Time Measurement and new theories in a Clepsydra-Driven World

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Abstract- Each new theory shares the same way in science. Its appearance is based on new experimental data and theoretical researches. They thought that experimental data are more valuable than theoretical research because any data can be proven by actual measurement and mathematical calculations. They believe also that agreement between physical measurement and mathematical calculations shows total proof for any way of thought. This paper shows inadequacy of that point of view and discusses well known facts from the history of science.

Index Terms- Space, Time, Clepsydra, Gravitation, Measurement, Theory.

I. Introduction

Scientific method uses experimentation as sufficient proof for each theory. No idea in any area of modern science can be recognized as a scientific one as long as they have no experimental proofs for that theory.

As it well known, Galileo was the first person who introduced that point of view to the general population. "***Galileo Galilei*** was Italian natural philosopher, astronomer, and mathematician who made fundamental contributions to the sciences of motion, astronomy, and strength of materials and to *the development of the scientific method*. His formulation of (circular) inertia, the law of falling bodies, and parabolic trajectories marked the beginning of a fundamental change in the study of motion. His insistence that the book of nature was written in the language of mathematics changed natural philosophy from a verbal, qualitative account to a mathematical one in which *experimentation* became a recognized method for discovering the facts of nature."[1]

Following generations of the scientists used the same way for their researches and shared the same advantage and disadvantage of that method. Many times problem appeared as a fundamental contradiction between experimental data, logic and philosophy because raw data are unable to produce satisfactory explanation of a new research by themselves.

II. Galileo's way

To follow his own point of view Galileo used some instruments available to him. Those were the first attempts of humankind to "read the book of nature" by information that nature itself gives to the person who conducts an experiment. The most famous one among all Galileo's experiments was a falling bodies experiment.

Obviously any experiment in the field needs some distance for a body to fall. Moreover, each body has some duration of the entire process of free fall and that duration should be measured as well by a person who makes observations of the experiment. The primary reason for interest in that area was Galileo's desire to examine Aristotelian postulate of falling bodies. Certainly that was a prolific plan to make a comparison between a postulate produced by the human mind and experimental data that are produced by the nature itself. "Galileo demonstrated, by dropping bodies of different weights from the top of the famous Leaning Tower, that the speed of fall of a heavy object *is not proportional to its weight, as Aristotle had claimed*. The manuscript tract *De motu* (*On Motion*), finished during this period, shows that Galileo *was abandoning Aristotelian notions about motion* and was instead taking an Archimedean approach to the problem."[2]

That point of view put Galileo under attack from the both sides. From the one hand, he was attacked by the humans. "… his attacks on Aristotle made him unpopular with his colleagues, and in 1592 his contract was not renewed. His patrons, however, secured him the chair of mathematics at the University of Padua, where he taught from 1592 until 1610."[3] That is the best example of traditional response of humans (regardless of their position in the society or science) on any new idea that stays in contrary to so called "well established point of view", even if that point of view has support from *the experimentation*.

From the other hand, Galileo was attacked by the nature itself. To make measurement of the process of falling bodies he needed some method that was able to do estimation of duration of that process. To reach a solution of that problem, he should use any other process that demonstrates constant duration to be used as a measure for any given duration. That was not easy task for Galileo, because there is not any suitable device that meets all requirements for a Galileo's experiments in the 16th century. Willingly or not he used *a clepsydra* to make measurement of duration of each process of free-fall.

"Clepsydra, also called water clock, was ancient device for measuring time by the gradual flow of water. One form, used by the North American Indians and some African peoples, consisted

[1] **Galileo.** (2008). Encyclopædia Britannica. *Encyclopaedia Britannica 2008 Deluxe Edition.* Chicago: Encyclopædia Britannica.

[2] **Galileo.** (2008). Encyclopædia Britannica. *Encyclopaedia Britannica 2008 Deluxe Edition.* Chicago: Encyclopædia Britannica.

[3] **Galileo.** (2008). Encyclopædia Britannica. *Encyclopaedia Britannica 2008 Deluxe Edition.* Chicago: Encyclopædia Britannica.

of a small boat or floating vessel that shipped water through a hole until it sank. In another form, the vessel was filled with water that was allowed to escape through a hole, and the time was read from graduated lines on the interior measuring the level of the remaining water. It may have been an invention of the Chaldeans of ancient Babylonia; specimens from Egypt date from the 14th century BC. The Romans invented a clepsydra consisting of a cylinder into which water dripped from a reservoir; a float provided readings against a scale on the cylinder wall. Clepsydras were used for many purposes, including timing the speeches of orators; as late as the 16th century, ***Galileo used a mercury clepsydra to time his experimental falling bodies***."[4]

Everything went well that way. Galileo was able to demonstrate *experimental support* for his point of view and overpower Aristotelian teaching, but he was unable to determine cause and reason for events of his experiments. He did not know anything about purpose that was responsible for moving an object toward the Earth. Moreover, he was unable to explain clepsydra's principle of operation. Those difficulties were probably used to make a critique for his experimentation from the others. Moreover, Galileo himself considered a process of free-fall and indication of a clepsydra (water or mercury drop from a reservoir) as two different physical processes. From Galileo's point of view, a clepsydra shows the passage of Time and a falling body shows process of free-fall. In other words, operation of a clepsydra depends only on passage of Time and a process of free-fall depends only on motion.

III. Newtonian Ideas in a clepsydra-driven world

Sir Isaac Newton had made publication of his famous work about one century later. "Newton's *Philosophiae Naturalis Principia Mathematica* (*Mathematical Principles of Natural Philosophy*), 1687, was one of the most important single works in the history of modern science."[5].

"…Newton was able to show that a similar relation holds between the Earth and its Moon. The distance of the Moon is approximately 60 times the radius of the Earth. Newton compared the distance by which the Moon, in its orbit of known size, is diverted from a tangential path in one second with the distance that a body at the surface of the Earth falls from rest in one second. When the latter distance proved to be 3,600 (60 × 60) times as great as the former, he concluded that one and the same force, governed by a single quantitative law, is operative in all three cases, and from the correlation of the Moon's orbit with the measured acceleration of gravity on the surface of the Earth, he applied the ancient Latin word *gravitas* (literally, "heaviness" or "weight") to it. The law of universal gravitation, which he also confirmed from such further phenomena as the tides and the orbits of comets, states that every particle of matter in the universe attracts every other particle with a force that is proportional to the product of their masses and inversely proportional to the square of the distance between their centres."[6]

Everything went well again, and Newton's work was accepted quite readily, because he was the only one person who was able to explain many phenomena from one easy point of view. In other words, the law of the nature described by Sir Isaac Newton has global range and becomes applicable to any object in the Universe.

Suppose someone from the time of Newton had a decision to investigate the theory of Newtonian gravitation experimentally using well known "traditional instruments", which were used by Galileo himself. Way of thoughts of that person could be fairly straightforward. If each body in the Universe makes attraction to any other body, then result of that attraction must be measurable and detectable by applicable experiments. As soon as the Earth has determined gravitational attraction from two celestial bodies, the Sun and the Moon, their interaction with the gravitational field of the Erath should be measurable at any point of the Earth surface. Moreover, that measurement should be accurate at the points with remote location from a celestial body. Because gravitation goes through any object without any changes, force of gravitational attraction between falling bodies and the celestial body at the night side of the Earth should be the same as their interaction at the day side of the planet.

The person begins the examination to make support for his point of view. Figure 1 (see below) shows some steps of the experiment.

In the figure 1, point O is the center of the Earth. Circle ABC or circle "L" is the projection of the latitude, where the experiment has a place, to the plane of the figure. Points A, B and C are some points where measurements of the experiment had place.

According the person's point of view the experimental data should give him some variation in the duration of free-fall process at each point of the Earth surface. As soon as the person has the only one laboratory, the Leaning Tower, he used rotation of the Earth to make measurements at different points. At each of those points, relative location between the tower, the center of the Earth and the celestial body has some variation. As a result, vector diagram of gravitational force applying to a falling body should be changed at those points. Hence, duration of the process of free fall for each body should be identical for the same point where the experiment took place, but different locations should show different duration of the same process. That relation can be clearly shown mathematically.

$$\overline{F_G} = \overline{F_E} + \overline{F_S} \quad (1)$$

Equation 1 means that force vector of gravitational acceleration of a falling body (F_G) equals to the vector sum of two other vectors. Those are vector of gravitational interaction between the falling body and the Earth (F_E) and vector of gravitational

[4] **clepsydra.** (2008). Encyclopædia Britannica. *Encyclopaedia Britannica 2008 Deluxe Edition.* Chicago: Encyclopædia Britannica.

[5] **Newton, Sir Isaac.** (2008). Encyclopædia Britannica. *Encyclopaedia Britannica 2008 Deluxe Edition.* Chicago: Encyclopædia Britannica.

[6] **Newton, Sir Isaac.** (2008). Encyclopædia Britannica. *Encyclopaedia Britannica 2008 Deluxe Edition.* Chicago: Encyclopædia Britannica.

interaction between the falling body and the analyzing celestial body. In case of the Sun, that vector becomes a vector of gravitational interaction between the falling body and the Sun (F_S). Scale between those vectors shown in the picture is not accurate.

of his experimental data, the other laboratories confirm their failure to recognize theoretical predictions for freefalling bodies using any towers with any height and any *clepsydras* with any reservoirs.

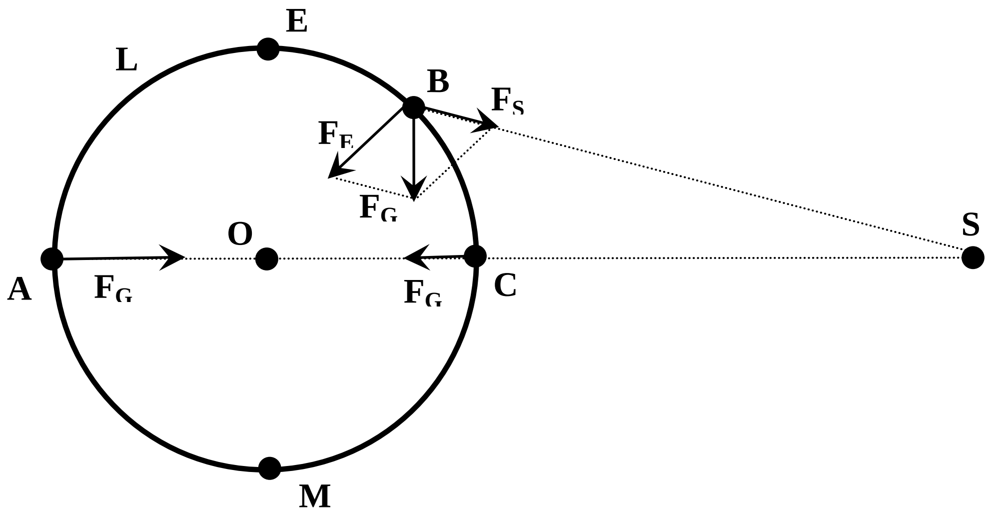

Fig. 1

According to the person's point of view, his experiment must show greater acceleration of a falling body at the point A that coincides with the midnight location of the Tower relatively to the Sun. Consequently, the Midday location of the Tower (point C) must show the slowest acceleration of a falling body, because the force of gravitational interaction between a falling body and the Earth slightly reduced by the opposite force of gravitational interaction between a body and the Sun. Measurement of acceleration of a freefalling body at any other point must show a value between those maximal and minimal values taken by measurements from the points A and C. Point B is one of the examples of those points in the fig. 1.

Hence the person had strong theory and powerful instruments to conduct the experiment. After the experiment, the person makes comparison between his predictions and data from an actual experiment. To his utter amazement he had seen that. The conducted experiment shows no correlation with the theory of gravitation. Despite of the best explanation of motion of the planets around the Sun, physical experiment failed to produce direct measurement of elementary consequences of theoretical predictions.

Obviously such a situation turns the person to the nonplus because of his inability to support the theory by means of a direct measurement. From the person's point of view, he has done a strictly accurate measurement. The height of the Tower was constant all the time during the experimentation. The *clepsydra* shows the duration of the process of free-fall of each body and that duration was accurately measured each time by the person.

However, despite all his efforts, experimental data was the same for each location of the Tower. The person had conducted the test again and again without any success. Moreover, after publication

What should they do under such unusual discrepancy between theory and experimental results? Obviously they should suggest a hypothesis for the new theory that would be able to explain all experimental data. Had they any chance to find a suitable way? The most likely one was the way of a presumption of hidden interaction between so called Time, according to clepsydra's indications, and so called Space.

According to the new theory, location in the Space of each laboratory that conducts the experiment should change the rate of Time according to indication of each *clepsydra*. As a result, Time *should run faster* at the points with a greater value of gravitational attraction between a falling body and the celestial bodies. That theory should use basic equation for Time difference (estimation) according equation 2.

$$T = T_0 - T_d \cdot \cos(\varphi) \qquad (2)$$

In the equation shown above, T_0 is the speed or Time at the point of Morning or Evening (Sunrise - point M in the figure 1; or Sunset –point E); T is the rate of Time at any given location; φ is the angle between zenith and location of the Sun in the sky, at any given point on the Earth surface; T_d is some variation of Time relatively to a given celestial body.

Such a theory could provide an explanation of all test results and should be in use as long as a methodology of the experiments does not change. In that case, Newtonian theory of gravitation should be declined as a theory that cannot be proven by any experiments in *an open or closed laboratory*.

IV. Matter of Measurement and Precision

Such disagreement had not a place in the real history of science. There was the only one reason for that – invention of an escapement clock at the time when Sir Isaac Newton proposed his theory of gravitation. An escapement clock uses duration of its internal recurrent physical process to make its indications possible.

The problem with experimental support of theory of gravitation mentioned above could have the only one reason. That is misunderstanding of clepsydra's principle of operation. They believed that a clepsydra shows the passage of Time. Because Time is independent of any spatial dimension of the Universe, a clepsydra should indicate ever right Time, its passage and rate of changes (because Time changes ever).

The whole situation was saved from development of additional theory only by the invention of escapement clock (as it mentioned above). They should call that theory as "relativistic gravitational theory". Any other way cold lead to a great question of "inconsistency of theory of gravitation", because any clepsydra, despite its precision, gives the same indication ever. In other words, it does not matter of the instruments precision. It does *matter of methodology*.

Even through they produced a clepsydra with 1,000 times better accuracy, the instrument was unable to detect expected result of the experiment. That happened because the operation of a clepsydra depends on gravitational interaction between a clepsydra and celestial bodies. Same interaction is responsible for measurable property of a falling body. That is duration of process of free-fall and that process depends on the same level of interaction between a falling body and celestial bodies. As a result, both processes (process of a falling body and rate of changes of clepsydra indications) depend on the same physical property. That is force of gravitational interaction and its magnitude.

That hidden interaction changes indications of a clepsydra according to its location relatively to celestial bodies. The same process makes a delusion for an experimenter about his inability to make experimental support for the theory of gravitation without "relativistic gravitational theory".

V. Conclusion

Each time when an experimenter conducts an experiment, the person should use only methods and instruments that have not any connection (direct or indirect one) with a measuring value. Unfortunately, we cannot see such a mistake in some experiments until we reach some higher level of understanding of principle of operation of devices that make measurement in the experiments.

Moreover, we should not create any new theory based on data of those experiments until we have correct knowledge of each physical process that was used in any given experiment. Otherwise, science would face the same problem again and again. Each new experiment put "a well established theory" under question. Moreover, that question cannot be answered until we see a new device that can be used in *a different research methodology and practice*.

References

[1] Encyclopaedia Britannica 2008 Deluxe Edition. Chicago: Encyclopædia Britannica. (electronic edition)

[2] Allan Zade - Human's Delusion of Time - published at: *"International Journal of Scientific and Research Publications (IJSRP), Volume 2, Issue 10, October 2012 Edition"*.

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