

Experimental Chemistry in Mexico at the end of the XVIII century. Comments on the *Discurso físico sobre la formación de las Auroras Boreales*, by José F. Dimas Rangel, 1789.

Marco Arturo Moreno Corral¹ y María Guadalupe López Molina²

¹ Instituto de Astronomía, Campus Ensenada, Universidad Nacional Autónoma de México. Km 103 Carretera Tijuana-Ensenada. Col. Pedregal Playitas. Ensenada 22860, Baja California, México. Tel: (646) 174 45 48, ext. 227 mam@astro.unam.mx

² Departamento de Ciencias e Ingenierías, Universidad Iberoamericana, Puebla. Blvd. Niño Poblano 2901, Unidad Territorial Atlixcáyotl. Puebla 72430, Pue., México. Tel: (222) 2 29 07 02, ext. 115. musi.lopez@iberopuebla.edu.mx

Abstract: The development of chemistry in Mexico is a part of our scientific history which has not been researched in depth, mainly regarding to the process of implantation of this science within the national territory. This contribution comments on the *Discurso físico sobre la formación de las Auroras Boreales*, by José Dimas Rangel, written in 1789. This document has the historical value of being one of the most ancient scientific Mexican writings and refers extensively on the process for the production of hydrogen. It could be considered as an important original source of information for evaluating the knowledge of experimental chemistry in Mexico at the end of the XVIII century.

Key words: Chemistry in colonial Mexico, History of chemistry

Resumen: El desarrollo de la química en México es una parte de nuestra historia científica que aún no se ha investigado con profundidad, sobre todo en lo referente al proceso de implantación que tuvo esta ciencia en el territorio nacional. Esta contribución comenta sobre el *Discurso físico sobre la formación de las Auroras Boreales*, de José Dimas Rangel, escrito en 1789. Este documento tiene el valor histórico de ser uno de los escritos científicos mexicanos más antiguos donde se habla con amplitud del proceso de obtención del hidrógeno. Puede considerarse como una fuente original importante de información para evaluar el conocimiento de la química experimental en México al final del siglo XVIII.

Palabras clave: Química en el México colonial, Historia de la Química.

Introduction

Chemistry, such as it is understood at present, is a relatively young science which took shape in the second half of the eighteenth century, when different researchers arrived at key concepts within this field and were able to standardize chemical nomenclature. In our country, its institutionalization began in 1916 when, thanks to the efforts of Juan Salvador Agraz, the Escuela Nacional de Química Industrial began its activities [1]. However, this does not mean that there was previously no chemical activity in Mexico in different fields [2,3]. As an illustration [4], let us mention the extraction and use which the Indians gave to sodium carbonate or tequesquite and other salts [5]. The Método de Patio, developed by Bartolomé de Medina in order to improve the process of silver extraction by means of amalgamation [6], or the discovery of Vanadium (originally Eritronium) by Andrés Manuel del Río in 1801 in the chemistry laboratories at the Colegio de Minería [7].

A rather unusual event

On the night of November 14, 1789, the inhabitants of Mexico City and its surrounding areas, as well as people in Puebla, Pue., San Miguel Allende, Gto., Papantla, Ver., Oaxaca as well as in different towns in the state of Zacatecas were able to observe an Aurora Borealis. This attracted great attention due to the rarity of this type of phenomenon being observed

at this low geographic latitude, and it inspired some citizens of New Spain to publish information on this event. Among the pamphlets which were written for this purpose, the one titled *Discurso físico sobre la formación de las Auroras Boreales*, written by José Dimas Rangel, was published that year in Mexico City [8]. This document is currently almost unknown. A search of important ancient libraries in the country has not turned up a single copy. The copy we have used was taken from an original in the collection of the Biblioteca Nacional de Chile. We believe that the information it contains will undoubtedly enrich the historical wealth of Mexican Chemistry. It is for this reason it should be shared with the community of chemists, which will then be able to judge its relevance. In this writing Dimas Rangel attempted to scientifically explain the nature and the origin of the aurora boreal. It must be mentioned that at the moment which his paper was published there were several theories on the cause of this phenomenon [9]. However, none of these theories explained the phenomenon satisfactorily, because the physical causes which produce it were not explained until the mid-twentieth century, so, the theory set forth by this citizen of New Spain was one of many, but for us its importance lies in the fact that it demonstrates that experimental chemistry was practiced in Mexico during that period. As will be illustrated, Dimas Rangel attempted to explain this spectacular phenomenon, building a theory which invoked the presence of hydrogen in the upper atmosphere, which led him to provide a detailed description of the method used to obtain it in a laboratory.

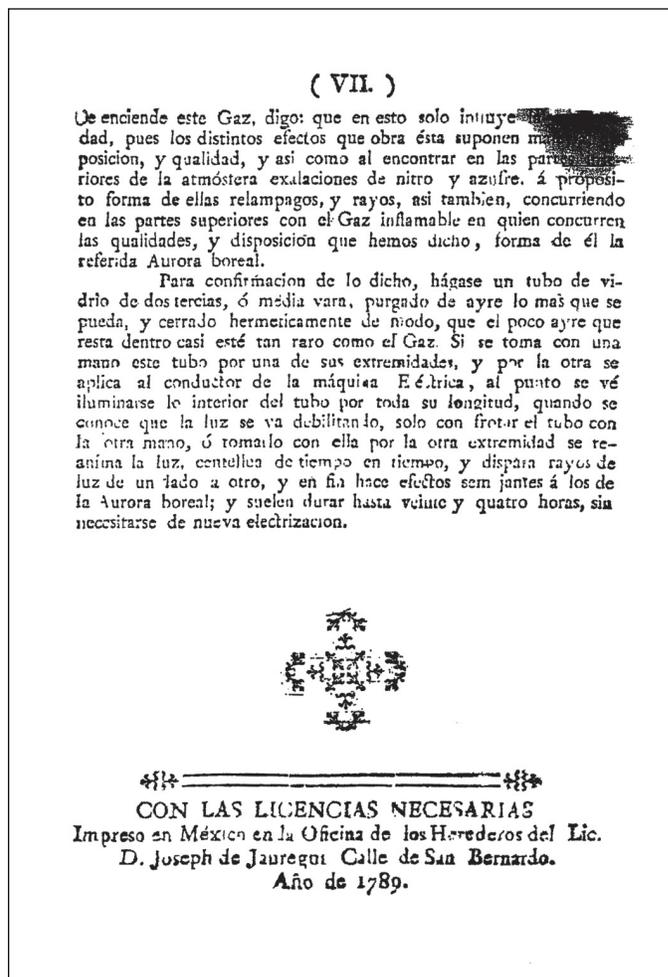
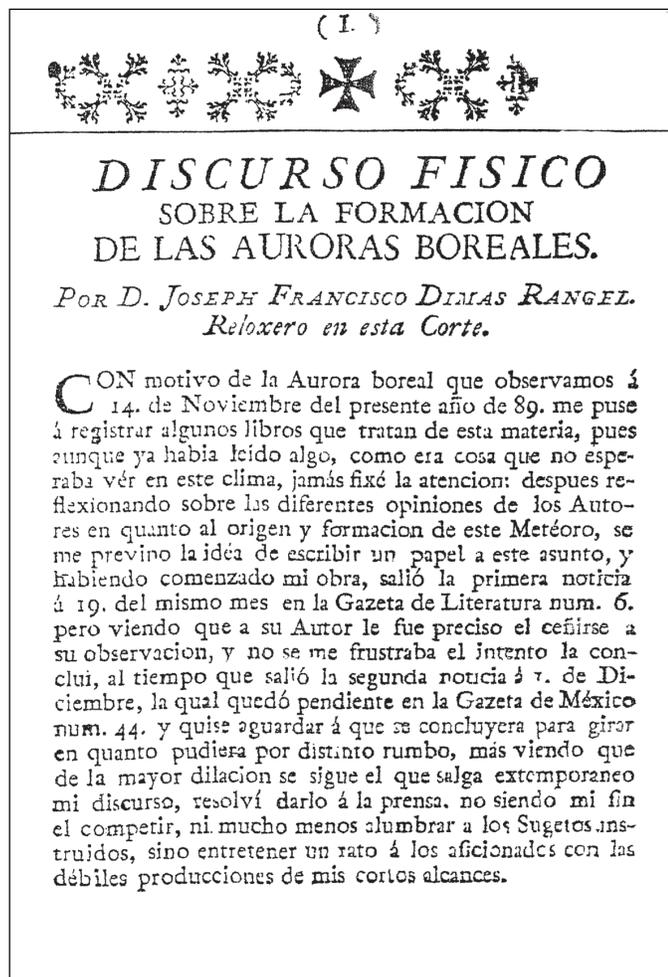


Fig. 1. Primera y última páginas del Discurso físico sobre la formación de las Auroras Boreales, de Joseph Francisco Dimas Rangel. 1789.

Hydrogen

Although hydrogen is the most abundant chemical element in the Universe, it is only found on Earth in its free state in very small quantities, and for this reason was not known until the sixteenth century when Paracelsus accidentally obtained it as a result of his research into Iatrochemistry, however, he did not recognize it for what it is. In 1766 Henry Cavendish isolated it as part of the experiments in which he made sulfuric and hydrochloric acids act on different metals such as iron, zinc and tin. In addition to recognizing it as a chemical element, he baptized it a flammable gas, due specifically to the great capability it has to enter into combustion. It was not until Antoine Laurent Lavoisier discussed the decomposition of water in his *Traité élémentaire de Chimie*, published in Paris in 1789 that he made a description of the methods used to obtain it and he called it hydrogen, a word with Greek roots which are hydor = water and geinomai = to generate, because the experiments he did with it showed him that its participation in different chemical processes propitiated the production of water.

The flammable gas of New Spain

Dimas Rangel, a watchmaker who was born in the capital of New Spain, began the *Discurso físico sobre la formación de las Auroras Boreales* by indicating the regions of the northern hemisphere where the auroras are more commonly observed. He also spoke of the forms they take and made a historical summary of the interpretation they had been given ever since ancient times and went on to speak about the research scientists of his period had done on them. It is noteworthy that he claims to have read the work on this topic published by Euler, Mairan, Paulian, Mussenbroek, Cassini, Lalande and other authors; this indicates he was a person with current scientific knowledge. Because it is not relevant to the topic of interest, we will not go into this part of his work nor the possible implications, but will instead revisit what he stated about the production of hydrogen in the territory of New Spain. The explanation which Dimas Rangel offered on the existence of the aurora borealis was based on the coloring which they present when they evolve in the atmosphere and which is pres-

ent in some chemical reactions which -he states- should take place in Nature. In his writing he declares: "It is well known to modern physicists that among the known aeriform substances, there is none with a lower specific gravity than flammable gas (hydrogen). This name is given to a type of subtle air which is generated in considerable amounts from the mixture of vitriolic acid (sulfuric acid) or marine acid (hydrochloric acid) with the scrapings of iron, tin, zinc, rectified wine spirits (ethyl alcohol), vitriolic ether (ethyl ether), the spirit of terebintine (turpentine) and many other simple and compound substances in various chemical operations. Many animal substances distilled on an open fire generate a great deal of this air which is extremely flammable. This same air is naturally generated in the bowels of the earth in different locations around the globe". The part of his paper which we consider most important follows, because it is the part where a detailed description of the process to be followed in order to generate hydrogen in the laboratory is described. It is transcribed below exactly as it was published. "Among the different gases which have been recognized, the lightest results from the following composition, six ounces of well concentrated vitriolic acid, mixed with 18 ounces of distilled water and four ounces of mold-free steel or iron scrapings collected with a magnet and sifted through a sieve; after the first effervescent effect, a strong odor, reminiscent of garlic, is perceived; at this moment the proper vessel is applied to the pneumatic chemical device described by Maquer (Pierre J. Macquer) and a Paris cubic foot of this gas will be generated. A much lighter version of this gas can be extracted with the same method using 6 ounces of zinc scrapings, six ounces of very concentrated marine acid and six ounces of distilled water, ..." According to our author, the reason the aurora appeared more commonly at high altitudes of the globe was a consequence of the existence of iron mines and active volcanoes at these sights because -he stated- it was there where hydrogen was produced in a natural manner, due precisely to volcanic activity, especially the activity of the active volcanoes in Iceland, which disgorged great amounts of sulfur into the atmosphere and this is an essential component in order to achieve sulfuric acid by the interaction of the metal in the magnet-stone mines in Lapland (Norway, Sweden, Finland and part of Russia) produced the hydrogen which finally gave way to the aurora borealis. Invoking the recent ascensions made in hot air balloons in Paris between the years of 1782 and 1784, because some of them took place in artifacts filled with hydrogen. Dimas Rangel concluded that, due to its lightweight characteristics, this flammable gas must be found in the upper parts of our atmosphere. In order for this gas to catch fire in this region, he recurred to the phenomenon of atmospheric electricity, which was a topic of great interest to researchers from various parts of the world at that time, including those of New Spain [10]. An electric spark was enough —he stated— for the hydrogen to catch fire and produce an aurora. We will conclude this paper demonstrating that Dimas Rangel had practical chemical experience and that his knowledge of the process of obtaining hydrogen was not a product of theoretical learning taken from chemical textbooks which existed in New Spain at

the time, but were instead the actual results of his experiments. At the end of his pamphlet he describes a procedure by means of which it was possible to reproduce the type of light which characterizes auroras. This clearly indicates that he did know how to carry out laboratory manipulations and procedures.

Another paragraph follows: In order to confirm what was previously stated, make a glass tube of half or two thirds of a vara, (measurement equivalent to 0.84 meters) purged of as much air as possible, and seal it hermetically in such a way that the remaining air within is almost as rarified as the gas. If this glass tube is taken in the hand by one of its edges, and is applied to a lead of an electrical machine on the other, the whole length of the tube will immediately light up. When this light begins to dim, just rubbing the tube with the other hand or taking it by the other end, the light brightens, and flashes from time to time shooting rays of light from one side to the other, and creates effects which are similar to the aurora borealis, which may last as long as 24 hours without needing additional electrification.

Comments

The reading of the paragraph where Dimas Rangel explained in detail the procedure used to obtain hydrogen indicates that he carried out the experimental procedure which he describes, because, in addition to mentioning the substances and amounts involved in the production of this gas, he also spoke of the effervescence which occurs when they are mixed, but particularly he mentioned the characteristic odor which emanates from the chemical combination which produces hydrogen. From the terminology used in the *Discurso físico*, we can gather that the author's chemical knowledge was that in use between 1766, period during which hydrogen was discovered and called a flammable gas, and 1789, which was when Lavosier published *Traité élémentaire de Chimie*, a book which Dimas Rangel was surely not familiar with at the time he published his theory on the origin of auroras, because, this fundamental chemistry book was published in Paris just a few months before the pamphlet written by the New Spain author, our author never used the name hydrogen, which was published in Paris for the first time. The first Chemistry course formally taught at a school of advanced learning in New Spain was taught by Fausto de Elhuyar at the Real Seminario de Minería in 1797 [11]. Therefore at the time the paper here commented was published, there were no institutions teaching chemistry courses in the country, although there is information regarding the fact that some citizens of New Spain were interested in the study of this discipline at that time. Such was the case of Jose Ignacio Bartolache, a physician who due to his knowledge of metallurgy and chemistry became the Apartador General of the Mint or Casa de Moneda in Mexico [12]. In this individual's personal library different chemistry texts of that period have been identified [13], which due to the contacts which existed between the main New Spain creoles of those times, could well have been familiar to and used by Dimas Rangel. Due to

the fact that there is no evidence that the latter had formal university training, besides his trade as a watchmaker in Mexico City, it is feasible to think he acquired his knowledge of chemistry in a self-taught fashion. It is also likely that in the same way as other citizens of New Spain who were interested in chemistry, he may have had a workshop-laboratory, where he carried out experiments such as the one described in his paper on auroras. Some data which contributes to this supposition is the confirmed fact [14] that he built a printing press, including the type made of melted lead which worked with punches and other metallic tools he designed for the purpose.

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