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EMANUEL LIAIS: A SCIENTIST OF TWO CONTINENTS

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Geomagnetism has a prominent place in the History of Science, because it has been often a fruitful seed in human enterprises, from the Great Navigations to the Space Age. In particular, Geomagnetism is linked to important events in the History of Brazil. Its influence can be detected one century before the official discovery of the country.

Sagres School, the first astronomical and geophysical national institute of Western Europe, was a landmark in the great Portuguese oceanic adventure. The wisdom of its creator, the Infante Dom Henrique, recognized the importance of the compass in the intrepid voyages of the 15th and 16th centuries (Campos, 1943).

There are strong evidences of a close association between Sagres' navigators and the adventurous vikings. It is very probable that some Portuguese sailors had been in viking vessels, as a consequence of the happy marriage of Filipa, Henrique's cousin, with Eric of Pomerania (Barreto, 1987).

The "variation of the needle variation" or, in modern language, the "declination change", was a common method to obtain longitudes, and it was well known at Sagres. It is conceivable that the scholars from Sagres knew that in the 15th Century, isogonic lines were close to meridian direction in the Southern Atlantic, but they had somewhere an East-West direction in the Northern Atlantic. This regional peculiarity of the geomagnetic field could be a strong reason to underestimate the distance between Europe and the unknown Continent, America, a probable argument for Portuguese choice of a Trans-African route to India, and for the refusal of Colombus' project by the Lisbon Crown (Barreto, 1991).

As a consequence of the economical and political importance of the navigations, it is easy to understand the scarcity of clear historical documents about them. Geography and Cartography were classified subjects, and Portugal used Sagres' experience to expand its power over the New World.

During the first two centuries of Brazilian History, there are few examples of scientific activities, in many cases related to flora and fauna, crude charts where magnetic declination is indicated in a very simple way. When Admiral Pedro Alvares Cabral arrived at the lovely Porto Seguro Bay, his surgeon, physicist and astronomer, Joao Emeneslau, determined the latitude and the "needle variation" of the paradisiac place.

The short but brilliant work of George Marcgrave at Mauricio City in Northeastern Brazil, from 1637 to 1644, represents the operation of the first astronomical observatory in America (Moraes, 1956). The remarkable scientific project of Marcgrave (Marcgrave, posthumous works, 1942) was not completed because the exceptional administration of Prince Mauricio de Nassau-Sieben was terminated for political reasons (Nogueira, 1900). The dream of a Dutch Western India and a great scientific civilization in South America vanished. It was a frustration to know that the main portion of Marcgrave's observations and writings were lost

with him. However, according to Lalande, Bigourdan and Flamstead, two centuries later, Marcgrave's writings were found at the "Dépot des Plans" in Paris and at Cadiz, Spain (Moraes, 1956). From some old chronicles (Pingré, 1901) there was a large series of magnetic declination data in Marcgrave's records.

In spite of their incidental nature, scientific activities were carried out in Brazil by distinguished Europeans. La Condamine, Couplet and Halley are examples of such men. Edmond Halley, during his famous trip to the Southern Hemisphere, between 1698 and 1700, constituted a real turning point in the History of Geomagnetism.

In the middle of the 18th Century, the necessity to explore a new land induced the Portuguese Crown to send to the Colony many geographers and cartographers, such as Parigai, Cieira, Pithon, Basco, Alpoin (Carvalho, 1985). It was a crude beginning of Astronomy and Geophysics in Brazil. However, the efforts to establish a regular scientific practice with those specialists were insufficient to be considered as the birth of scientific research. It was necessary to create a true national scientific institution and the conditions for the entry on the scene of the main actor in our story: Emmanuel Liais.

At the end of the 18th Century, the development of Brazil, an old colony, now a Vice-Kingdom, required a permanent operation of two scientific services: a good time keeping system and a reliable control of the "magnetic variation". In 1781, Bento Sanchez Dorta and Francisco de Oliveira Barbosa arrived in Rio de Janeiro to install a Royal Observatory, to provide those services that were crucial for the increasing movement in Brazilian harbours. They intended to use the precarious instruments and installations used by Jesuit priests in Rio downtown (Arend, 1962). In spite of their efforts, Dorta and Barbosa could not complete their mission, and they left Rio in 1788.

Few years later, in 1808, a great change occurred in the Brazilian political structure, when the Portuguese Royal Family arrived in Rio de Janeiro to escape from Napoleon's troops. Brazil turned out to be the core of a Kingdom. The new political and cultural circumstances permitted the creation of important institutions, such as the Public Library, the Royal Printing House, the Naval and Military academies. In the Royal Military Academy a well-elaborated course on Astronomy and Cartography was given by Manoel Ferreira de Araujo Guimarães, the author of a thick compendium with many explanations on Terrestrial Magnetism.

In spite of the efforts of the great scholar, José Bonifacio de Andrada, to create a University, this important source of wisdom could not be achieved. Scientific research had an amateurish and erratic sense. All astronomical or geophysical activities were restricted to routine tasks at an old Jesuit church, in an unofficial way. It must be said that Geophysics was considered as a secondary branch of Astronomy, and its results were surrounded by a superstitious atmosphere.

Brazilian political autonomy was a natural consequence of that displacement of the Royal power, not a warlike movement as had occurred in other Latin-American countries, because the Prince of Portugal became the first Brazilian Emperor, with the name of D. Pedro I (Pedro the First). José Bonifacio de Andrada had a prominent action in that peaceful political change.

José Bonifacio was a distinguished scientist, whose works on Mineralogy were well recognized in Europe. In spite of his notable ideas to improve Science and Culture in Brazil, he was banished to Europe, because the Emperor's stormy temperament was difficult to be controlled. As fertile seeds , Bonifacio's projects grew in Pedro the First mind. Five years after

the Independency, the Academy of Fine Arts, the Imperial Post Office, the General Council of the Empire, the Supreme Court of Justice, the Imperial Military Academy and the Imperial Observatory were created.

The practical needs of a new and large nation were stronger than scientific inquires when Science had not a weighty position as assumed at the end of the 19th Century. To prepare skillful cartographers, to preserve local time carefully for longitude determination, and to obtain correct magnetic declination data to be used in navigation and in land surveying, were the main goals of the new Observatory. Those objectives outlined the future activities of the current Department of Geophysics and the National Observatory Time Service, one of the best at present.

In October 15, 1827, the young and impetuous Emperor promulgated a Decree creating the Imperial Observatory and, as a tropical paradox, unofficial astronomical activities had been almost interrupted for an incredible bureaucratic reason: there was not a person to accept the post of Director. Araujo Guimarães, professor of Astronomy at the Militar Academy was a very important personality to serve in such a humble position. Only eighteen years later the new Emperor, D. Pedro II (Pedro the Second) appointed Eugenio Fernando Soulier de Sauve as the first Director of the Imperial Observatory of Brazil.

There are few historical references to the works of Sauve, who died in 1850. From his reports to the Director of the Military Academy and his notes, it is possible to know that he taught Cartography and Terrestrial Magnetism. This last activity could be deduced from his administrative reports, where he insisted on the necessity of other site for the Observatory, because the old building at the top of "Morro do Castelo" (Casttle Hill) presented a strong "needle instability".

Antonio Manoel de Mello replaced Sauve and, in 1852, started the publication of the "Imperial Observatory Ephemeris", a historical series, which is published today under the tittle "Efemérides do Observatório Nacional".

Between 1865 and 1868, Antonio Joaquim Curvello d'Avila did his best to improve Observatory conditions, in spite of the difficulties provoked by the horrors and bloodshed of the Paraguayan War.

From its origin up to the 1870 decade, the Imperial Observatory was a kind of institution dedicated to "scientific services", since research was not included in its normal activities. On the other hand, the Observatory's History was changed by the occurrence of very blissful circumnstances duly detected by clever Emperor D. Pedro II. He discovered, at the eleventh hour, the opportunity to invite Emmanuel Liais, the leading man in this story, to manage his Observatory.

If Liais had been only a great astronomer, an excellent naturalist, a competent engineer and an efficient statesman, his name would be briefly quoted here, because these notes intend to analyze his importance in the History of Geomagnetism. Liais made an important contribution to Terrestrial Magnetism, although his activities in this science are not his most notorious work.

To understand Liais' scientific importance it is necessary to make a short review of the Science in the middle of the 19th Century.

Emanuel Liais: A Scientist Of Two Continents

Newton's Principia, published in 1687, is an authentic milestone in the History of Science. It was followed by a series of magnificent works from Euler, MacLaurin, Lagrange, Laplace, Gauss.

Consequently, in the middle of the 19th Century, Science was placed in an unprecedented place in the convictions of Mankind. It could be possible to say that Pythagoras and Kepler's dreams were the main rules of Nature's behavior.

Mechanical principles would be the guide of Human Faith, and Determinism arrived at the frontiers of the Absolute. It could be possible, through complete knowledge of the mathematical equations, to predict all physical events in the Universe, including human conduct. If this inmense power could be given to Man, it could be a signal of our mental impotence, perhaps the end of the concepts of innocence and sin, love and hate, possibly a dangerous approach to "Scientific astrology".

However, it was essential to obtain concret proof of such theories. A young French mathematician, Urbain Le Verrier, furnished that proof in 1846 when he indicated the correct position of an unknown planet, using only mathematical, mechanical and calculation tools.

Le Verrier's success was a tremendous shock for the structure of Science and it is easy to understand his fast ascension to Paris Observatory Directorship, after Arago's death. The scientific community and the general public in the World gave to Urbain Le Verrier an incontestable authority as the genius who established, for all time, the mathematical supremacy over the apparent variability of natural phenomena.

On the other hand, some discrete experiences and discoveries indicated other kinds of phenomena with an unimaginable variability of natural events. Some astronomers decided to work on fields different from classical Astrometry, the observational basis of Celetial Mechanics. Those works were the origin of the future breakdown of Determinism in Science. The good fortune of Neptune discovery had obscured the works of Fraunhoffer, Secchi, Huyggens, Fizeau, Foucault and Jansen. We must say that Astrophysics came to life, but it was not recognized as an exact science until the studies of Homer Lane, Schwarzchild, Russel, Hertzprung and Eddington.

In a broader sense, Physics in the 20th Century penetrated into the fantastic field of Quantum Mechanics and Relativity with Planck and Einstein. Now, Le Verrier's certainty of a regular mathematical behavior of the world could be disbelieved.

Another shock to scientific concepts occurred simultaneously with Neptune's discovery: Charles Darwin's Origin of the Species.

There are some differences between Le Verrier's and Darwin's scientific works. Le Verrier was admired for having proved the orderliness of Nature, but Darwin was reproved for having destroyed the old beliefs of eternal stability of living creatures. Le Verrier was an authentic theoretician, who refused to observe his own discovery, but Darwin was a reliable observer of Nature. Le Verrier gave orders to natural phenomena, but Darwin asked Nature to answer his questions at its own convenience.

It was in that spectacular scene in the scientific stage that our hero, Liais, performed his role.

Emmanuel Liais was born in Cherbourg on February 15, 1826, son of a modest merchant, Anténor Liais and Mathilde-Francoise Dorey. During his childhood and up to 26 years old he lived at Cherbourg, which was one of the passions of his life.

Since the early days of his youth, Liais demonstrated an extraordinary ability for the exact sciences, mainly in their experimental aspects. A quick glance at a list of Liais' articles published between 1850 and 1854 (Ancellin, 1986) discloses his multiple interests from Celestial Mechanics, Climatology, scientific instruments and observational methods to the improvements of many kinds of electrical devices. In all Liais' writings there is a strong emphasis on experimental aspects of the events.

In 1852 Liais visited Paris Observatory for the first time. He caused a strong impression on Arago, the old and respected Director. Liais, in his article "Influence de la Mer sur les climats" gave a vivid description of Arago, who was very sick in the last days of his life (Ancellin, 1986). In one of his last wills he promised Liais a place in his Observatory.

After Arago's death, Le Verrier, a national name in France, was appointed Director of the Paris Observatory. He maintained Arago's promise and Liais was appointed Assistant Astronomer in 1854. Only three years later he rose to the status of Titular Astronomer and received the title of "Chevalier de la Legion d'Honeur".

The fast professional ascent was due to an intense and original scientific work. Le Verrier, who was parsimonious concerning explicit quotations about his colleagues and assistants, was prodigal in references to Liais' work. If this initial good relationship between Le Verrier and Liais could be considered as the recognition of fine work, on the other hand, it was a source of dislike on the part of the other astronomers (Barreto, 1987), because Liais was falsely considered as a "creature of Le Verrier".

A remarkable book about Liais' life (Ancellin, 1986) gives a clear view of Science in the middle of the 19th Century. Ancellin's description of the contrast between Le Verrier and Liais is a good example of the indescribable encounter of theoretical and experimental Science, a characteristic of the last Century.

After that friendly beginning, step by step, Liais and Le Verrier relations deteriorated. Two remarkable reasons for that disruption were the strong temperament of both wise men and the differences in their scientific behaviors.

During Arago's time, Paris Observatory was a kind of a Garden of Eden, as a consequence of the affability and amenity of the Director. According to Flamarion (1911), Arago was a sort of candid patriarch, not an energic Director, the exact opposite of Le Verrier.

Le Verrier changed Paris Observatory in a drastic way. A strong centralization could be noticed in all activities, including the important "Bureau des Longitudes". If Liais had been a peaceful man, or if he had a mild temperament, scientific inquiry was not born. A similar question occurred few centuries before, between Tycho Brahe and Kepler, but the later had the necessary perseverance to suffer Brahe's bad temper, in order to receive the great heritage of a priceless set of observations.

Differences and similarities could be found in Liais and Le Verrier. Both were conscious of their high scientific level. Both had very fast careers and very strong temperaments. On the other side, they had few but serious differences. Le Verrier had great political influence, mainly during Napoleon the Third Government, and Liais was linked to republican circles. Le Verrier suffered from a chronic stomach illness and Liais was a healthy man. Those similarities and differences are important to explain the subsequent events in Liais' life and the reasons why he could be considered a scientist of two Continents.

Le Verrier took into account Arago's references and the previous works of Liais to appoint him Head of the Meteorological Division of Paris Observatory.

It is interesting to remember that, in the middle of the 19th Century, Terrestrial Magnetism was considered a branch or, at least, a correlative subject of Meteorology. One of the main contributions of Liais to Science was his attempt to separate Geomagnetism from Meteorology. In three consecutive articles (Liais, 1851, 1852, 1853) published in the "Annales de l'Academie des Sciences Naturelles de Cherbourg", he proposed and applied and observational method to measured the height of the Polar Aurora , in order to prove that such a spectacular phenomenon occurs above the atmospheric regions where meteorological events took place.

As a consequence of his correct interpretation of geomagnetic and meteorological phenomena, Liais used different methods and scientific treatments to both kinds of events. In some sense, he anticipated by three quarters of a century the creation of the IATME (International Association of Terrestrial Magnetism nad Electricity) (Aldredge, 1981) the predecessor of IAGA .

Few months after his appointment to the Meteorological Division, in 1855, Liais presented to Le Verrier a detailed project to reorganize the respective service at the Paris Observatory. The use of telegraph to forecast meteorological conditions was a revolutionary improvement to increase the percentage of accuracy.

However, it was difficult to convince the Director about the importance of a complete change in the meteorological activities of the Observatory. In spite of the scant interest of Le Verrier in those activities, in 1858 Liais finished a complete reorganization of French Meteorology.

Liais in his "L'Éspace Céleste "(1881) presents clear indications about the beginning of his dispute with Le Verrier. He said that it was easy to explain Le Verrier's aversion to Meteorology, because "a man dedicated to the rigid rules of Celestial Mechanics cannot understand atmospheric mutability, a function of many unknown variables". Only observational means could furnish a reasonable value of that function.

Liais extended the use of the telegraph to longitude determinations (Du Moncel, 1874), in order to avoid the difficult and precarious methods of Moon occultations and the eclipse of Jupiter's satellites. A large network of longitude stations was used on French territory. Later, he used that method in his second country, Brazil.

Besides, his activities in Meteorology during four years, Liais spent a great part of his time to improve scientific instruments and methods. Du Moncel (1874) gives a detailed description of those works, where Liais gave strong attention to important points: the increase of precision and the facility to obtain measurements.

This intention is present in his works on electromagnetic clocks, impersonal micrometers for meridian transits and on geomagnetic variometers.

Liais associated his electromagnetic clock with an impersonal micrometer, in order to obtain a precision of one hundredth of a second in a meridian transit of stars. Such a device was used until recent times (Barreto, 1960) with good results. To build that equipment, Liais developed a prototype proposed by Carl Braun according to an original idea of Rédier (Barreto, 1987).

Since those early years at the Paris Observatory, Liais had the revolutionary idea of using an altazimuthal instrument to obtain simultaneously time and latitude. Such an original instrument was completed during his stay at the Imperial Observatory of Brazil. Today it is a fine ornament in a room of the National Observatory. On the other hand, the Liais' altazimuth is the ancestor of the impersonal astrolabe created one century later by another great French astronomer, André Danjon (Barreto, 1975).

To complete the description of Liais' life between 1855 and 1858 at the Paris Observatory it is necessary to quote his important works on Terrestrial Magnetism. Besides his original effort to dissociate Geomagnetism from Meteorology, Liais started a real scientific research in that science: his work to install variometers with photographic recordings. His variometers were not the first ones to be operated, but they were the first ones to be used in continuous operations for many years.

The success of the new variometers was so great that Le Verrier presented to the Paris Academy of Sciences an enthusiastic report where he gave complete credit to Liais. Perhaps it was the last time that Liais' work was recognized by the Director.

The relations between Liais and Le Verrier evolved from a very small divergence to a strong rupture. Written quarrels, oral altercations were very common in 1858. There are many stories, perhaps historical anecdotes, about that incredible scientific war, such as a traditional helicoidal staircase exclusive of the Director and a fictitious intramercurial planet supposed by Le Verrier and erased from Science by Liais. The rigid temper of Le Verrier could not resist Liais flexible and funny dialectics. Today, one and a half centuries later, we must regret such loss of time by two scientific geniuses.

Possibly the starting point of that historical dispute was a communication made by Le Verrier to the Academy of Sciences, in 1858, about meteorological results. The name of Liais was omitted from the paper.

That omission must be compared with a previous Le Verrier paper also presented to the Academy in August 1856, where he quoted Liais' results obtained with his micrometer associated to his electromagnetic clock. Le Verrier said: "the chronographic instrument built by M. Liais furnished very precise results. I cannot present here all details of such an ingenuous device created by M. Liais to overcome many technical difficulties...".

A careful analysis of both papers could locate in time the beginning of the intellectual dispute, very common among scientists, in the main, among astronomers.

At this point of our story, we must cross the Atlantic Ocean, in order to meet a very singular person living in Rio de Janeiro, the Capital of a large and new country: the Second Emperor of Brazil, Pedro the Second or, as he preferred to be called, Pedro de Alcantara or, finally, as he is known by some historians, Pedro of Brazil (Oliveira Torres, 1957; Barreto, 1987).

The temper of the second Emperor was the opposite of that one of his father. If the First was an ardent lover with frequent explosive decisions, the Second was a virtuous husband with calm and careful resolutions. The First resigned from two thrones, the Brazilian, to his elder son and the Portuguese to his daughter, but he was proud of his power and royalty. He was a King in two continents.

Pedro of Brazil considered his royalty as a painful moral obligation or, using his own words: "I would prefer to be a school teacher than an emperor".

He was able to speak fluently many living languages besides being an expert on Latin and Greek. However, his great passion was science and its applications. It was in his honor that a minor planet discovered in Nice, during one of his trips to France, was named "Brasilia". The strong support given by Pedro to his recent invention was the reason for the success of Graham Bell's telephone. Few months after the return of Pedro de Alcantara from Philadelphia Fair, where he met Bell, a small telephone network was installed in Rio de Janeiro.

The Second Brazilian Emperor was an assiduous pen-pal of many European and North-American scientists. The great Simon Newcomb was one of his best friend. After the visit to Philadelphia Fair, Pedro visited Washington D.C. solely to talk with Newcomb and to visit the Naval Observatory Time Service. In a legend about that visit (Guimarães, 1961), Pedro invited Newcomb to spend some months at the Imperial Observatory of Brazil, in order to see some improvements of the Brazilian Time Service. It is easy to understand that such improvements had been made by a special man: Liais.

As a consequence of his intense correspondence with foreign scientists, Pedro had an extensive knowledge of world-wide scientific events, including the noticeable dispute between Le Verrier and Liais. This was a happy coincidence for the Imperial Observatory of Brazil.

Precisely, in 1858, when the situation at the Paris Observatory was almost insupportable, Pedro the Second sent an invitation to Liais to work in Brazil. Since the Imperial Observatory was, at that time, a small institution for so great a scientist, Pedro offered Liais a contract with many scientific and technical activities. The proposed plan of work included a detailed survey of the São Francisco Valley with geological prospection, geodetic and topographic measurements, determination of magnetic declination and a final report about the economical potentialities of that vast region. Besides that great work, Liais would prepare some projects to improve Brazilian harbours and railroads. Finally, Liais was invited to be a permanent scientific advisor of the Emperor. This last item included the reorganization of the Imperial Observatory.

Liais accepted the offer and his first mission was the observation of the total Solar Eclipse of September 7, 1858, at Paranaguá, Southern Brazil. The observations gave to Liais the material to publish five interesting papers in the "Comptes Rendues des Séances de l'Academie des Sciences de Paris".

Ancellin (1986) reports that in some letters to his good friend Le Jolis, Liais said that he had frequent talks with the Emperor about the results of the eclipse. Some interesting conclusions are presented in those papers, such as (Barreto, 1987):

-an observational evidence that the Solar Corona is physically linked to the Sun, as a part of its atmosphere;

-the coronal light is polarized;

-there was a considerable difference (about 42 seconds of time) between the observed and calculated duration of the eclipse. In a short citation, Liais remembered that the instants of the event were calculated by using Le Verrier tables.

The second task of Liais was an ample cartographic work in the province of Pernambuco. In order to expedite field observations, Liais created a "movable observatory", whose main instrument was an altizimuth, a mixed theodolite-transit instrument designed to perform his original method quoted above as the predecessor of the Danjon-astrolabe.

This "mobile observatory" was installed at the city of Olinda, where Liais observed sunspots and discovered on February 26, 1860, a comet with a double tail (Liais comet).

Pedro de Alcantara received the news from Olinda with great enthusiasm and he went to that distant place (2000km from Rio) to visit his friend and scientific adviser.

In July 1860 Liais returned to Rio de Janeiro on board the vessel "Cruzeiro do Sul" where he observed a great comet discovered in Europe, 13 days before. Just after his arrival in Rio, he went to the "Morro de Castelo" (Castelo Hill) where the Imperial Observatory was installed, in order to observe that spectacular comet, the Great Comet of 1860. Those observations resulted in two papers published in the "Comptes Rendus".

During the next year, 1861, another great comet provoked exaggerated excitement among laymen. The comet was discovered on May 26, 1861 in Dydney, and it was very bright, covering a large part of the sky.

From his careful observations, Liais calculated the comet's orbit, and it was possible to prove that the Earth had crossed a great part of the tail. In an interesting paper, Liais presented his results and conclusions that there is no danger or poisonous materials in a comet's tail, because nobody noticed that encounter of our planet and a space vagabond, in reality "a bag of nothing" in Liais'words.

According to his contract, Liais would return to France in 1864. Three years was a short period to complete the most important part of his mission, the survey of the São Francisco Valley. In spite of the prospecting difficulties of that work, Liais found enough time to continue his scientific dispute with Le Verrier.

As an effect of the splendid success of Neptune's discovery, the Director of the Paris Observatory spent a great part of his busy time on arduous calculations to find another planet, looking for some small irregularities of familiar planetary orbits. Mercury was a very fine object for this research, because its well-known orbit exhibits such irregularities. Today we ascribe that abnormal behavior to a relativistic effect.

However, Le Verrier attributed to an unknown planet, situated between the Sun and Mercury, the source of those irregularities. Perhaps, the great astronomer went so far in his beliefs, and christened the intruder as "Vulcano".

In spite of the distance between Rio de Janeiro and Europe, Liais sent a paper to the "Astronomiches Nachrichten", where he attributed to an optical illusion the pretended observation of a Vulcano transit over the solar disk. That observation was reported by a modest vicar, who lived in a small town, far from Paris. The Director of the Paris Observatory went to that distant village, excited by a possible observational proof of his calculations. He suffered a strong deception when he saw the precarious instruments of the humble priest.

Such an event was a magnificent gift to Liais. In that paper, published in Germany, Liais was sarcastic and irreverent. A legend presented by Flamarion described Le Verrier's astonishment when he discovered that the modest priest was squint-eyed.

As a consequence of the article published in a country that was "the great French adversary", the political situation of Liais in France was very bad. The French Emperor, Napoleon the Third, refused Liais an ascent in the "Legion d'Honeur" and, a few years later, a place in "l'Academie des Sciences". On the other hand, another Emperor, Pedro do Brazil, appointed Liais chevalier of the "Ordem da Rosa", the most important aristocratic title of the Brazilian Empire.

Before his first return to France, in 1864, Liais executed the best work of his life, the São Francisco Valley Survey. Margaritha Trouven van Krenenbroeck, his extraordinary wife, was a perfect companion during the trip to inland Brazil. Besides her strong personality, Margaritha was a skillful and ingenious painter. For this reason, she played an important role in illustrating Liais' writings.

During the arduous expedition to São Francisco, Liais suffered a serious disease, and Margaritha performed all scientific observations, including the measurement of magnetic declinations. For this reason, that beautiful little woman, with lovely green eyes and charming brown hair, was the first South-American lady expert in Geomagnetism (Durand, 1866).

Some years later, in 1874, Margaritha died in France, as a victim of a tropical fever, a result of the trips in her second homeland (Durand, 1874).

The masterpiece of Liais, the book "L'Espace Céleste ou description de l'Univers accompagné de récits des voyages enterpris puor en compléter l'étude", includes a detailed report of the São Francisco Valley Survey. Another magnificent book is the "Traité d'Astronomie Appliquée et de Géodesie Pratique". If this second book is essentially a scientific treatise, the first is a broad essay about the Central-Eastern Brazilian Region, as an extension of concepts about the Earth and the Universe.

From 1864 to 1867, Liais lived in France where he wrote the main parts of those books, and improved the theory of his altazimuthal method to obtain latitude, longitude and to prepare star catalogues.

In 1867, Liais returned to Brazil with the difficult task of organizing the Imperial Observatory. It was a very complicated mission, because bureaucratic problems were present. The Observatory was responsible to two ministries: Ministry of War for the elaboration of the "General Chart of the Empire", and the Ministry of the Navy, for time keeping and magnetic declination measurements. In spite of strong support from the Emperor, it was difficult to conciliate many opposite and contradictory opinions. Frequently, Liais decided in favor of the Army and, in consequence, he earned the antipathy of the powerful Admirals.

The main administrative query of Liais occurred many years later with the most important man of the Empire, the Duke of Caixas, the powerful Commander of the Brazilian Army during the Paraguayan War and hero of a dozen of battles. When the Duke refused a credit to the Observatory, Liais used his own money to continue his scientific activities (Barreto, 1987).

Liais could not stand bureaucratic disputes and he returned to France in 1871. The political and economical situation in France suffered strong changes in 1870. In particular, Paris Observatory presented an unsustainable turbulence. A group of French astronomers, including Villarceau, Wolf, Loews, André, Lévy Rayet, Tisserand, published an article "Mémoire sur l'état actuel de l'Observatoire Imperial". That writing was worse than the most caustic of Liais' criticisms, because the later ones had mainly a scientific aspect.

In spite of those attacks, Le Verrier resisted in his strong place as Director of the Observatory, Senator, Academician and a good friend of the French Emperor, "Napoleon le Petit".

However, the Franco-Prussian War started on July 19, 1870, and it ended quickly and badly, when the French Emperor, on September 1st, 1870, became a prisoner of Von Moltke, the winner of the Metz and Sedan Battles.

Paris Observatory gained another Director, Charles Delaunay, a friend of Liais, who was invited to return to his previous position.

In August 1872, Delaunay suffered a tragic accident on trip Paris-Cherbourg, and the Observatory Directorship was a possible option for Liais.

Notwithstanding that incomparable opportunity, Liais was embarrassed, because he had on his hand a fraternal invitation from his Brazilian best friend. Pedro de Alcantara proposed to Liais a permanent appointment as Director of the Imperial Observatory of Brazil, without bureaucracy and under exclusive responsibility to the Ministry of Interior, with easy access to the Emperor. Besides those facilities, Pedro promised him the use of the Emperor's private funds in addition to the normal budget of the Observatory.

Liais faced a great dilemma: to be the Director of a small observatory in a new country or to direct one of the most important scientific institutions of the world.

The Southern location of Rio de Janeiro was the key for Liais' choice. In spite of all foreseeable difficulties in Brazil, it would be possible to organize the best observatory in the Southern Hemisphere and perhaps, the first in the History of Astronomy where a real "Observatory of the first order" could be operated, according to Liais'astronomical concepts.

The choice was not an easy decision, because Liais suffered a heavy pressure from his French friends and the Parisian newspaper (Ancellin, 1986).

After many months of troubled reflections, Liais decided to return to Brazil for the third time. In fact, a decisive step for this option was the visit of Pedro the Second to Paris in 1872.

Pedro looked up Liais and, in an unforgettable meeting, he reminded Liais of his promise to organize the Imperial Observatory of Brazil.

Both friends went to the popular journal "Le Moniteur Universel" and the Emperor introduced his friend Emmanuel as the present Director of the Imperial Observatory of Brazil.

During his stay in Paris, between 1871 and 1874, Liais was not scientifically inactive. Many letters were sent to José Maria dos Reis, a competent mechanician, to explain all details for building his "great altazimuthal instrument". A prototype was sent to Europe and, in 1873, Liais presented it to the Universal Fair in Vienna. It was considered an original and revolutionary instrument.

On the other hand, Liais published many interesting books and papers, such as "Climats, Géologie et Geographie Botanique du Brésil", "Sur l'analyse spectrale de la lumiere zodiacale et sur la Coronne des eclipses", "Sur les observations méridiennes absolues dans les basses latitudes de l'Hemisphere Austral".

An unusual book was also published by Liais: "Suprémacie intelectuelle de France: réponse aux allegations germaniques", where he followed Victor Hugo in the broad patriotic movement to save France from its deep depression after the 1870 defeat. Another Liais facet was exposed: the patriot, a real Frenchman of the 19th Century, and an artificer of the heroic moment of the Third Republic in 1914.

Notwithstanding those multiple activities, Liais found time to prepare the Observatory for his return. Several letters were interchanged with the Viscount of Prados, who was his temporary substitute.

Prados followed Liais' instructions and started a site survey to move the Observatory from the "Morro de Castelo", since that place "...was not a good site for heavy telescopes or for performing the delicate magnetic measurements...". It was the first trial to find a place that

would meet some important requirements: a free horizon, a reasonable climate and the proximity of the harbour, in order to attend naval needs.

In Europe, Liais ordered many modern instruments and he suggested to Prados some improvements in the old buildings at the summit of Castelo.

Some years later, in the introduction to the first volume of the "Annals of the Imperial Observatory", Liais (1882) said that Prados was "...very competent, dynamic and a notable Director...". In an interesting comment, he reported that Prados refused the salary of Director, because he considered himself a mere substitute.

Before his return, Liais suggested to Prados to send to Europe two or three young assistants, in order to obtain a Doctor's Degree on Astronomy or Geodesy. Julião de Oliveira Lacaille and Francisco de Oliveira Junior were the first Brazilian astronomers with a Doctor's Degree from the Sorbone University.

The much desired altazimuthal instrument was completed by José María dos Reis and a modern set of magnetic instruments was acquired by Prados, using his own money.

Liais arrived at Rio de Janeiro on November 14, 1874 and, for seven years, he performed a considerable change in his Imperial Observatory. From a modest station dedicated to simple routine operations, the Imperial Observatory was transformed into one of the most important in the world. Using Liais' words, it was a real "Observatory of the First Order", where it was possible to determine the astronomical fundamental frame and the precise positions of fundamental stars with its own observational data. Liais stated that an "Observatory of the First Order" was able to maintain the "absolute time" reference. Many years later, Danjon (1954) considered such attributes as the definition of a "Fundamental Observatory". It is curious to note that both French astronomers created their own instruments based on the same principle.

It is difficult to report here all the scientific works performed by Liais in those seven years. When we look at a specialized bibliography (Gama, 1977; Ancellin, 1986; Morize, 1987; Barreto, 1987) and the old Liais' reports, we wonder about his titanic activities coming from a completely administrative organization of the Observatory and the Commission of the General Chart of the Empire, to the publication of important scientific papers. In spite of that difficulty, it is indispensable to quote briefly two examples of those works: the determination of the difference in longitude of Rio and Paris and the attempt to install the first magnetic observatory in Latin-America.

In the first example, Liais obtained a remarkable scientific result and a notable victory against his opponents. In the second instance, he was defeated by the bureaucratic vampire, allied with those adversaries.

In 1878 the Imperial Observatory started a vast program on geodetic measurements. It was planned to determine the precise values of longitudes of many points in the Brazilian coastline. It is important to remember that it was very difficult to take such measurements a century ago, when there were no radio facilities.

First of all, it was necessary to establish a very accurate value for one point, referred to an international data basis. For this purpose, Liais projected an electrical link between Rio de Janeiro and Europe, using an existing submarine cable. In a detailed report, Liais explained the method and he concluded that one important result would be a comparison between previous Mouchez' data with the new ones. Another interesting point of that report was the reference

about the advantages that could be obtained by the North-American technicians and engineers in using the Imperial Observatory facilities and know-how.

Some time before the beginning of the work, in 1874, Liais designated astronomer Manoel Pereira Reis to measure the difference of longitudes of Rio and Barra de Pirahy. The assistant obtained good results and Liais intended to appoint him to coordinate all field works of the program. However, Reis was not very enthusiastic with such a job and, without any reason, he refused to continue the measurements.

A possible explanation for that refusal could be Reis' affinities with naval authorities. The Navy was not happy with the Imperial Observatory's program, because it was related with all Brazilian ports, and the naval authorities supposed that, at least, the "sailor" Pereira Reis would be in charge of the work at the harbour, not in the interior of the country, an Army land.

Liais sent a strong and hard memorandum to Reis, asking him about the reasons for that refusal. No answer was given to the Director, and Reis left the Observatory, in order to teach Astronomy and Navigation at the Naval Academy (Ancellin, 1986).

It was the starting point of a lifelong dispute and, probably, the reason for Liais' return to France in 1881. Manoel Perira Reis commenced an insidious campaign against the Imperial Observatory. His relations with the newspapermen were used for that purpose, and it is easy to understand the low level of such disputes. It must be said that Liais mantained a very ethical position and he ordered his assistants to keep complete silence.

In spite of that serene disposal, some of Liais' assistants, possible Lacaille, Souza Jacques and Cruls (Barreto, 1987) answered the attacks with sarcastic and burlesque mockeries, using words derived from Greek and Latin ("polimacróticos = big ears" for instance).

On the other hand, the longitude program continued at a good race. The difference of longitudes between Rio and Paris was obtained with a probable error of about 3 seconds, a notable value one century ago. A detailed explanation of that important geodetic work was published in the Imperial Observatory Annals and is discussed by Barreto (1987). Pereira Reis contradicted Liais' results and the dispute was scientific, for the honour of both men. A careful analysis of the previous results presented by Mouchez, Manoel de Mello and the U.S. Comission of Longitudes confirmed the accuracy of the new values.

The work on longitudes had not impeded the continuation of other scientific activities of the Observatory, as could be noticed in several Liais reports. Regular observations of sunspots were started and a very original research on visual double stars was initiated by Luís Cruls, an active and competent Belgian astronomer, who was to be the successor of Liais. Cruls' observations on double stars were the first in the Southern Hemisphere, and they were recorded in the files of the Lick Observatory, the international center for that subject at the time (Barreto, 1987).

However, Liais was not satisfied because he intended to install a complete and modern geomagnetic observatory. He tried to perform magnetic observations at Castelo Hill, using old magnetometers. However, the conditions of the soil were a serious obstacle to reasonable precision. Besides, strong parasite currents provoked considerable compass deviations, there were many local anomalies.

For those reasons, Liais planned to move the magnetic equipment to a new site, not far from Castelo. He obtained from the Government authorization and reasonable funds to buy new magnetic instruments. That administrative success would be followed by full-time

assistance of a competent specialist. For this reason, Liais contacted the well-known Dutch geomagnetist Van Rickjervosel, who accepted the invitation.

Soon after his arrival, Van Rickjervosel studied two possible sites to install the new magnetic observatory: Castelo Hill and Santo Antonio Hill. Both had similar elevations and they were distant one from the other about 1 km. Today both hills do not exist because they were demolished to give way to large modern avenues.

Santo Antonio had a better shape than Castelo, because of its plane summit. Van Rickjervosel agreed with Liais about the adventages of Santo Antonio, and a small and cheap project was prepared.

At this point of our story, the malign bureaucratic monster was used by the enemies of the Imperial Observatory. When Liais asked the Government for the necessary authorization to build a few modest pavilions for the installation of the magnetic instruments, he received and absurd answer. Such constructions would not be authorized because all the area of Santo Antonio Hill had been reserved for the installation of a new and well-equipped Naval Observatory ("the first serious astronomical institution in Brazil" in the words of the newspapers), that would be directed by Manoel Pereira Reis. It was an incredible shock to Liais, who left his country and opportunity to direct a great observatory in order to spent the rest of his life in Brazil.

In February of 1881, Liais received the notice of his mother's death. In a letter to Le Jolis (Ancellin, 1986), Liais said that he was "strongly depressed after the depth of the two angels in his life: Margaritha and his mother".

Personal misfortune combined with strong scientific deceptions and he decided to return to France. However, before his departure, Liais gave Luís Cruls full detailed instructions and advice to continue his notable project for an "Observatory of the First Order", including the Geomagnetism in Brazil.

Van Rickjervosel was impeded from performing his mission to install a new magnetic observatory but, in spite of this disappointment, he performed other important work: the magnetic survey of a large area in Eastern Brazil, including the São Francisco Valley. As a result of that great work, Van Rickjervosel elaborated the first set of magnetic charts of Brazil for the epoch 1883. Using Liais data and other old values, he outlined provisional values of secular variation. Van Rickjervosel's results were very important for later studies on secular variations (Godoy, 1972; Barreto 1989I; Barreto, 1989II).

Some years after his last return to France, Liais was elected Mayor of Cherbourg (Ancellin, 1986) and he ended his useful life as politician.

Today Liais lies beside his beloved Margaritha at the Hardinvast Cemetery, Cherbourg, under the shadow of bamboos and palm trees imported from his second homeland. An inscription on his tombstone reads: *"Here lies Emmanuel Liais, Astronomer, Explorer and Naturalist, Directeur-Adjoint of Paris Observatory and Director of the Imperial Observatory of Brazil".*

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