Planck's hypothesis, Sommerfeld's fine structure, Dirac's relations, causality, and metrological standards

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The alternative cosmologies with variable gravitational constant *G* contribute to fundamental constants branch of metrology as well as to dimension and similarity analysis in physics. There is discussed recent Rybicki's derivation of Planckian units containing *G,* which are variable, too. We discuss the consistency of this result and compare it with Dirac's large number hypothesis and with our considerations on gravitational constant variability.

Keywords: dimensional analysis in physics, causal paradox, gravitational constant, Dirac's large numbers coincidences, Planckian units, similarity of metrological quantities

1. The speed of light and Sommerfeld's constants

a) The well known values of some fundamental standards, such as the fine structure constant $\alpha = e^2/\hbar c$ (e – electric charge, $\hbar$ – Planck constant, c – the speed of light), have not been adequately explained. Similarly, the ratio of masses of proton and electron $m_p/m_e \approx 1840$ awaits explanation. As Staruszkiewicz [1] points out, accounting for Sommerfeld constant α is the most important problem in physics.

In the branch of metrology considered here, it is sometimes suggested that the fine structure constant $\alpha \approx 1/137$ is not constant due to the variability (cosmological changing) of c. Acording to Grabińska [2], however, the speed of light c and Sommerfeld's constant α are constant.

b) Dirac [3] arrived at some large numbers, i.e.: 1) the ratio of the electric to the gravitational forces

$$N_1 \sim e^2/G$$

(where G – gravitational constant), and expressed in atomic units; 2) the so-called cosmological radius

$$N_2 \sim H^{-1}/e^2$$

(where H – Hubble constant); 3) the cosmological mass

$$N_3 = M_U/m_p \approx N_2^{\ 2},$$

(where M_U – mass of the Universe), and 4) the cosmological time $N_4 \approx N_2$. There is $N_5 \sim k^{1/2} \approx N_2$ (where k – Boltzmann constant), too.

The new aspect of N_5, the new Dirac large numbers' coincidence found in [4] by means of Dhibay & Kaplan physics

[5] fits well the Dirac's hierarchy of numbers. It could *a priori* undermine Dirac's conjecture

$$G \sim 1/t$$

(where t – cosmological time), but it is not the case. Namely, Dirac's picture forms a consistent language [6]. The new relations N_5 and N_6 generated in the framework of *large number dimensional* physical analysis (as in [5]) are in excellent agreement with Dirac's theory predictions, i.e.,

$$G \sim 1/t, N_3 \sim t^2.$$

Dirac's theory was discussed in the Astronomical Observatory of the Jagiellonian University at Cracow for many years. Some of the scientists from the Institute of Physics claimed that the new large numbers would falsify (negatively verify) Dirac's theory.

2. Metrologic *versus* big bang consequences for Dirac's large numbers

Metrology and fundamental constants generate cosmological questions connected with the mega-radius R. Rybicki's [7] recent work can serve as an example. What did Rybicki present? He demonstrated that cosmology as a whole scheme of new Planck's constants cosmology is not inconsistent with the original conjecture given by Planck [8]. He revealed new theoretical aspects in Planck's approach to measurement patterns.

Rybicki proposed that the values of some constants change, whereas some relations among them remain constant. The fine structure constant is constant, c = const, h = const, G grows linearly with the scale of the Universe and time.

Rybicki used the well-known big bang heuristics of time and space scale related to $1/H$. In such heuristics N_4 is fixed by N_2.

Nevertheless, from a more fundamental point of view of the dimensionless analysis in physics [9], outside the big bang heuristics, N_4 is generally independent of N_2.

This consequence, as well as N_4 being an independent quality in mega-physics, have not been recognized in lectures and articles, e.g., of French physicists, such as Demaret, who accepted the Hubblean expansion dogma (as Rybicki did in his proposal).

Dirac conjectured in his mega physics that $G \sim 1/R \sim 1/t$, where R is the global scale of the so-called Universe. Nevertheless, from the point of view of dimensional analysis in physics [10], the time scale and linear scales are not necessarily the same, contrary to the universal expansion according the big bang theory, where spatial scale and time are determined by H.

Global aspects of space and time are independent according to dimensional physics [11] (developed by Weisskopf [12]), not requiring each other, and not requiring the same value (N_1).

R cannot be as strongly related with time as it is hypothesized by expansion in the standard models, i.e., the relativistic models [13]. The Universe of the global scale N_2 (and the global mass N_3), can be much older than of N_4 .

3. What is so important in Rybicki's work?

a) Consistency

I claim that the main achievement of Rybicki's work is the proof of consistency [14]. Namely, he showed that the possibility of new relation

$$G \sim t \sim R \,,\ c = \text{const},$$

forms a new internaly consistent language.

Consistent means here not contradicting the whole branch of Planck' s conjecture which concerns the Sommerfeld's fine structure constant.

Rybicki has obtained an internally consistent language in the framework of fundamental constants and basic metrological standards.

I suppose that the whole Planck's branch, as proposed by Rybicki, is no less consistent than standard relativity.

b) An example of consistency

Such a generally consistent situation as in point 1.b) has been predicted by Grabińska [15] in the framework of general conventionalistic approach to theoretical physics.

c) Rybicki' s conjecture $G \sim t$ or $G \sim 1/t$? Causality

Dirac's [16] proposal that $G \sim 1/t$, $r \sim t$ results in the Universe without causal paradox. Thus the reversed proposition, i.e. $G \sim t$ was not considered as a solution to the causal paradox. In 1976, I demonstrated that the causal paradox in cosmology disappears when

$$G \sim t^{\beta}, \beta > 0;$$

$G \sim t$ for pressure $p = 0$, $\beta = 1$. It was pointed out by myself that Dirac's solution $r \sim t$ is receivable for growing value of G [17].

4. A final remark. The concept of "cosmological second"

As far as I know, "the Rybicki's second" can only be compared with the "the second of cosmologists" which was considered by Rudnicki in [18]. Rybicki assumed special cosmologies, which generated "the second of cosmologists". He proposed such a model in which the instruments "measuring time" were involved in specific equations of Planckian dynamics.

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