Experimental Investigations of New Interaction by Use of Stationary High-accuracy Quartz Gravimeter

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Smooth anomalous in time dependence recordings of a high accuracy quartz gravimeter with a constant magnet attached to it, were revealed. These anomalies of minute’s duration have amplitudes sometimes by more than an order of magnitude greater than that of the Moon tide, and may not be explained with the aid of current physical concepts. The experimental procedure was based on the hypothesis of a new interaction arising when acting on physical vacuum by magnetic systems through their vectorial potential. The coordinates of physical space magnetic anisotropy due to existence of the cosmological vector potential $A_g$, a new basic vectorial constant, are determined. In particular, the declination coordinate $\delta \approx 34^\circ$ of the vector $A_g$ (second equatorial coordinate system) is determined for the first time by experiment. The hypothesis considered was used for physical justification of the results obtained.

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I. INTRODUCTION.

In papers [1-5], the results of experimental investigations of a new interaction discovered, are presented, which arises when acting on the process of elementary particle charge number formation by magnetic systems through their vectorial potential. In classical and quantum field theory, the potentials, as a rule, have no physical meaning by themselves (cannot be measured), only their derivatives have it. In particular, the vectorial potential of the electromagnetic field is determined, in existing conventional theories, with an accuracy of an arbitrary function gradient (gauge invariance), which is closely related to the law of conservation of elementary particle charge numbers. It is shown [6-10] that if, for example, electric charge $e(x)$ of an elementary particle is varied over a set $\{x\}$, the potentials become single-valued. Masses of elementary particles are found [9-10] to be proportional to modulus of the cosmological vector potential $|A_g| \approx 1.95 \times 10^{11}$ CGSE units, a new basic vectorial constant appearing in one-dimensional discrete objects called byuons\(^{\dagger}\) from a finite aggregation of which, by a new paradigm [11,12], the entire surrounding world is formed, and specifically, the three-dimensional space observed, the interior space of elementary particles as well as their charge numbers are.

Now, if we direct the vector potential $A$ of any magnetic system toward the vector $A_g$, we shall meddle in the process of mass formation of elementary particles, and, according to suggestion made in Refs [11,12], a new force must appear to eject elementary particles (and hence any substance) from a region with reduced modulus of the cosmological vector potential $A_g$, in the direction of this vector. It is precisely this force that was detected in experiments with strong resistive and superconducting magnets by torsion and quartz piezoresonance balances.

In these experiments, the magnitude of the force was variable from 0.08$g$ to 0.01$g$ with magnetic fields $B$ from 1 to 14$T$ in $40 - 53 mm$ diameter solenoid apertures and for various relative positions of the torsion axis and test bodies (approximately 30$g$ by mass) with respect to the solenoid walls. One of two coordinates of the vector $A_g$ direction, the right ascension $\alpha \approx 270^\circ \pm 7^\circ$ (second equatorial system)\(^{\ddagger}\) was revealed, whereas the second coordinate, the declination $\delta$, failed to be found experimentally for lack of strong magnetic system with horizontal axis of symmetry.

The vector $A_g$ declination could be evaluated from astrophysical observations. As the Sun has a strong magnetic system with vector potential always directed (in some region) toward $A_g$, the Sun has to move, under the influence of the new force, in direction of $A_g$ relative to the nearest stars [11,12]. This direction (the Sun’s apex) is known [13] to have the coordinates $\alpha \approx 270^\circ$, $\delta \approx 30^\circ$. In Ref. \(^{\ddagger}\) the Sun’s motion was modelled with the aid of a superconducting magnetic system, but only the angle $\alpha \approx 270^\circ - 300^\circ$ had been measured, which was in quali-

\(^{\dagger}\) The former name is “one-dimensional discrete magnetic fluxes”.

\(^{\ddagger}\) Further, all astrophysical coordinates will be indicated only in this coordinate system.
tative accord with the Sun’s apex coordinate α. The declination of $\mathbf{A}_g$ was estimated too by a revealed anisotropy of solar flare distribution over the Sun’s surface, which flares are associated, as is known, with floating up of magnetic flux tubes to the surface of the Sun under the action of buoyancy force. This anisotropy turned out to be around 8σ where σ corresponds to the uniform distribution of solar flares over the Sun’s surface, therewith $\alpha \approx 277^\circ, \delta \approx 38^\circ$ for it. The anisotropy effect is attributed to action of the new force on a magnetic flux tube during its floating up.

In this paper an attempt is made to determined the coordinates α and δ of the vector $\mathbf{A}_g$ direction in terrestrial conditions with the aid of a stationary high-accuracy quartz gravimeter.

II. THE DEFINITION OF THE PROBLEM AND EXPERIMENTAL PROCEDURE.

As an experimental set-up, the tide gravimeter developed in the Sternberg astronomical Institute of Moscow University on base of a standard quartz gravimeter "Sodin" (Canadian production) and described in more detail in Refs. 11–13, was used. The experimental investigations were carried out in a specialized gravimetric laboratory. The gravimeter was placed in an underground room on a special foundation separated from that of the building. A schematic diagram of a quartz sensitive system is shown in Fig.1. Its main component is a quartz lever 1 (2cm in length with a platinum mass $m = 0.05g$) suspended on torsion quartz fibres 2 and additionally off-loaded by a vertical quartz spring 3. Such a construction gives to the device high sensitivity to changes in gravity up to $1\mu$Gal ($10^{-8}m/s^2 = 10^{-9}g, g$ is free fall acceleration) as well as sufficient protection against microseismic disturbances. The optical recording system comprises a galogen lamp 4 fed from a high-stabilized power source, light of which lamp enters into the instrument through the objective lens 5 with the aid of optical fibers. The quartz rod 6 welded to the level is a cylindrical lens, it forms an image of the point light source, which falls further on a photosensor rule 7 with a sensitivity on the order of $1\mu m$. The digital signal from the photosensor rule output enters further through a special interface to a computer which executes preliminary processing and averaging of data over the interval of 1 min. The accuracy of minute’s data is $(0.5 – 1.2) \times 10^{-9}g$ depending on the microseismic noise level varying considerably in the course of a day. The sensitive system of the instrument includes some additional units (not shown in Fig.1) protecting it from thermal, electrostatic, and atmospheric pressure disturbances. Calibration of the instrument is carried out by the inclination procedure with an accuracy of about $(0.5 – 1.0)\%$ which is quite sufficient for the experiment being considered. The amplitude of constantly recorded by the device changes in gravity due to Moon-Sun tides and corresponding Earth’s deformation, is $(50 – 200) \times 10^{-9}g$, which allows to evaluate magnitudes of possible anomalous effects against the background of tides. To measure the new interaction by the Sodin gravimeter, a constant magnet (60mm in diameter, 15mm in height, the field $B$ in the center of 0.3T) was attached to it in such a way that the vector potential lines of the magnet in the vicinity of a test platinum weight (see Fig.1) should be directed perpendicular to the Earth’s surface (i.e. towards the vertical component of the vector $\mathbf{A}_g$), since it was assumed on base of astrophysical data (see above) that the declination δ for $\mathbf{A}_g$ is around $30^\circ – 38^\circ$.

In Fig.2 the technical diagram of the experiment is presented. If the declination δ of the vector $\mathbf{A}_g$ is near $30^\circ$, two nearly opposite positions of the gravimeter will arise (for the latitude of Moscow (≈ 56°)) during Earth’s daily rotation as associated with the arrangement of the gravimeter sensitivity axis with respect to the vector $\mathbf{A}_g$ (see Fig.2: positions A and B). In the position A, the new force $\mathbf{F}$, hypothetically collinear with $\mathbf{A}_g$, will be directed along the sensitivity axis of the gravimeter, whereas in the position B it will be perpendicular to this axis. If the values of δ measured should be much more or less than $30^\circ$, the new force may manifest itself in the position B, too. To estimate the magnitude of the new force $\mathbf{F}$, acting on the test platinum weight of mass 0.05g, the following formula was used [12]:

$$|\mathbf{F}| = 2N\Phi m_{\nu\nu}c_0^2 \frac{1}{A_g} \frac{\partial \Delta A}{\partial x_1} \left(1 - \frac{\Delta A}{A_g}\right),$$  \hspace{1cm} (1)

where $N$ is a number of stable particles (protons, neutrons, electrons) in the test body; $m_{\nu\nu}c_0^2$ is the minimum residual potential energy of four-contact interaction of byuons forming the interior space of an elementary particle, which is identified with the rest mass of a pair “electron neutrino-antineutrino” (≈ 33eV); $\Phi = \frac{e^2}{\hbar c} \frac{\partial}{\partial x_1}$ is part of energy $m_{\nu\nu}c_0^2$ which can be acted upon by vector potential of the magnetic system $\mathbf{F}$; $e$ is the elementary electron charge; $h$ and $c_0$ being the Planck’s constant and light speed, respectively; $x_0 = 10^{-17}cm$; $c_0 t^* \approx 10^{-13}cm$; $\Delta A/A_g$ is the derivative of variation of $\mathbf{A}_g$ modulus due to vector potential of the constant magnet at the location point of the platinum weight, over the spatial coordinate in direction of the detector (the potential $\mathbf{A}$ was calibrated so that its magnitude on the axis of the constant magnet should be zero).

In our case, it was assumed that

$$\frac{\partial \Delta A}{\partial x_1} \approx \frac{B_1 r_1 - B_2 r_2}{\Delta x} \approx 10 \text{ CGSE units},$$

where $B_1$ and $B_2$ are, respectively, the magnitudes of magnetic field at the location points of the platinum weight and detector (point ”O” on the quartz fibre of
the gravimeter (Fig.1)); \( r_1, r_2 \) are distances from the axis of the constant magnet to the platinum weight and point “O”, respectively; \( \Delta x \) is the distance between the platinum weight and point "O". The estimating calculations by the formula (1) show that the constant magnet is capable to create \( F \approx 10^{-10}N \). With the Moon tide amplitude equal, on the average, to \( 10^{-7}g \), the gravitational force of Moon is around \( 10^{-10}N \), too. Therefore, at first glance, the force \( F \), created by a constant magnet, may be measured with the aid of the gravimeter. But, as is shown by experiments [1-5] and calculations of the Sun’s motion velocity in its apex direction under the action of the force \( F \) [11-12], the formula (1) gives by an order of magnitude higher magnitude of the force \( F \), because it does not take into account nonlinearity of the \( (\Delta A - \text{dependence of mass change and nonlocal character of the phenomenon itself} [12] (\text{point. “O” in Fig.1}) \) and test body). In Refs. [13,14] the following expression for \( F \) is given, which accounts for nonlinearity of interaction and estimates its nonlocality:

\[
F = -2N \Phi m v_c c^2 \lambda(\Delta A) \frac{\partial \lambda(\Delta A)}{\partial \Delta A} \frac{\partial \Delta A}{\partial x_1} A_g, \tag{2}
\]

where

\[
\lambda(\Delta A) = \sum_{k=1}^{\infty} \lambda_k \exp \left\{ - \frac{\Delta A}{A_g} \frac{r}{\Delta x} \left( \frac{1}{\Phi} \right) \right\} \Delta A^k,
\]

\( \lambda_k \) are dimensional coefficients of the set; \( r \) is the mean radius between the test body and the point "O" (Fig.1) measured from the axis of constant magnet. The theoretical computations by formula (2) agreed satisfactorily with experiments [13,14]. It can be shown that at \( k = 1 \), the magnitude \( F \sim \Delta A \frac{\partial \Delta A}{\partial x_1} \). Therefore, in connection with that there exists actually, in the vicinity of the Earth, certain summary potential \( A_g \) equal to the sum of \( A_g \) and magnetic field potentials of Earth \( (A_E \approx 10^5 \text{ CGSE units}) \), Sun \( (A_S \approx 10^6 \text{ CGSE units}) \), Galaxy \( (A_G \approx 10^{11} \text{ CGSE units}) \) etc., and defined by some law yet unknown, and that fluctuations of these huge potentials are possible, one might hope the force \( F \) to be measured by a gravimeter with a constant magnet. Therewith \( \Delta A \) should be created by some natural sources, and \( \frac{\partial \Delta A}{\partial x_1} \) should by a constant magnet attached to the gravimeter, since \( A_g \) from spatial sources varies at immensely long distances, with an infinitesimal value of \( \frac{\partial \Delta A}{\partial x_1} \) at a point of the gravimeter location.

### III. EXPERIMENTAL RESULTS.

In Fig.3 a typical recording from the Sodin gravimeter with the constant magnet, obtained at the period between Dec. 29, 95 and Jan. 5, 96 is shown. The major deflections of the gravimeter, being repeated every 24 hours, are associated with the Moon’s pull of gravity. Denote an average amplitude of Moon tide by \( L \), an amplitude of accidental events, recorded by gravimeter and corresponding to an increase in pull, by \( kL^+ \), and that corresponding to a decrease in pull, by \( kL^- \), where \( k \) is a factor indicating the value of deflection in terms of Moon tide amplitudes. The event recorded on Dec. 30, 1995, at 15.00 (Fig.3) correspond to a local stroke in Moscow, for example, machinery in building (local earthquake); the event of Jan. 01, 1996 (10.30) was caused by a planetary earthquake. As is seen from Fig.3, both events are oscillatory in character. The event of Jan. 2, 96 recorded at 10.36 (here and below the local solar time is used), is uncharacteristic as of an earthquake signal so of any other known disturbance having been encountered earlier when operating with a Sodin gravimeter (noises in power, electronics, transition jumps in quartz, etc.). The time interval of this event was 2 min, amplitude nearly 0.2\( L^+ \). In a time of 2 minutes a pull smooth increasing took place, and the readings of the gravimeter returned to a normal Moon tide curve. Fig.4 shows the results of an uninterrupted experiment from Feb. 24 to Mar. 22, 96. Three events were documented: on the 28th of February, at 10.05; 4th of March, at 10.58; 18th of March, at 20.54. Two last of them had a huge amplitude (13.6\( L^- \) and 15.2\( L^- \), respectively) and \( \Delta t \approx 10 \text{ min} \). A time profile of the event on 18th of March, 1996, is shown in Fig.5 at a more large scale of time. As is seen from this figure, in a time of nearly 10 min a smooth moderation of the Earth’s gravitational pull on the platinum weight of gravimeter took place, and then the gravimeter readings returned to the Moon tide curve. Similar is the event on 4th of March. In 1994-96 years, the experiments with the Sodin gravimeter and magnet attached to it were interrupted. From 13th of April, 1996 the experiment in consideration goes uninterrupted. Its procedure was improved: close by the gravimeter considered another one was located, with no magnet. The first one recorded an event with an amplitude of 1.8\( L^+ \) and \( \Delta t \approx 2 \text{ min} \) on 19th of April, 1996, at 7.27, whereas the magnetless gravimeter has not recorded this event. The events recorded by the gravimeter with magnet are shown in Fig.6, all numerated chronologically and asterisked on year and day circles.

### IV. DISCUSSION.

The smooth minute’s variations recorded by Sodin gravimeter with magnet cannot be due to known noises in this instrument as well as due to known external factors like earthquakes. Therefore, these recordings are proposed by us to be attributed to manifestation of the new interaction in accordance with the experimental procedure above considered. It should be noted once again that the event on 19th of April, 1996 (7.27) being recorded by the gravimeter with magnet, has not been documented by the magnetless instrument. As is seen
from Fig.6, eleven events of the twelve recorded locate in a sector Δ, which confirms, in accord with above methodology, the value preserved of the δ-coordinate for the vector \( \mathbf{A}_g \) equal to 30° – 38°. The only event 11 (Fig.6) with the greatest deflection amplitude of the Moon tide curve (≈ 15.2L ), falls within the sector B. The event 10 with an amplitude of about 13.6L therewith was yet in the sector Δ, i.e. in the course of the event 11, such a change in vector \( \mathbf{A}_\Sigma \) direction occurred that the gravimeter, when in position B, recorded a force directed up from the Earth’s surface. Hence, the coordinate δ increased up to δ = 34° which magnitude may be taken as a coordinate for the vector \( \mathbf{A}_g \) if it assumed to be parallel with \( \mathbf{A}_\Sigma \). It is also seen from Fig.6 that there was no events between the groups of events 3, 4, 6 and 1, 2, 5, 7, 9, 10. Absence of events in this angular sector may be explained by that the derivative \( \frac{\partial \mathbf{A}_g}{\partial x} \) (1, 2) equals zero in the region of the maximum decrease in the vector \( \mathbf{A}_g \) magnitude due to the potential \( \mathbf{A}_\delta \), which decrease being associated with some cosmic event changing its right ascension coordinate α (extremum point), hence the force \( \mathbf{F} = 0 \) precisely in direction of \( \mathbf{A}_g \) and increases drastically on both sides of this direction. Therefore, the formula (2) gives only an approximate direction for \( \mathbf{F} \) assuming \( \mathbf{F} \parallel \mathbf{A}_g \). Fig.6 shows clearly the angle α for the vector \( \mathbf{A}_g \) to be around 270°. This result corresponds completely to all previous experimental researches [1-5] as to astrophysical observations [6,7]. Based on data of IZMIRAN institute for the Earth’s magnetic surrounding, an investigation was carried out by us to find a synchronisation of the events recorded with such known phenomena as magnetic storms, solar flares, crossing by the Earth the boundaries of Sun’s magnetic field sectorial structure, i.e. with those phenomena capable to produce considerable changes in vector \( \mathbf{A}_g \) magnitude. The investigation has shown that in this time there was no solar flares, and none of the events corresponded to intersecting the Sun’s magnetic field sectorial structure boundaries, where, in the vicinity of the Earth, the highest electric currents may flow. The nearest events documented by us were offset by approximately one day (15th Dec., 1994) and two days (4th of March, 1995) from the well ascertained polarity change time point of the sectorial magnetic field. Only two events (15th Dec., 1994 and 19th of Apr., 1995) correspond, with an accuracy of the nearest day, to weak magnetic substorms on Earth. Therewith the event on 19th of April, 1994, coincides, to an hour, with the origin of a magnetic substorm, which could not cause a change of \( \mathbf{A}_g \) magnitude more than 10⁶CGSE units. It should be noted that the four events observed from 18.12.95 till 21.12.95, inclusive (see Fig.6), preceded a phenomenon of a shock wave type in solar corona which was recorded by radio-frequency emission. Hence, the events of a minute’s duration, recorded by us, do not correspond to usual magnetic phenomena near the Earth recorded by measuring magnitudes of magnetic field B. We believe therefore to have discovered a fundamentally new natural information channel predicted in Refs. [11,12,13,14] and associated with physical space structure changes caused by \( \mathbf{A}_\Sigma \) variations measured by a gravimeter as manifestations of a new force. \( \mathbf{A}_\Sigma \) may vary, for instance, due to disturbances of the toroidal component of the Sun’s magnetic field from which \( B = 0 \) in Earth’s orbit but the vector potential exceeds 10⁶CGSE units, or due to some yet unknown events in Galaxy and Universe. The experiments on the new force investigation by gravimeter are being continued. The authors are grateful to L.S.Kuzmenkov for the discussion of the results obtained, as well as to V.N.Ishkov for data presented on near Earth magnetic conditions, and to V.D.Jushkin for assistance in experimental work.

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Fig.1 Sensitive system of the Sodin quartz gravimeter:
1 - beam,
2 - horizontal quartz wires suspension system,
3 - main spring,
4 - lamp,
5 - object lens,
6 - beam,
7 - CCD-SCALE,
8 - prism,
9, 10 - thermocompensator,
11, 12, 13, 14 - micrometric compensation mechanism,
15 - constant magnet.

Fig.2 Methodological diagram of the experiment:
1 - Earth’s surface,
2 - gravimeter,
3 - sensitivity axis of the gravimeter,
\( \phi \) - Moscow latitude.

Fig.3 Readings of the gravimeter from Dec. 29, 1995 to Jan. 05, 1996, inclusive.
y - the displacement of platinum weight.
One division is equal to 0.1\( \mu \) and corresponds to 0.2\( \mu \)Gal;
x - time (in minutes).

Fig.4 Readings of the gravimeter from the 24th of February to the 22nd of March, 1996, inclusive.
y - the displacement of platinum weight.
One division is equal to 0.1\( \mu \) and corresponds to 0.2\( \mu \)Gal;
x - time (in minutes).

Fig.6 Total combination of events recorded by the gravimeter with constant magnet:
1 – 15.12.94(13.42)(0.9\( L^- \), \( \Delta t \approx 10min \));
2 – 18.12.95(14.02)(0.06\( L^+ \), \( \Delta t \approx 2min \));
3 – 19.12.95(10.46)(0.07\( L^- \), \( \Delta t \approx 2min \));
4 – 21.12.95(10.00)(0.05\( L^- \), \( \Delta t \approx 2min \));
5 – 21.12.95(13.29)(0.1\( L^+ \), \( \Delta t \approx 2min \));
6 – 02.01.96(10.36)(0.2\( L^+ \), \( \Delta t \approx 2min \));
7 – 08.01.96(15.36)(0.8\( L^+ \), \( \Delta t \approx 2min \) (main peak),
total time \( \approx 15min \));
8 – 09.01.96(11.48)(0.7\( L^- \), \( \Delta t \approx 2min \) (main peak),
total time \( \approx 10min \));
9 – 28.02.96(10.05)(0.125\( L^- \), \( \Delta t \approx 2min \));
10 – 04.03.96(10.58)(13.6\( L^- \), \( \Delta t \approx 10min \));
11 – 18.03.96(20.54)(15.2\( L^- \), \( \Delta t \approx 10min \));
12 – 19.04.96(07.27)(1.8\( L^+ \), \( \Delta t \approx 2min \)).
Fig. 2
