

# The Hubble Law and Gravity as Manifestations of Linear Measurement Standards Variability

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## Abstract

An approach to study universe simulators based on the idea of linear measurement standards variability is discussed. It permits us to develop free of contradictions simulators of the universe, describing the Hubble law and gravity as manifestations of linear measurement standards variability. The latter allows us to interpret gravity also as manifestation of reaction forces in the anisotropic medium thus giving us a possibility to control gravity as well as conditions of experiments for its verification: the paper describes statement and results of our experiments which are based on the use of charged deployed capacitors and a high voltage for gravity control and for optimization of the experimental conditions.

*Keywords:* Deployed capacitor; Universe simulation; Experimental verification; Gravity; High voltage

## 1. Introduction

Any measurement in the natural sciences, such as geography, physics, chemistry, biology, geology, etc., is based on the use of measurement standards and it is generally accepted that the most important feature of any measurement standard is its stability: value of any measurement standard used must not be a function of time. Confidence in the stability of the measurement standards today is supported by successful applications of this paradigm in the natural sciences and in various technological processes in architecture, construction, mining, electronics, metallurgy, etc. One of the most important results of step by step usage of this approach in astronomy is in creation of the Standard Model. Its start can be considered in the seventeenth century, when Sir Isaac Newton (1667) published his famous equation of the gravitational interaction between the two physical bodies. Then after about 250 years, its development has resumed in the 20-th century.

In Germany Einstein (1915) demonstrated a new theory of gravitation based on his Theory of Relativity and on the idea of a stable universe. In the Soviet Union Friedman (1922) is credited

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with developing of dynamic equations based on the theory of Einstein resulting in an expanding universe with the linear dependence velocity/distance for the case of a uniform distribution of matter in the universe. In the late twenties of the 20-th century three important events happened, the first two confirming previous Friedman's findings, whereas the third one contradicting them: in Belgium Lemaitre (1927) published his Big Bang theory; in USA Hubble (1929) published his work reflecting linear dependence velocity/distance for the galaxies meeting Friedman's results; at the same time Zwicky (1929) proposed a "tired light principle" - an opposite approach, based on the stability of the universe.

Taking into account the Hubble Law, Einstein (1931) had to correct his theory, noting that it was possible, only if used by Hubble explanation of the redshift by the Doppler Effect was true. At the same time the Standard Model, which explains a lot of phenomena, seems to be not free of inherent contradictions and a number of works due to different reasons cast doubt on the basic concept of the Standard Model - expansion of the universe (Laviolette, 1986; Martinez-Vaquero et al, 2009; Marosi, 2013; Wetterich, 2013). Some of these contradictions are listed below: the Hubble-Sandage paradox: composition of the Hubble Law and equal density of matter distribution in the universe if linear measurement standard is equal or exceeds  $10^9$  light years corresponds to the Friedman's results, but for the smaller linear measurement standards the distribution of matter in the universe is not uniform, whereas in these conditions Hubble's Law also holds, thus contradicting the results of Friedman; for the galaxies located at the distances not exceeding 2 - 3 Mpc. from the Centre of the Local Neighborhood, velocities do not meet the Hubble Law; all attempts to simulate dark energy distribution explaining *status quo* for the distances not exceeding 4 Mpc from the Centre of the Local Neighborhood, failed (Martinez-Vaquero et al, 2009); equal density of matter distributed in the universe if linear measurement standard is equal or exceeds  $10^9$  light years contradicts the Big Bang idea.

A common feature of those sciences and technologies which successfully use models based on the constancy of measurement standards is a relatively short measurement time and the time of data transfer to the observer: negligibly small changes of measurement standards if they occur during comparatively short time intervals are found insignificant, thus reinforcing the opinion of the constancy of standards. But one of the specific features of astronomy is a prolonged data transfer time: negligibly small changes of measurement standards during a long data transfer time can result in significant deviations leading to the contradictions in the theories based on the measurement standards stability. That is why below is developed the approach which is based on the variability of linear measurement standards for new simulators of the universe, and, simultaneously, believed to be free of the above problems with the new explanation of two phenomena i.e. the Hubble law and gravitational interactions (Groppen, 2011 - 2014).

## **2. The Hubble Law as Manifestation of Linear Measurement Standards Shortening**

Any result of measurement taken by an observer can be presented as a ratio with the actual value of the measured object in auxiliary units in the numerator and measurement standard value in the

same auxiliary units in the denominator (Groppen, 2013). Below we use this definition to determine the dependence of linear measurement standard on time. The classical formulation of the Hubble law:  $V=HL$ , where  $V$  is velocity of space object,  $H$  – the Hubble constant,  $L$  – distance fixed by an observer, due to the definition above can be transformed as follows:

$$\frac{d}{dt}\left(\frac{R}{r}\right) = H \cdot \frac{R}{r} \quad (1)$$

where:  $R$  is distance value measured in auxiliary units;  $r$  is linear measurement standard value in the same units;  $t$  is the running time;

$$L=R/r \quad (2)$$

Keeping in mind variability of a linear measurement standard (1) can be transformed as follows:

$$\frac{1}{r} \cdot \frac{dR}{dt} - \frac{R}{r^2} \cdot \frac{dr}{dt} = H \cdot \frac{R}{r} \quad (3)$$

As (3) is true for any value of  $R$ , it is also true if  $R$  is constant, thus permitting substitution of (4) by the following equation:

$$\frac{1}{r} \cdot \frac{dr}{dt} = -H \quad (4)$$

Solving (5) we get the following linear measurement standard – time relation:

$$r = r_0 \cdot \exp\{-H \cdot t\}, \quad (5)$$

where  $r_0$  is equal to value  $r$  if  $t = 0$ .

Below we use (6) to determine a distance between two points under two different conditions:

- these points belong to the same solid body;
- each point belongs to its “own” physical body.

In the first case the shortest distance between any two points of a solid body can be used as a linear measurement standard, thus equation (5) reflects the following features of any solid body:

- linear dimensions of any solid body are exponentially decreasing functions of time;
- as linear measurement standards change according to the same laws, as the measured objects, observers do not detect these changes directly.

In other words, an observer gets an illusion that the geometric parameters of physical bodies are constant.

Analyzing the second case of  $L$  distance between two space objects in coordinate system  $O_1$  as fixed by an observer when at least one of them has shortening linear measurement standard value

meeting (6), an observer at the latter, using this shortening linear measurement standard  $r$  of “his” object, will fix  $L$  distance value as growing with time:

$$L = \frac{R}{r} = \frac{R}{r_0} \cdot \exp[H \cdot t] \quad (6)$$

The time derivative of both sides of (6) allows us to transform (6) into (1), thus giving us an opportunity to explain the Hubble law not only with redshift, but also with the help of the exponential reduction of linear dimensions of solids. In other words the Hubble Law can be explained not only by the universe expansion, but, alternatively, by shortening of the linear measurement standard value. The latter, as opposed to the currently accepted Standard Model, results in a comparatively stable according to velocity/distance parameters universe.

### 3. Spontaneous Mass Loss by a Physical Body

Described above shrinking of any physical body can result either in mass loss by this body or in its mass stability. As mass “ $m$ ” of any physical body can be presented as a product of this body  $\rho$  density and its  $V$  volume:  $m = \rho \cdot V$ , intensity of this mass loss is determined as follows:

$$\frac{dm}{dt} = \rho \frac{dV}{dt} + V \frac{d\rho}{dt}. \quad (7)$$

Below we assume that mass density of any physical body  $A$  is inseparably connected to its spontaneous mass emission towards the points nearest to  $A$ , in which the density is lower with the emission intensity towards  $\varphi$  direction depending on the difference of density at the surface of  $A$  body and in the near proximity to it in  $\varphi$  direction and in the first approximation true is the following equation:

$$\frac{d\rho}{dt} = q \cdot \rho, \quad (8)$$

where “ $q$ ” is an unknown coefficient.

As any physical body can be used as a linear measurement standard, due to (6) true is the following equality:

$$\frac{dV}{dt} = -3 \cdot H \cdot V. \quad (9)$$

Substituting (8) and (9) in (7) we have:

$$\frac{dm}{dt} = m(q - 3H). \quad (10)$$

Solving (10) results in the following mass/time relation:

$$m = m_0 \cdot \exp\{[q - 3 \cdot H] \cdot t\} \quad (11)$$

where  $m_0$  is equal to  $m$  if  $t = 0$ .

To determine coefficient “ $q$ ” value below we describe the energy  $E$  of a photon in two different ways, the first one corresponding to the  $E$  energy – depletion interpretation of the “tired light cosmology” (Laviolette, 1986), whereas the second one reflecting mass-energy relation:

$$\begin{cases} E = E_0 \exp\{-Ht\} \\ E = mc^2 \end{cases} \quad (12)$$

System (12) and equation (11) combination results in  $q = 2H$  and in the following equation:

$$m = m_0 \exp\{-Ht\} \quad (13)$$

reflecting exponential mass loss by any physical body.

#### 4. Gravity as a Sum of Reaction Forces

According to the above assumptions, shrinking of any physical body results in its’ spontaneous mass loss. This mass loss in  $\varphi$  direction should lead to the forces of reaction proportional to the difference between the density at the surface of this body and in the near proximity to it in  $\varphi$  direction. It is easy to prove: if the space adjacent to such physical body is isotropic and this body does not experience any external effect, then the sum  $F$  of reaction forces in each unit of its surface  $F_s$  is equal to zero (Groppen 2012):

$$F = \oint F_s ds = 0. \quad (14)$$

As opposed to a single material point in the isotropic medium, two losing mass material points A and B with masses  $m_A$  and  $m_B$  located at  $L$  distance from each, create anisotropic medium round each of them. Thus reaction force  $F$  in any of these points depends on two factors: on the mass flow from one point which reaches another point, and on the emitted mass of the latter. Using polynomial for  $F$  value modeling and keeping in mind that equality to zero of mass of any of these bodies according to (14) results in equality to zero of reactive force  $F$ , true is the following system:

$$F = \sum_{i=0}^{\infty} \sum_{j=0}^{\infty} k_{i,j} \left( \frac{1}{4\pi L^2} \cdot \frac{dm_A}{dt} \right)^i \left( \frac{dm_B}{dt} \right)^j; \quad \forall j: k_{0,j} = 0; \quad \forall i: k_{i,0} = 0. \quad (15)$$

In the first approximation, when the indices “ $i$ ” and “ $j$ ” do not exceed “1”, keeping in mind (15), system (15) can be substituted by the following equation:

$$F = \frac{k \cdot H^2 \cdot \exp(-2H)}{4\pi} \cdot \frac{m_A m_B}{L^2} \quad (16)$$

where  $k = k_{1,1}$ .

Comparison of (16) with the Newton's gravity law permits us:

- to interpret gravitation as reaction forces imbalance caused by the physical objects mass loss in the anisotropic medium;
- to determine the "k" coefficient value:

$$k = \frac{4\pi\gamma}{H^2 \cdot \exp(-2H)}. \quad (17)$$

To determine the  $V$  velocity of the lost mass particles, Meshchersky equation can be used (Miele, 1962):

$$V = \frac{F \cdot c}{\sqrt{F^2 + H^2 m^2 c^2}} \quad (18)$$

where  $F$  is equal to the reaction force, coinciding with the force of gravitational interaction.

According to the experimental results shown below in the seventh paragraph the value of  $V$  is close to the velocity of light " $c$ ". To verify suggested above interpretation of the forces of gravitational interaction a series of experiments was made, which are described in Groppen (2013 – 2014). Due to low value of interaction forces fixed during these experiments the purpose of the experiments described below is optimization of geometry of deployed capacitors which are used for the control of gravity forces allowing to increase these forces.

## 5. Gravity Control Experiment Conditions

The main idea of gravity control below includes the following points (Groppen 2014): distribution of energy of charged deployed capacitor which is referred below as a physical body "A" in the neighborhood above it; creation of mathematical model in which this energy is substituted by the physical body "B" with an equivalent mass i.e. force of the gravitational interaction of these bodies  $F_L$  is directed opposite to the direction of the  $F_E$  force of gravitational interaction of body "A" with the Earth therefore reducing the weight of "A" body (Fig. 1a).

As mentioned above as body "A" samples and, simultaneously, generators of stored energy distributed above the upper surface of these samples during the experiments are used horizontally positioned deployed capacitors (Fig. 1b,c) connected to the high voltage power supply (Fig. 2,1). The energy  $E_A$  above such "A" body is equal to:

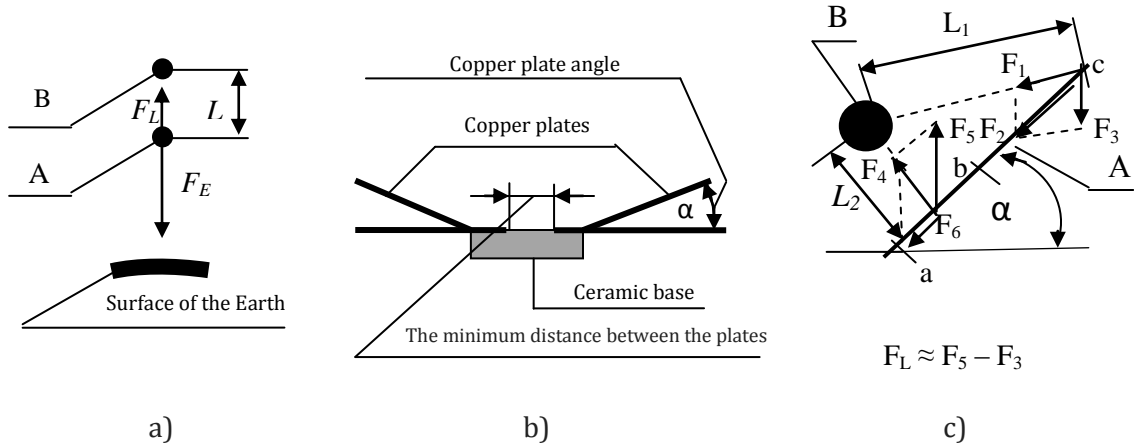
$$E_A = \frac{C_A U^2}{2} \quad (19)$$

where " $C_A$ " is the capacity of a charged "A" body-capacitor, " $U$ " - power supply voltage.

Due to the relationship  $E = mc^2$  the corresponding lifting body "A" force  $F_L$  value in accordance with (19) is determined by the Law of gravity:

$$F_L = \gamma \frac{m_A C_A U^2}{2L^2 c^2} \quad (20)$$

where “ $\gamma$ ” - gravitational constant, “ $L$ ” - distance between the “A” and “B” bodies (Fig. 1a).



The directions of forces of interaction of “A” body with “B” body and with the Earth.

The main features of the design of deployed capacitors used (the end view).

The lifting force  $F_L$ , acting on each plate of deployed capacitor “A”, as a result of  $F_1$  and  $F_4$  forces of gravitational interaction of its parts with body B.

**Fig. 1.** Schemes of use, design and determination of lifting force of deployed capacitors

From (20) it follows that the lifting force  $F_L$  depends on two parameters: on the energy of the capacitor and on the distance  $L$ . Dividing each copper plate of deployed capacitor (Fig. 1b) on “ $n$ ” strips of mass  $\Delta m_i$  ( $i = 1, 2, \dots, n$ ), it is easy to show that the lifting force  $F_L$  is equal to:

$$F_L = \sum_{i=1}^{i=n} F_{L_i} \quad (21)$$

where  $F_{L_i}$  - the lifting force generated by the  $i$ -th strip (at Fig. 1, c value “ $n$ ”=2, the ends of these strips are the segments “ab” and “bc”). The number and value of oppositely directed vectors  $F$  depends on the distance  $L$  and on angle  $\alpha$  reflecting inclination of copper plates of a deployed capacitor with respect to the horizontal plane. According to (20) forces  $F_1$  and  $F_4$  values in Fig. 1c can be described as follows:

$$F_1 = \gamma \frac{m_1 C_1 U^2}{2L_1^2 c^2} \quad (22)$$

$$F_4 = \gamma \frac{m_2 C_2 U^2}{2L_2^2 c^2} \quad (23)$$

where all the components with index "1" correspond to the strip with end "bc", whereas the components with index "2" are associated with the strip end "ab".

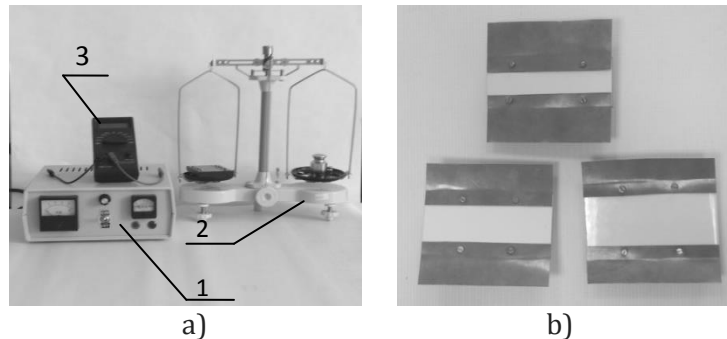
It is easy to see that the lifting force  $F_5 = F_4 \cdot \text{cosec}(\alpha)$  as well as force  $F_4$  increase with growth of angle  $\alpha$ , but simultaneously opposite directed force  $F_3$  grows. Since the total lifting force  $F_L$  is equal to a difference  $F_5 - F_3$ , this force also depends on the angle  $\alpha$ . Thus this angle can be used as a tool to control the value of  $F_L$  and the aim below is to determine conditions – voltage  $U$  and angle " $\alpha$ " values maximizing  $F_L$  value, *ceteris paribus*.

Denoting  $F_e^0$  the weight of a capacitor before experiment whereas  $F_e^1$  - its weight during experiment when the electrodes on its surface are applied to voltage equal to  $U$ , it is easy to determine the value of lifting force  $F_L$ :

$$F_L = F_e^0 - F_e^1. \quad (24)$$

## 6. Equipment, Experiments Statement and the Results Obtained

To verify the assumptions above a series of experiments was set up in which were used deployed capacitors each consisting of two broad copper strips on the upper side of ceramic plate (Fig. 1b, Fig. 2 b) with capacity 3 – 10 pf. depending on length of these strips and distance between them. During experiments capacity of each sample was determined by tester CM7115A allowing accuracy of measurements up to 0.1 PF (Fig. 2a, 3), then each sample-capacitor was connected to the high voltage power supply IVNR-20/10 guarantying voltage range 1 – 20 kV, power 200 wt. (Fig. 2a, 1) and installed on the cap of mechanical precision scale AB-200 with maximum weight equal to 200 gram and precision equal to 0.001 g (Fig. 2a, 2).



a) Power supply (1), scale (2) and tester for electric capacity measuring (3)

b) Deployed capacitors with different distances between the cooper plates: top view

**Fig. 2.** Equipment (a) and deployed capacitors (b) used during the experiments



The scheme of each experiment over deployed capacitor with fixed angle  $\alpha$  of copper plates includes the following steps:

1. A capacitor is installed on the left weighing pan of precision mechanical scale AB-200 and balanced. Its weight is equal to  $F_e^0$ .
2. High voltage generated by the power supply IVNR-20/10 is applied to the capacitor, thus unbalancing scale AB-200.
3. Balance is restored by removing part of the weights from the right weighing pan of the scale AB-200. New weight of capacitor is equal to  $F_e^1$ .
4. Equation (24) is used for lifting force  $F_L$  determination.

Optimal geometry design for each deployed capacitor below means determination of voltage and angle  $\alpha$ , maximizing lifting force  $F_L$ . It includes the following stages:

1. For each capacitor with fixed i-th value of the angle  $\alpha$ , coefficients of polynomial, describing dependence of force  $F_L$  value on voltage  $U$  are determined:

$$\forall i: F_L(U, \alpha_i) = \sum_{j=0}^{j=2} k_{i,j} U^j \quad (25)$$

2. For each j-th coefficient of polynomial (25) is determined dependence of this coefficient value on the angle  $\alpha$  of inclination of the expanded capacitor copper plates to the horizontal plane:

$$\forall j: k_j = \sum_{t=0}^{t=2} q_{t,j} \cdot \alpha^t \quad (26)$$

3. After substitution of (26) in (25) analytically are determined optimal values of voltage  $U$  and angle  $\alpha$ , maximizing  $F_L$  value.

Below the first step of this technology of optimal deployed capacitors design is illustrated for the sample with weight equal to 78.1 gram and capacity  $C = 3.9$  pF. The experimental dependences reflected by the second-order polynomials of system (27) are received during the experiments with the voltage  $U$  range  $8 \text{ kv.} \leq U \leq 20 \text{ kv.}$  and angle  $\alpha$  range  $0^\circ \leq \alpha \leq 75^\circ$ :

$$\begin{cases} F_L(U, 0^\circ) = - 5.606849 \cdot 10^{-5} + 9.372896 \cdot 10^{-9} \cdot U - 2.3 59637 \cdot 10^{-13} \cdot U^2; \\ F_L(U, 15^\circ) = - 2.187184 \cdot 10^{-4} + 3.70103 \cdot 10^{-8} \cdot U - 1.171214 \cdot 10^{-12} \cdot U^2; \\ F_L(U, 30^\circ) = 1.365225 \cdot 10^{-4} - 2.327098 \cdot 10^{-8} \cdot U + 1.004177 \cdot 10^{-12} \cdot U^2; \\ F_L(U, 75^\circ) = - 9.719616 \cdot 10^{-5} + 1.504437 \cdot 10^{-8} \cdot U - 5.762575 \cdot 10^{-13} \cdot U^2. \end{cases} \quad (27)$$

At this stage the mean relative deviation of lifting force experimental and analytical values does not exceed 25%. In the second step, the least squares method and system of equations (27) are used to search the second-order polynomials reflecting dependences of system (25) coefficients  $k_j$ , ( $j = 1, 2, 3$ ) on angle  $\alpha$  value:

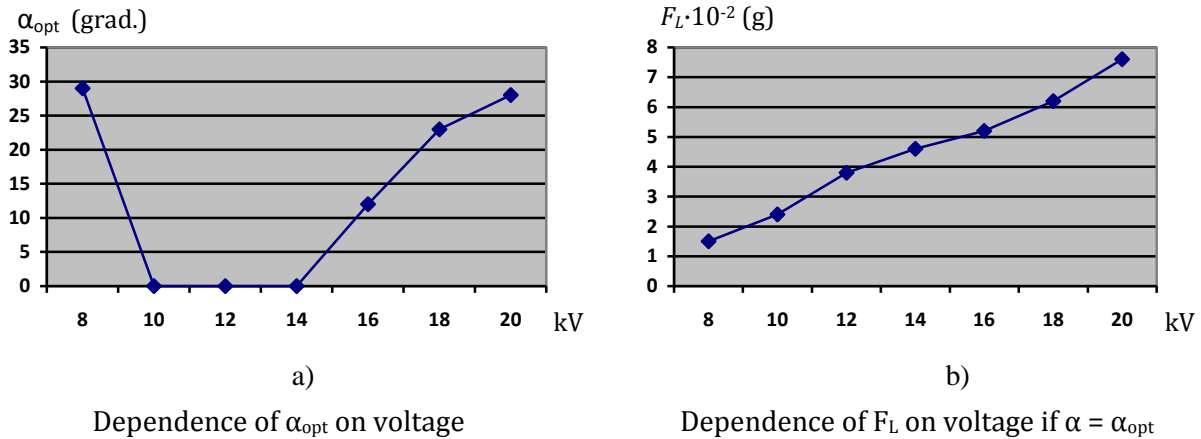
$$\begin{cases} k_1 = -1.291076 \cdot 10^{-4} + 7.602323 \cdot 10^{-6} \cdot \alpha - 9.352698 \cdot 10^{-8} \cdot \alpha^2; \\ k_2 = 2.19204 \cdot 10^{-8} - 1.269118 \cdot 10^{-9} \cdot \alpha + 1.532739 \cdot 10^{-11} \cdot \alpha^2; \\ k_3 = -6.7967321076 \cdot 10^{-13} + 5.088674 \cdot 10^{-14} \cdot \alpha - 6.46965 \cdot 10^{-16} \cdot \alpha^2. \end{cases} \quad (28)$$

In this case the relative deviation does not exceed 5%.

Thus the experimental dependence of the lifting force  $F_L$  on the voltage  $U$  and on the angle  $\alpha$  is defined by the following system:

$$\begin{cases} F_L = -1.291076 \cdot 10^{-4} + 7.602323 \cdot 10^{-6} \cdot \alpha - 9.352698 \cdot 10^{-8} \cdot \alpha^2 + (2.19204 \cdot 10^{-8} - 1.269118 \cdot 10^{-9} \cdot \alpha + 1.532739 \cdot 10^{-11} \cdot \alpha^2) \cdot U - (6.796732 \cdot 10^{-13} - 5.088674 \cdot 10^{-14} \cdot \alpha + 6.46965 \cdot 10^{-16} \cdot \alpha^2) U^2; \\ 8000 \leq U \leq 20000; \\ 0^\circ \leq \alpha \leq 75^\circ. \end{cases} \quad (29)$$

At the third step from (29) it follows that the optimum value of  $\alpha$  depends on voltage value: if  $U$  value exceeds 15 kV, then angle  $\alpha_{opt}$  maximizing  $F_L$  value exceeds zero ceteris paribus (Fig. 3,a), whereas the dependence of lifting force on the voltage if  $\alpha = \alpha_{opt}$  was almost linear (Fig. 3, b).



**Fig. 3.** Experimental dependences of the optimal value of the angle  $\alpha$  and of the corresponding lifting force value on the power supply voltage.

During the experiments in some cases, the use of the optimum angle  $\alpha$  value resulted in doubling of the lifting force.

## 7. Conclusions

The above analyses and experimental data lead to the following five conclusions:

The Hubble Law can be interpreted as a reflection of a comparatively stable universe according to velocity/distance parameters, whereas used by an observer linear measurement standards are

exponentially shortening with time; spontaneous mass loss by physical bodies can also be explained by the exponential reduction of linear measurement standard in time; charged deployed capacitors can be used to control the forces of gravitational interaction; optimal geometry of charged deployed capacitor permits to increase its lifting force *ceteris paribus*; for further experiments high voltage power sources with a wider range of voltages should be used.

The difference between the investigated above approach and the effect of Biefeld-Brown (Tajmar, 2004) should be noted: changing the power supply polarity during experiments did not lead to a change in the direction of the interaction forces; in the experiments were used deployed capacitors with identical electrodes.

However, to eliminate the influence of charged particles motion in the air, creating the Biefeld-Brown effect on the lifting force, a series of control experiments should be carried out in vacuum.

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## References

- Einstein, A. (1915). The theory of relativity. Die Physik, Under reduction of E. Lechner, Leipzig, T. 3, pp. 703 – 713, (Ger.)
- Einstein, A. (1931). About the cosmological Problem of General Theory of Relativity. Sitzungsher. preuss. Akad. Wiss., phys.-math. (K1, pp. 235 – 237), (Ger.)
- Friedman, A. (1922). On the Curvature of Space. Z. Phys. (**10** (1), pp 377–386), (Ger.)
- Groppen, V.O. (2011). Shrinking Planets Illusions. In Recent Researches in Communications, Automation, Signal Processing, Nanotechnology, Astronomy and Nuclear Physics. (pp. 95-98) Cambridge, UK.
- Groppen, V.O. (2012). Spontaneous Mass Loss as a Tool of Gravity Control. In Recent Advances in Systems Science & Mathematical Modeling. Proceedings of the 3-rd International Conference on Mathematical Models for Engineering Science (MMES'12). (pp. 85 – 89) Paris, France.
- Groppen, V.O. (2013). Features of the Universe Simulators Based on the Variability of Time Measurement Standards. In Recent Advances in Robotics, Aeronautical & Mechanical Engineering (pp. 149 – 154) Athens, Greece.
- Groppen, V.O. (2013). Manifestations of Measurement Standards Variability in the Universe Modeling. Lambert Academic Publishing, Saarbrucken.
- Groppen, V.O. (2014). Control of the Forces of Gravity: Modeling and Experimental Verification. In WSEAS Transactions on Applied and Theoretical Mechanics, ISSN / E-ISSN: 1991-8747 / 2224-3429, Volume 9, (pp. 215-221), Art. #19.
- Hubble, E.P. (1929). A relation between distance and radial velocity among extra-galactic nebulae, In Proceedings of the National Academy of Sciences of the United States of America, (Vol. 15, no. 3, pp. 167–173).
- Klimishin, I.A. (1983) Relativistic Astronomy. M.: Science Publishers (Russ).

- Karatchentsev, I., Chernin, A. The islands in the ocean of dark energy.  
[http://wsyachina.narod.ru/astronomy/dark\\_energy\\_4.html](http://wsyachina.narod.ru/astronomy/dark_energy_4.html) (Russ).
- Laviolette, P. A. (1986). Is the universe really expanding? *Astrophysical Journal*, Part 1, (vol. 301, pp. 544-553), ISSN 0004-637X.
- Lemaître, G. (1927). Un Univers homogène de masse constante et de rayon croissant rendant compte de la vitesse radiale des nébuleuses extra-galactiques. *Annales de la Société Scientifique de Bruxelles*, (French) 47: 49. Bibcode:1927ASSB...47...49L.
- Marosi, L.A. (2013). Hubble Diagram Test of Expanding and Static Cosmological Models: The Case for a Slowly Expanding Flat Universe. *Advances in Astronomy*, Volume 2013, Article ID 917104, 5 pages, <http://dx.doi.org/10.1155/2013/917104>
- Martinez-Vaquero, L.A., Yepes G., Hoffman Y. and Gottlober G. (2009) Near Field Cosmological Simulations: Is Dark Energy Playing a Role in Our Local Neighborhood? *Proceedings of the International Conference "Mathematics and Astronomy: a Joint Long Journey"*, (pp. 166 – 174) Madrid, Spain.
- Miele A. (1962). *Flight Mechanics Volume 1: Theory of Flight Paths*. Addison-Wesley Pub., US.
- Newton, I. (1667). *The mathematical principles of natural knowledge*.
- Tajmar, M. (2004). Biefeld-Brown Effect: Misinterpretation of Corona Wind Phenomena, *American Institute of Aeronautics and Astronautics Journal*, 42: 315, DOI:10.2514/1.9095 .
- Wetterich, C. (2013). Universe without expansion. arXiv:1303.6878v3 [astro-ph.CO].
- Zwicky, F. (1929). On the red shift of spectral lines through interstellar space, *Proceedings of the National Academy of Sciences of the United States of America*, (vol. 15, no 10, pp. 773-779), US.