesting hypothesis has been formulated in this edition, proposed by A. I. Arbab [1,2], based on a proposition of varying gravitational constant, G. The main ideas are pointed out, and alternative frameworks are also discussed in particular because the idea presents a quite different approach compared to the present common beliefs in astrophysics and cosmology, i.e. that the Earth is not expanding because the so-called Cosmological expansion does not take place at the Solar system scale.

2 Basic ideas of Arbab's hypothesis

Arbab's hypothesis is mainly an empirical model based on a set of observational data corresponding to cosmological expansion [1]. According to this model, the day increases at a present rate of 0.002 sec/century. His model started with a hypothesis of changing gravitational constant as follows [1]:

$$G_{\text{eff}} = G_0 \left(\frac{t}{t_0}\right)^{\beta} . \tag{1}$$

We shall note, however, that such a model of varying constants in nature (such as G, etc.) has been discussed by numerous authors. The idea itself can be traced back to Dirac, see for instance [3].

What seems interesting here is that he is able to explain the Well's data [4, 5]. In a sense, one can say that even the coral reef data can be considered as "cosmological benchmark". Furthermore, from this viewpoint one could expect to describe the "mechanism" behind Wegener's idea of tectonic plate movement between continents [6]. It can be noted that Wegener's hypothesis has not been described before in present cosmological theories. Moreover, it is also quite safe to say that: "There has been no consensus on the main driving mechanism for the plate tectonics since its introduction" [7].

It is worth noting here that the idea presented in [1,2] can be considered as quite different compared to the present common beliefs in astrophysics and cosmology, i.e. that the Earth is not expanding because the so-called Cosmological expansion does not take place at the Solar system scale. Apparently in [1] the author doesn't offer any explanation of such a discrepancy with the present beliefs in astrophysics; nor the author offers the "physics" of the causal relation of such an expansion at the Solar system scale. Nonetheless, the empirical finding seems interesting to discuss further.

In the subsequent section we discuss other alternative models which may yield more-or-less similar prediction.

3 A review of other solutions for cosmological expansion

In this regards it seems worth noting here that there are other theories which may yield similar prediction concerning the expansion of Earth. For instance one can begin with the *inhomogeneous scalar field cosmologies* with exponential potential [8], where the scalar field component of Einstein-Klein-Gordon equation can be represented in terms of:

$$\phi = -\frac{k}{2} + \log(G) + \psi . \tag{2}$$

Alternatively, considering the fact that Klein-Gordon equation is neatly related to Proca equation, and then one can think that the right terms of Proca equation cannot be neglected, therefore the scalar field model may be expressed better as follows [9]:

$$(\Box + 1) A_\mu = j_\mu + \partial_\mu (\partial_\nu j^\nu) . \tag{3}$$

Another approach has been discussed in a preceding paper [10], where we argue that it is possible to explain the lengthening of the day via the phase-space relativity as implication of Kaluza-Klein-Carmeli metric. A simpler way to predict the effect described by Arbab can be done by including

equation (1) into the time-dependent gravitational Schrödinger equation, see for instance [11].

Another recent hypothesis by M. Pitkanen [12] is worth noting too, and it will be outlined here, for the purpose of stimulating further discussion. Pitkanen's explanation is based on his TGD theory, which can be regarded as generalization of General Relativity theory.

The interpretation is that cosmological expansion does not take place smoothly as in classical cosmology but by quantum jumps in which Planck constant increases at particular level of many-sheeted space-time and induces the expansion of space-time sheets. The accelerating periods in cosmic expansion would correspond to these periods. This would allow also avoiding the predicted tearing up of the space-time predicted by alternative scenarios explaining accelerated expansion.

The increase of Earth's radius by a factor of two is required to explain the finding of Adams that all continents fit nicely together. Increases of Planck constant by a factor of two are indeed favoured because p-adic lengths scales come in powers of two and because scaling by a factor two are fundamental in quantum TGD. The basic structure is causal diamond (CD), a pair of past and future directed light cones forming diamond like structure. Because two copies of same structure are involved, also the time scale $T/2$ besides the temporal distance T between the tips of CD emerges naturally. CD's would form a hierarchy with temporal distances $T/2^n$ between the tips.

After the expansion the geological evolution is consistent with the tectonic theory so that the hypothesis only extends this theory to earlier times. The hypothesis explains why the continents fit together not only along their other sides as Wegener observed but also along other sides: the whole Earth would have been covered by crust just like other planets.

The recent radius would indeed be twice the radius that it was before the expansion. Gravitational force was 4 time stronger and Earth rotated 4 times faster so that day-night was only 6 hours. This might be visible in the biorhythms of simple bacteria unless they have evolved after that to the new rhythm. The emergence of gigantic creatures like dinosaur and even crabs and trees can be seen as a consequence of the sudden weakling of the gravitational force. Later smaller animals with more brain than muscles took the power.

Amusingly, the recent radius of Mars is one half of the recent radius of Earth (same Schumann frequency) and Mars is now known to have underground water: perhaps Mars contains complex life in underground seas waiting to the time to get to the surface as Mars expands to the size of Earth.

Nonetheless what appears to us as a more interesting question is whether it is possible to find out a proper metric, where both cosmological expansion and other observed expansion phenomena at Solar-system scale can be derived from the same theory (from a Greek word, *theoros* — "to look on or to contemplate" [13]). Unlike the present beliefs in astrophysics and cosmological theories, this seems to be a continuing journey. An interesting discussion of such a possibility of "generalized" conformal map can be found in [14]. Of course, further theoretical and experiments are therefore recommended to verify or refute these propositions with observed data in Nature.*

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*At the time of writing, we are informed that Arbab's forthcoming paper will discuss a more comprehensive and theoretical approach of his hypothesis [15]. Our remarks here are limited to his papers discussed in this issue, and also in his earler paper [16].