Buenaventura Suarez, the First American Astronomer in South America V. 3

Ramon Isasi

ra_isasi@arnet.com.ar isasi.ramon@gmail.com

July 16, 2016

Abstract.-

In this short essay, we consider some details of the life of Father Buenaventura Suarez, his astronomical research and activities as a craftsman in the complete manufacture of his scientific instruments by using only the means that nature offered in those places where the Jesuit Missions were located. Also, we include a brief biography, a short description of his scientific productions and communications. Some comments regarding his book Lunario de un Siglo of 217 pages published the fourth Ed. in 1752 is given

Keywords.- Buenaventura Suarez; Jesuit Missions; Primitive telescopes; Galileo-Riccioli pendulum; Astronomical observations; Longitude determination.

1.- Introduction

The following analysis is not a limitation of mere wishful or merely voluntaristic expression of alleged facts, instead the possible implementation of the facts. For the realization of one elaborated enterprise, the sum of the following interactions is required: I.- Intellectual capacity of the protagonist. II.- Willpower. III.- Project. IV.- Materials and technology available. V.- Adaptation of the model. In those times and in that place, the sum of all these elements leads to the realization of a project by the simplest and most economical way. It is noteworthy, that within a very limited contour, also with very limited elements available, for each conjunct of variables there can be only few solutions, or rather only one. This leads to the semantic meaning of the sentence: “alternatives are not” or “there is not other choice”. All this brief narrative, is just an attempt to point the power of the will of a singular man.

Finally concerning our figure, after reading the hegemonic and extensive manuscript of Galindo – Rodriguez Meza; Part I and Part II (S. Galindo et al 2011), also (M. de Asúa 2004) and (H. Tignanelly, 2004), then, it may be supposed that there is no more to say... but, there is always a little more to say.

2.- Some biographical antecedent

The protagonist of this history belonged to a main family in the society of those times, which allowed him to receive the best education available in their social media. Buenaventura Suarez began his studies at the College of the Immaculate in Santa Fe de la Vera Cruz and his higher education was made in the Collegium Maximum, in Cordoba which was the origin of the present University of Cordoba considered the fourth founded in America. The academic formation at the liberal Jesuit educational institutions, was not exclusively focused on Philosophy, Latin and Theology, but also mathematics and natural sciences were taught. Among mathematics instructors, there was a priest with knowledge of land surveying, (Garcia Venturini 2011) who dedicated to measurement and demarcation of the vast territory under the Jesuit domination, which imparted knowledge of trigonometry and the use of their primitive theodolites. It is not known if there were some astronomers or telescope, but as they were Jesuit, some knowledge of astronomy and optics have had. It is certain that the Jesuit priests with academic degree, sometimes did not raised their eyes only to find God, but were also attracted by their curiosity towards astronomy. These capabilities, added to their skills in manual labors were an important factor in the future realization of the undertaken projects. After graduating as a priest at age 23, he was sent to his destination in the Jesuit Reductions at San Cosme and San Damian, where the entire story of his life was developed.

A summary genealogy is as follows:

I .- Juan de Garay ; m. 1564 Isabel de Becerra

among other sons:

II.- Juan de Garay II ; m. 11/30/1613 ? Juana de Sanabria y Saavedra

among other sons:

III.- Maria de Garay ; m. 1645 Mateo de Lencinas

among other sons:

IV.- Maria de Lencinas Garay; m. 06/01/1671 Antonio Suarez de Altamirano

among other sons:

Buenaventura Suarez b. 07/11/1679; d. 06/24/1750

This means that Buenaventura Suarez was great-great-grandson of the Conqueror Juan de Garay, who founded Buenos Aires and Santa Fe city. On the Sanabria line, his great-grandmother Juana de Sanabria was grand niece of Juan de Sanabria (1505-1549) who was the III Adelantado of the Rio de la Plata (Carminio Castagno J.C. 2014). Moreover, Juana de Sanabria was half sister of Fray Hernando de Trejo y Sanabria (1554-1614), the founder of the Collegium Maximum in Cordoba. Also, Juana de Sanabria was sister of Hernando Arias de Saavedra (Hernandarias 1561-1634) Governor of the Provincias del Rio de la Plata 1596 – 1618. For those family influences and as a Jesuit mostly, certainly from the jungle and from a colony in the End of the World, he was facilitated to make contacts or at least a better shipping of his scientific communications to Europe.

3. - Making the astronomical equipment

In the Introduction of his book "Lunario de un Siglo" (page 4) Suarez states: *"...because of lack of instruments I could not have made these observations (...) if I had not made these instruments required for the observation with my hands (...) which are a pendulum clock with minute indices and second, astronomical quadrants to adjust the clock to the true hour of the Sun, dividing each grade in minutes . The telescopes have two convex glasses of various graduations from 8 to 23 feet (...) the largest are 13 to 14; 16 - 18; 20 – 23 and 20 to 23 feet, which are used its for the immersions and emersions of the four satellites of Jupiter that I observed in the village of San Cosme during thirteen years...".* Suarez makes no description of the techniques used to build his astronomical instruments. This could be an intentional omission to evade the prejudices of credibility in the eyes of the prestigious European colleges ("*pauperes resource, pauperes consequitur*"). On page 5 he notes: *"...I used the astronomical tables of Philippe de la Hire given to the light in Paris in 1702..."*

3 - 1 Construction of tubes

In the making of the telescope tubes, the material used was *Bambousoidas* bamboo cane (vulgar name : taquara), very common in the Missions whose perfectly circular stem can reach over 15 m high and 10 cm in diameter. The stalks are a straight hollow cane and 25 to 40 cm separate nodes. To build the tubes, perfectly straight rods are selected in their green state, the nodes are relatively soft and can be removed by rotating inside by means of another smaller diameter cane with a grinding stone at the end. The cane is mounted horizontally on two or three Y shaped frames made from tree branches which are firmly drive into the ground. The rotation of the rod with the abrasive element may be effected by using a wood wheel with handle and also exerting an axial pressure. For the construction of telescopes of large focal distance the nodes should not be completely removed, since these provide the flexural resistance.

The tubes for a single telescope are two, the larger in diameter is the objective tube and the other is the eye piece tube. The longitude of both tubes is dependent on the focal distance on the lenses.

3 - 2 Construction of the lenses

The glass used in the first telescopes was of poor quality with iron impurities, bubbles and inhomogeneous refractive index. Also, the manufacture of glass in the missions would be a challenging task and perhaps impossible.

Rock crystal in those regions is abundant, of high purity, very transparent and large. The Guarani Indians were clever craftsmen in carving gems and arrowheads from rock crystals whose skill was profited by Father Suarez to build lenses from these crystals. After the selection of the best crystals, the first task is to reduce in gross with a punch by carefully biting departing from both extremes. Then, the piece is further reduced by scraping using a more or less flat emery stone. This scraping by hand, back and forth combined with rotating movement is a long and tedious task, but of extreme care. For the objective lens from rock crystals of 5 – 7 cm of diameter this operation can last days and for the ocular lens of 1- 1.5 cm much less time.

A pottery wheel in the initial termination in gross is used for the construction of the abrasive grinding tool pieces which are made with a mixture of clay and successively other grinding pieces are made adding finer grades of abrasive grains . This mixture is placed in a circular mold and to obtain the sphericity, it is required to align the center with a wooden stick or cane held vertically in plumb line whose length exactly equals to the curvature of the lens. At the upper end, the rod is firmly held in a rafter (or at least a strong branch of a tree). Also, this end must be articulated by a pivotal joint. In the other extreme, a small hemispherical section of calabash (*lagenaria vulgaris*) - which is a very smooth material - is fixed. This mechanism, is of crucial importance, since the conical movement of the extreme in contact will give the desired focal length by the concave sphericity in the clay matrix. As the operational mode is rotative, combined with a pendular movement across the center, it does not reproduce the sphericity of the surface in contact since the spherical radius is given by the rod longitude. These molds, which must be dozens were labeled with a number in accordance to the fineness of the grain which impregnate the clay pieces and then, they are carefully dried. Once the clay is dried - as it contracted – the piece is easily separated from the mold to be finally baked at a temperature of 1000 º C approximately.

For the initial polishing in these ceramic abrasive concave pieces, the quartz lens in gross is firmly centered and successively finer grains of abrasive suspended in a slurry of clay are added. In the final polishing the used disc is covered with suede leather and the abrasive is almost pure clay or a mixture of dry clay and wax. The rotational dynamics is executed by a rope coiled twice around its axis. Pulling the rope, the wheel rotates in one direction and pulling the other end, the first cord is rolled, running the wheel in direct mode and reverse rotation and so on. To improve friction, resin powder is added to the cord. Ropes built by the Guarani natives were very good, with similar design to the naval rigging of Spanish ship. The material of these cords was hemp, jute or linen that the Jesuits introduced in these lands.

The numbers of telescopes made by Father Suarez were at least about ten with a length of 8 to 23 Roman feet. As the Roman feet unit is equal to 0.2957 meters, the length of those instruments was of 2.36 to 6.80 meters.

On July 1745, a crate containing two clocks and two English telescopes of 12 and 24 palms (2.5 and 5.0 meters) arrived at the port of Buenos Aires. These instruments had been requested by Father Suarez in 1735 (Furlong, 1929). Therefore, it is logical that at least half of then were destined to the only astronomy observatory that existed in the Provinces of the Rio de la Plata. At this time, he was already a recognized astronomer in Europa and as it were an irony, these instruments were received when he was 66, his health delicate and his vision diminished.

3 - 3. - Construction of the pendulum clock

It is a fact that all the astronomical observations described in his book Lunario were made by using the primitive handcrafted instruments solely. In the present time, the only object that still remains is located in San Cosme, which is a sundial built of stone and everything else has dissapeared.

However, it is a proven fact that the Guarani indians were skilled craftsmen good at reproducing with high quality in manufacturing European musical instruments such as violin, harps, guitars, organs and even a printer. But it is very difficult to have been able to build a complete pendulum clock. Those regions have the most varied wood, like Palo Santo (*Bulnesia Sarmientoi*), which is hard, easy to carve, veined with almost isotropic mechanical property, unaffected by the humidity and low mechanical friction. The lack of high precision tools was a decisive cause which made it impossible to make the escapement mechanism. This is not all, also the manufacture of a system of fully engaged precision gears without the right tools is not easy either. For these reason, the pendulum clock used by Suarez, undoubtedly was a simple Galileo - Riccioli pendulum, which has a quasi exact half period of one second (Koyré 1953). This pendulum clock does not have escape mechanism, steel spring, gears and neither clock needles. It was just a pendulum, which had a length experimentally obtained or by Huygens Equation (1) with a simple period of one accurate second. As we will describe, this clock essentially can only function when it is connected to another mechanism which is the human.

Due to the impossibility of having a thin metallic chain and the inappropriate replacement by a yarn built by any available fiber, since the constancy of the longitude is crucial, then Suarez could use a very straight and polished section of bamboo, similar to that the indians made the arrows for their arcs. As this rod is mechanically much more resistant, its thickness could be much thinner than the one used in the arrows . Another advantage is a little sensitivity to the tension and change due to the humidity. In the superior extreme a pivotal joint is made with two metallic rings and a bronze sphere is firmly attached to the other extreme.

3 - 4 Operational mode of the pendulum clock

This hypothetical mechanic–human coupled clock works with the following components:
1.-A pendulum of length of 0.99 meters[1] and a period of 2 seconds (Galileo–Riccioli pendulum).

2. - Energy recovery by manual input.

3. - Escapement system, none.

4. - Gears, none.

5. - Clock hands, none.

---

[1] According to Huygens formula $L = (g \, . \, 1s^2) / \pi^2$ = 3 Roman feet, 4.2 inches = 0.99 m

The management and control of the pendulum is performed by the supervision of a priest and two trained and reliable indians, who are sitting on both sides of a table and on the opposite extremes where the adopted amplitude is reached. The recovery of the lost energy by friction is given by one of them, very gently by pushing the pendulum ball every one or two periods with a small bundle of feathers obtained from the wing of a bird. Another very soft feather is placed on both ends for the visual control of the elongation alignment.

The time marked by the pendulum is recorded by using an abacus which has three lines with different colored beads. The first one, which marks one period or 2 seconds, e.g. has 30 red balls; the second line that marks the minutes has 60 blue balls, and the green bead that mark the hours have 12 green balls. When the pendulum starts running, for each period, the operator begins to run red balls which means 2 seconds. After completing the first line with 30 balls, the operator runs a blue ball and now continues counting the pairs of seconds from the right to the left. After 60 minutes, the first green ball is run which means that the first hour was completed. e.g. if it has 15 red balls; 12 blue balls and 2 green ones the time elapsed was 2 hours, 12 minutes and 30 seconds. This detail that looks redundant and very obvious, is intended just to point out that these cyclical manual operations are exactly equivalent to a gear system connected to the clock hands.

This whole system must be located in a room well-protected from the air currents. In order to make a specific time record, the communication between the astronomers and the clock operators must be immediate, a code being used with a bell. These operations of time measurement were certainly a monotonous and a boring routine. Therefore, to preserve the quality of the measurement, it would be appropriate that operators were replaced every half hour with a half hour of rest. It is remarkable to say that this exhausting routine is not repeated every day, since the astronomical observational practices depend primarily on clear skies, circumstances that are not prevalent in this subtropical jungle.

4. - Longitude determination by measuring the local time

Regardless of the radius of the Earth – which was imprecise in those times – the equivalence between both sexagesimal systems is completely unequivocal: the time system and the same geometrical system used in the terrestrial sphere.

360 º --- 24 meridians ---1,440´--- 86,400´´--- 24 h --- 1,440 m --- 86,400 s

In the first page of Lunario, "Introduction" Father Suarez says: "...*Every place or city has its noon on which the 12 hours are counted (....) Example: if a meridian is a great circle which passes through the poles, Artic and Antartic (....) because it divides the day into two equal parts, and any other meridian also does it....*"

Therefore, from a specific geographic point, having a known longitude where the time of a particular astronomical phenomenon is precisely registered, e.g the occultation or appearance of a specific Jovian satellite, then by using this information at any point of the Earth, only by registering the local time when the same phenomenon was observed, it allows to determine the longitude of the local place. Later, in the second page Suarez added: *"...I was sent to Europe to the Father Nicacio Grammatici of the Compania de Jesus, who told me his own observations at the Imperial College of Madrid.....also copious and accurate observation of Nicolas Isle made in Petersburg and other from Father Ignacio Koegler, done in the Court of Pekin in no way inferior to those of Petersburg, ... the same were from Dr. Pedro de Peralta who made them in Lima (...) to whom I gave my own data and I had the knowledge of the true longitude of the meridian of San Cosme, which is 321 degrees and 45 minutes from the Isla de Hierro in Canarias...."*

In those years the Prime Meridian was fixed in the Isla de Hierro, defined as the geographical coordinate whose longitude is 0º, and departing from this, the longitudes were counted eastward in the same direction of the rotation of the Earth.

In present times with respect to Greenwich, the longitude of Isla de Hierro is: 17º ; 39´ ; 46´´ W and for San Cosme is : 56º ; 21´ ; 0´´ W , which means by counting eastward:

(360º – 56º; 21´; 0´´) + 17º; 39´; 46´´ = 321º; 18´; 46´´ E

From both results, there is a difference of 0º ; 26´; 14´´ equivalent to a terrestrial distance of about 45 Km. or an error of 0.12 %.

5. - Jovian satellites , Uppsala Collection 1741 – 1742

In 1999 Magnus Mörner in the book The Jesuits, Edited by John O´Malley, page 308 says: *"… around 1741 he published a Moon calendar (Lunario) covering 101 years which was printed in four editions and distributed widely in Europe. His Swedish colleagues Anders Celsius (1701–1744) and Pehr Wargentin (1717–1783) are among those who praised his work….."*

The records of 147 eclipses of the Galilean Satellites – which are also moons - were not listed in his book Lunario, but rather were sent through a handwritten letter attached in the form of an interpersonal communication by means of the Jesuit Nicacius Grammaticis.

Other Jesuit, Domingo Muriel in his book Rudimenta Iuris Naturalis, makes the following reference: *"….In the Acts of Uppsala in Sweden, belonging to the years 1741–1742 the celebrated astronomer Wargentin, among eight hundred observations made by different astronomers in several parts of the World referring to the immersion and studies of the period related to the satellites of Jupiter, mentions the observations made by Buenaventura Suarez, who lived in a small town in San Cosme, and asserts that these observations are comparative to those that have been made in Paris, London, San Petersburg, Pekin and elsewhere in spite of the fact that the ones performed by Father Suarez only had the aid of a telescope, quadrant and a pendulum clock made by him in those Missions…".*

Not long ago, (Lieske, J.H. ; 1986) published a collection of eclipses of the four Jupiter Galilean satellites, containing 16,802 historical records made in 1,432 different sites, that start from 1652 to 1983. This array contains *"…more than 7,000 observations prior to 1800 recovered from the literature and manuscript collections…"* (Lieske ibíd). Galindo and Rodriguez Meza (op.cit) found in this collection 96 measurements made by Suarez between 1720 and 1733 which were registered in five different places with their source data and their respective standard deviations (Table I).

6. - Apogee and extinction of the Jesuit Missions

The Jesuit Missions where Father Suarez developed his activities for almost all the rest of his life, were located in the American subtropics on both sides of the Parana River. The people of the Jesuit Missions had an integrated economic system between the town and the countryside. In the urban part, there were the Church, building, some emerging industries and workshops engaged in the manufacture of clothes, carpentry and manufacture of basic tools of forged iron. The farming area was divided into community parcels with cattle and grain crops, cotton, etc. Also, for defense the Missions were organized militarily to suppress the repeated invasions of the Portuguese Bandeirantes, who made raids of natives to subdue them to slavery on their plantations. The presence of Spanish, Portuguese or any other foreign people was forbidden within the limits of the Mission. During their heyday, the 30 Missions reached a population of 140,000 inhabitants.

These missions had a population of Guarani natives, many of whom when they were children received a basic primary education with the ability to do simple mathematical operations with numbers and measures. They could also read and write in Spanish and do basic translation to Guarani as interpreters. The manufacture of musical instruments was linked to social and educational policy of the Jesuit, as a means to persuade the willingness of the natives through the love of music. These capabilities, added to their skills in manual labors were an important factor in the realization of the projects undertaken by Father Suarez.

In Volume I "Compilation of the Leyes de Indias" Chapter IV of the Pacification pages 814 – 815 establishes rules for treating the indians: "…*must provide these peoples, procure peace and friendship with the indians who inhabit those lands, doing good deal and works (…) should aim with great diligence not to do the indians any insult, strength, or harm, or make other evil, or they take their wealth, but give them good treatment…*". Later it added: *"...seek to attract their friendship, with loving care and affectionately, giving them goods to forge their friendship and alliance with the principal lords of the tribes..."* As these were not enough, it adds: *"… cleric and religious, must put very great care and diligence that the indians are well treated favored and regarded as close friends and do not make them theft, injuries or abuse. If it is done, without condition of the person, they will be punished with the full rigor….".* Even, if all the above seems incredible, King Felipe II in April 1568 ordered: "…*to cause more admiration and attention, it would be appropriate to use music, song and singers to tame the indians, also pacify and persuade the indians who were at war….".*

In America these noble Laws, were only obeyed by the Jesuits. But, there were very few Spanish conquistadors who obeyed them. In the history of all conquests, brutality has always prevailed everywhere. Also a century later, it occurred in North America by the Anglo Saxons, as likewise the brutality was exercised by the major “civilized” European nations in the whole African continent until after the twentieth century. The same events in lesser extent, also occurred during the formation of the new Republics and Nations.

Because of intrigues, rivalries and reciprocal distrust, especially using the argument that these Missions were a “State within a State”, both the King of Spain and Portugal decided to dissolve them. On February 27, 1757 King Carlos III of Spain ordered the expulsion of the Jesuits which were replaced by Franciscans and Dominicans. During the control by those priests, the people of the mission were dissolved into decay. Later, after the revolutionary governments and the appearance of the new imperfect republics, the Missions were plundered and some parts of them demolished.

7. - The ultimate fate of the English telescope

I have to tell a history from José Tomás de Isasi, which was the grand father of my great grand-father, who had a personal and commercial relationship during more than a decade with the dictator Gaspar Rodriguez de Francia (who in 1814 proclaims himself the extravagant Title: “His Excellency the Supreme Dictator of the Republic of Paraguay”).This relationship was because de Isasi in those times had the monopoly of the naval transport in Paraguay through the Parana River to Buenos Aires. He said some thing that was repeated by generations, like the testimony that much of his very important library full of classic books, came from the plunder of the abandoned Jesuit Mission including an English telescope and one astronomical clock. The permanence and power of the dictatorship of this sanguinary and paranoid figure, was based on fear and widespread terror. One of the most used means of repression was espionage and dilation to pursue and destroy any supposed enemy. Furthermore, a false belief was created in the uncultivated and ordinary mass that such telescope installed on the terrace of his residence, which was used by Dr. Francia to observe the night sky aimlessly and was also used in the day to spy the common people. Among these people there was the myth of a supranatural ability power of this instrument in hands of the Dictator: as well as the heavenly bodies were brought closer to his view, he could also see anyone close, even, those who were in the most remote villages.

This history seems exaggerated since almost 200 years have gone by. But the father of my great grand-father narrates it to his grandson, then this grandson to his other grandson, or were repeated three times. Since old people keep better memory of the past than the present, now again, over 75 years old I repeat it in this manuscript for the fourth time only.

8. - Final remarks

The physical time is universal and ubiquitous marked solely by the irreversible order of the events. In change, if we consider history as the narration of the human events, it depends on the geographical location, social development, the economical resources and the correct decisions of its leaders. In South American astronomy, almost three centuries have passed since those archaic foundational times. Now, at present in a lapse of 50 years, the Great Astronomy is located in the north of the Chilean Andes. In this region there are almost 50% of the largest and the most modern optical, radio and high-energy astronomical systems belonging to the most prestigious academic institutions from Europe, USA, Japan and local. By singular and outstanding natural causes, the skies are clearest with very low light pollution, dust, humidity, and artificial electromagnetic radiation, which allows an average time of observation up to 320 days year.

Hundreds and thousands of records and reports of observations come from the data collected in these skies of South America. As well thousands of astronomers publish their articles and manuscripts in astronomy, astrophysics and cosmology in the most prestigious Journals. Likewise, thousands of new stars, galaxies, globular cumulus, etc. are registered in the UGC Uppsala General Catalog; NGC New General Catalog ; PCG Principal Galaxies Catalog; AGK Astromische Gesellschaff Katalog; SRS Southern Reference Star Catalog; GC General Catalogue of Nebula and Clusters; ESO European Southern Catalog; LSS Luminous Stars in the Sothern Milky Way and many others.

9. – References.

Asúa, Miguel de; 2004; The publications of the astronomical observations of Buenaventura Suarez (1679-1750), Journal of Astronomical History and Heritage. Vol. 7 Nº 2 p. 81 – 84

Carminio Castagno, J. C.; 2014; Revista XII Genealogía E. Ríos Ed. Dunken p. 492- 494

Furlong, Cardiff Guillermo; 1929 Glorias Santafecinas…. Ed. Surgo p. 106

Galindo, S. ; Rodriguez- Meza, M . A. ; 2011; Buenaventura Suarez (1679-1750) Part I, Rev. Mex. de Física p. E 57; p. 121 - 133

Galindo, S. ; Rodriguez- Meza, M. A. ; 2011, Buenaventura Suarez (1679.1750) Part II, Rev. Mex. de Física E. 57; p. 144 – 151

García Venturini, Alejandro; 2011; Historia de las Matemáticas Argentinas; Ediciones Cooperativas p. 14

Koyré, Alexandre; 1953; An Experiment in Measurement; Proc. of the American Philosophical Soc. p. 222-237.

La Hire, Philippe de; 1727; 2º Ed. Tabulae Astronomicae; Montalant Typographum pdf

Lieske, J. H. ;1986; A Collection of Galilean Satellite Eclipse Observation 1653- 1983; Part I A&A ; V 154; p. 61-76.

Lieske, J. H. ; 1986; A Collection of Galilean Satellite Eclipse Observation 1653-1983 Part II A&A Supl. Series p. 143-202.

Muriel, Domingo; 1791 Rudimenta Iuris Naturalis et Gertum; Spanish Transl. Ed. Peuser 1934.

O´Malley, John, Editor; 1999; The Jesuit, Culture, Sciences, Arts 1540-1773; Univ. Toronto Press, p. 307- 308.

Recopilación de las Leyes de los Reynos de Indias; Libro IV, Título IV; Ed. Univ. de Sevilla; 1861 pdf

Riccioli, Giovanni Battista; 1651; Almasgestum Novum; Typographia Benatii; Available Google Books

Suarez, Buenaventura; 1740; Lunario de un Siglo; Ed. Pablo Nadal; Barcelona 1752, IV Edit. Available Google Scholar

Tignanelli, H. L.; 2004, Revista de Historia de la Ciencia; Ed. Saber y Tiempo; p. 5-60.

viXra:108.0102; V1 submitted on 13-08-2015