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DATA FOR A HISTORY OF ASTRONAUTICS IN SPAIN UP TO 1939

J. J. Maluquer Wahl

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DATA FOR A HISTORY OF ASTRONAUTICS IN SPAIN UP TO 1939

J. J. Maluquer Wahl[1]

Work awarded the

Marial Prize of Astronautics

(Gold Medal)

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ABSTRACT: This is a bibliographical study of rocketry, astronautics and science fiction novels dealing with space travel. The paper discusses:

rockets in Spain, an extremely brief summary of the history of rocketry in Spain, in ancient and modern wars;

technical space studies concerning astronautics, stressing studies in aeronautics, space medicine and human behavior, conducted by Spaniards, and

the science fiction novel in Spain, which discusses Spanish and foreign science fiction novels dealing with space travel. Included here are works by a Catalonian writer, described as "Jules Verne's forerunner."

I. Study Plan

Any work involving the study of the history of astronautics must deal, first /1
of all, with the use of rockets in the country being studied, since rockets are the basic propulsive component that has made astronautics possible.

Likewise, the scientists and specialists who have carried out research in the field of astronautics are usually cited afterwards, with highlights of their most important achievements.

Last of all, reference is made to the works of novelists who are scientists

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1. Doctor of Industrial Engineering of the Special Faculty of Space Technology of the Superior Technical School of Industrial Engineers of Barcelona.

* Number in the right margin indicate pagination in the foreign text.

of a sort and who, as pioneers of science fiction, have been training the public at large for entry into the space age.

Therefore the present study includes the following sections:

rockets in Spain
Spanish technical studies of astronautics
the science fiction space novel edited in Spain,
both original and translated.

2. Rockets in Spain /2

2.1. Introduction

... "But it is very possible, and perhaps in the not too distant future, that artillery men will once again recognize all the advantages that can be gained from them (rockets), and that they will once again set their sights on them and readapt them in greatly improved forms ..."

This quotation was taken from a publication in the Memorial de Artillería, entitled "Baterías de coheteros a caballo en la Campaña de Cuba"[1] indicates in a way that leaves no room for doubt that, in Spain before the end of the Nineteenth Century, there were enthusiastic rocket specialists who, despite their apparent eclipse as a weapon of war, firmly believed that they would once again be used, "in greatly improved forms."

The V-2, the origin of all modern space, launching rockets irrefutably confirmed the clear vision of our compatriot, Lieutenant-Colonel of Artillery, Don Gabriel Vidal y Ruby, whom we may consider to be one of the Spanish forerunner of this branch of rocketry which is the basic foundation of modern astronautics.

2.2. Flying fire and rockets

According to what Sarton states in "Introduction to the History of Science" [2], the Chinese used gunpowder in the form of hand grenades or rockets in 1232.

Consequently, if its use was spreading gradually, it is probable that rockets did not reach Spain until many years later.

According to compiled data, gunpowder was introduced into our country by

the Arabs and, according to a passage quoted by I. S. Allouche in "Un texte relatif aux premiers canons" [3], gunpowder was used by the Arabs for the first time at the battle of Huescar (a town 110 km to the northeast of Granada) in Year 724 of the Egira, which is 1324. Ben-Hudsail, an eyewitness of the battle wrote a verse which, freely translated reads:

> "They, the Christians, believed that lightning and thunder were in heaven, and that it surrounded them on all sides, without seeing anything in the sky."

This was due to the fact that the hosts of the King of Granada, Ismail, used a large apparatus that operated by means of naft (naft is assumed to be gunpowder).

> "This apparatus hurled a red-hot ball of iron against the tower of the fortress. The ball exploded, spewing sparks, and fell among the sieged men, causing as much destruction as a bolt of lightening from the sky." [4] /3

Was it a ball hurled by a cannon? Was it a rocket, as the sparks seem to indicate? No one knows.

One should, of course, accept with a grain of salt the quotations of historians and chroniclers who used to confuse the Greek fire of antiquity, which was first placed in containers and hurled against the enemy by hand or by war machines, with rockets, which are self-propelled projectiles. The same thing happens with the so-called fireworks.

It seems that the most accurate description is the one given in the Espasa Encyclopedia in the article on "Pyrotechnics" in which, without naming any dates, it says: "In Spain the Arabs renewed the use of fireworks at all fiestas. The Aragonese and Catalonians brought them to other countries (Italy)." [5]. On the other hand the volume entitled Spain of the same Encyclopedia, in the section dealing with military science in the article "gunpowder and explosives," states: "In Spain the name bassora is given to a compound of distilled naphta, fish oil or galbanum and grain or seed oils which, although it had been known for centuries, along with other variants in every other country, did not contain saltpeter, a salt the properties of which were unknown at the time. Subsequently, once the qualities of saltpeter had been discovered, this ingredient plays the main role

in incendiary compounds. After 1240 colophony, live sulphur, the so-called flying fire or rockets, etc. were made with this ingredient down to the introduction of coal in the middle of the 13th century, which gave rise to primitive gunpowder." [6].

Evidently the terms "flying fire" and "rockets" are once again confused.

It is very possible that this is why Count Clonard says what he does in the first of the 15 volumes of his extensive Organic History of Infantry and Cavalry Weapons, since this historian is among those who confuse Greek fire with rockets. He says: "The invention of the rocket is almost as old as that of Greek fire, in the 9th century the soldiers of Emperor Leon the Philosopher made use of it; although at that time it was no more than a small tube filled with Greek fire which one hurled by hand at the enemy. When this fire was introduced in Spain, probably by the Arabs, the rocket acquired greater power and force and its effects were more efficient." [7]. We note that this dovetailing or confusion between "flying fire" and "rockets" is repeated in our country throughout the 13th and 14th centuries. Thus, in the conquest of Valencia (1238) it is said that Jaime I used against the Moors certain types of bombs made of inflammable materials that would explode upon contact when hurled into a plaza. The chronicler called them "rockets" [8], but, as Artillery Commander Don Juan Barrios Gutiérrez of the Military History Service says in his extensively documented work, to which we have made several references herein, this probably did not refer to rockets because the launching was done by mechanical devices. /4

A similar situation occurs with statements made by other authors who, basing themselves on the chronicles of Alfonso X, The Wise, refer to the "engines" or war machines used in the siege of Niebla in 1262. It would appear that these machines launched rockets to light up the area. When they exploded in the air they caused a great terror of the supernatural among those under siege. Antonio Ballesteros Barreta, in his documented study of this monarch, does not confirm this event but simply limits himself to pointing out that "some people believe gunpowder was first used in this siege (Niebla)." [10]

Almost three centuries later, between 1537 and 1540, the bookkeeper Luis Ortiz edited the Libro de Artillería , the oldest Spanish manuscript on this topic, in which he describes in detail the manufacture of fireworks and which

mentions the combustible balls and the sticks of fire launched by cannon, harquebus or hand [11].

In 1592 the famous Platica Manual de Artillería was published, written by the Spaniard, Luis Collado, who was born in Lebrija (Sevilla). This is the edition in Spanish of the work that had originally been published in Italian, which has sometimes resulted in our compatriot being taken for an Italian. In a conversation with the above-mentioned Commander Barrios I was told how, a few years ago, this fact surprised Frederick I Ordway III, the renowned modern historian of rocketry, to whom Commander Barrios had given some data on rockets in Spain.

In his work Collado describes the use of rockets by the troops of Charles I of Spain against besieged plazas and enemy cavalry [12], as was also done three centuries later in the African Campaign.

To conclude this brief historical sketch we do not think that it is necessary to stress the great general acceptance in Spain, and in certain areas of Valencia in particular, that everything concer ing the above-mentioned fireworks and their ultimate expression, rockets, has had.

2.3. The "Congreve" war rocket makes its appearance

Perfected and produced by Congreve (1804), the military rocket that bears his name, which was developed as a consequence of the successes achieved by the rocket corps of the sultan of Misore against the English near the end of the 18th century (battles of Seringapatan, 1792 and 1799), was quickly adopted as an offensive weapon by the armies of European countries. In addition to Spain, the countries of Sardinia, Denmark, Egypt, France, Italy, the Low Lands, Poland and Prussia added rocket batteries to their artillery [13].

Although Napoleon was originally opposed to the use of the military rocket, /5
he sent an artillery captain to Sevilla to make Congreve-type rockets. Even though the range attained was on the order of 1,000 toises (about 2,000 meters) [14], their success in combat, as General Vigón says [15], did not live up to expectations.

Nevertheless, the French used them against the Spanish and the English in the siege of Cadiz in 1810 and 1811 [16], while the English likewise used them

against their besiegers [17], without appreciable effect on either side.

Another interesting source involves an event in 1814 when a French corps, which had gone out to attack the Spanish and English troops blockading Barcelona, was thrown into disarray by means of rockets [18].

Spain, according to the Marquis of Viluma [19], became interested in this type of weapon after 1817, at which time the building and testing of rockets is done for the Junta Superior Facultativa de Artillería. They based their work on the incendiary rockets that the English had abandoned in Tarragona.

In Spanish America, General Pezuela, Viceroy of Peru, in 1819, repulsed the attacks carried out by Lord Cochrane's fleet against Callao de Lima. Lord Cochrane's fleet while in the service of Chile, used rockets on a large scale, but ineffectively [20]. There can be no doubt that Von Braun and Ordway III, when referring to these rockets, erroneously cite 1809, rather than 1819 [21].

In Havana, likewise, experiments were conducted by Spanish artillery men, as shown in Brigadier General Cacho's report [22]. Getting back to our country, as a result of the report of the Marquis of Viluma, according to the article on "Congreve rockets" in the Memorial de Artillería, rockets were purchased in England, that were used in 1835 in the war in the northern provinces of Spain (First Carlist War). Villamediana and Vendejo are cited as battles in which the Spanish rocket battery participated. The English rear line forces also used rockets in this war [23].

2.4. The war rocket in the African Campaign

In the middle of the 19th century the rocket battery is created, and is used successfully in the African War, or the Spanish-Moroccan Campaign, of 1859-60 [24, 25, 26, and 27].

It was Artillery Captain Miguel de Orus Barcaiztegui who, in a memorandum, praises the creation of a rocket battery to be used in the African War. The idea was accepted, and the corresponding Royal Order was given on December 23, 1859. The organization was effected in the record time of four days, so that on the 27th day of the same month the entire company, under Captain Orus' command, /6
embarked for Ceuta with all its materiel and livestock.

The rockets were supplied by the Navy. They had a caliber of 9 cm. They were composed of rectangular sections and had pointed tips. They had five burners located in the metal base and operated on the system of the gradual release of gases, i.e. the propelling rocket and the explosive charge did not separate during the trajectory [28]. The equipment used, i.e. the tripods, casings and rockets, was quite similar to French models. The battery was composed of eight tripod gun carriages and 48 transport boxes, five horses, 32 mules, 40 artillery men and 32 drivers.

The Spanish rocket battery assigned to the second corps of the Army commanded by General Prim took part in the decisive battles of the above-mentioned war, i.e. the Battle of Guad el Jelú, on 31 January, the Battle of Tetúan, on 4 February, and the Battle of Cualdras, or Was-Ras, on 28 March, 1860 [29]. Its effects must have been quite spectacular because Pedro Antonio de Alarcón, in his Diary of the African War, observes how the horses they were riding became frightened of the Congreve rockets [30]. He describes the intervention of the rocket battery in the Battle of Tetúan as follows:

"A new form of bitterness awaited them (the Moroccans). The rocket battery sees before it that swarm of cowardly monsters and begins to launch its frightening projectiles into their midst..." "The rockets take off like a flush of lightning rending the air with a screeching noise, penetrate the huts of the infidels like snakes of fire, writhe about, jump and shake their long tails, using the latter, to lash out at the foot soldiers and horsemen and finally, they explode, sowing death and destruction everywhere."

"This is fire from the heavens," (exclaimed the Moroccans). "The Christians have the breath of the High at their command..." [31]

As for the Battle of Gualdrás, the rocket battery's participation is cited as follows: "This heroic operation was crowned with the most brilliant success. The effort of the Navarra Battalion, commanded by Brigadier General Lacy, and the extremely successful artillery and rocket fire contributed to this new and glorious triumph of the brave General Prim... [32]

Throughout the entire campaign 196 of the battery's 432 rockets were fired. Of these, approximately 6 percent turned out to be defective.

Years later, Orus, who by then was a general, expressed the opinion that: "...during the African War the rockets rendered a valuable service with their great accuracy and the important material and moral effect that they produced on the enemy." [33].

The position of Captain Orus' rocket battery in the center of the line of the deployed army during the Battle of Guad el Jelú can be seen, as Commander Barrios points out in another of his interesting works [34], in Plate XIII of the Atlas Histórico y Topográfico de la Guerra de Africa 1859-1860 [35]. /7

But the days of the Congreve rockets were numbered because of the appearance of the rifled cannon barrel which replaced the military rocket, the aim and accuracy of which was less, and from 1870 onward these rockets practically ceased to be used by European armies.

Nevertheless, it is worth noting that in 1872 rockets were being made in Pirotécnica de Sevilla shop under the direction of Lieutenant Colonel of Artillery Castro [36]. It is noted that he interviewed the famous Russian rocket specialist, Colonel Constantinof, to collect information on how to avoid or reduce accidents when building or testing such devices.

2.5. The military rocket in the Cuban Campaign

The Cuban Campaign at the end of the last century renewed, temporarily, the interest in military rockets.

In fact, the Imparcial of Madrid published, on 8 October, 1896, the following news item concerning the expedition of Collazo, one of the rebel leaders of the Cuban insurrection. "It is assumed that this rebel leader has left Florida for Cuba, with an expedition of men and weapons... The materials carried by the expedition consist of 2,000 rifles, close to one million cartridges, 600 machetes, 400 pounds of dynamite, including the necessary accessories for making bombs, 500 aluminum Couspiere rockets and 3,000 grenades..." [37].

The above-mentioned expedition, which never materialized, reaffirms the interest in rockets that the Lieutenant Colonel of Artillery Gabriel Vidal y Ruby dedicates to this weapons system. He stubbornly defends the feasibility of using rockets in the Cuban Campaign [38]. The result is his plan to organize a battery of mounted rocketeers to be used in the campaign [39].

The organization of the classic rocket batteries used in Europe was divided into mountain batteries, which were mounted and on horseback, but Vidal, given the conditions of the terrain on the Island of Cuba, tends to favor the use of mountain rocket batteries in rough, mountainous terrain and batteries of mounted rocketeers in relatively flat or open terrain.

The organization of the battery of mounted rocketeers proposed by Vidal y Ruby is as follows:

materiel:	10	gun carriages with their tubes
	200	rockets
personnel:	3	officers (1 captain and 2 lieutenants) /8
	110	rocketeers
	5	workers

Since the entire crew is mounted, the battery would have 118 horses. Each tripod gun carriage would thus be served by:

1 rocketeer porting the gun carriage
1 corporal in charge of the gun carriage
1 rocketeer gunner
1 rocketeer gunner's assistant
2 rocket suppliers
4 assistant rocketeers

Every two tripod gun carriages (section) would be commanded by a master-sergeant, and every two sections by a lieutenant.

2.6. Rockets in the Civil War of 1936-39

According to Von Braun, during the Spanish Civil War of 1936-39, if one omits the use of conventional signal flares, rockets made a brief and obsolete appearance. In fact, it seems that modified versions of shipwreck S O S rockets were used to carry propaganda behind enemy lines.

To do this a special cone was built onto the rocket's tip so that it would open at a predetermined moment in flight, based on the distance to be traveled. In this way, the propaganda leaflets that it carried, which were printed on very fine paper, were dispersed over the ground [40].

This type of utilization did not give much of an idea, in a war considered by some to be a testing ground for a forthcoming world war, of the important role that the military rocket was going to play in the next few years.

On the other hand this did not represent anything new in that Schmiedl in Austria (1931) and Tiling and Zuckert in Germany (1931 and 1934) had already conducted tests on carrying messages by rocket in order to overcome obstacles posed by the terrain (mountains and inlets of the sea, respectively) [41].

On the other hand, even though we have been unable to obtain confirmation of this from the Military History Service due to the limited time available to finish this work, it seens that rockets were occasionally used as antiaircraft missiles in Zaragoza at the beginning of the Civil War. This foreshadows what would be done on a large scale and with great success by the English in the defense of London a few years later.

Nevertheless, the information which the author was able to gather in Zaragoza /9
(April 1970) from among the military personnel who took part in the fighting, does seem confirmed. In synthesis the information is as follows: "With sporadic efforts and under a purely local control of its use, it seems that, in some areas of the Aragón front, as well as among the nationalist forces, various types of locally produced rockets, similar to those used against hail, were utilized. They had a tail and a mast and were launched from fixed, multiple tripods.

Their mission, given their crude manufacture, could only have been for lack of anything better, to give the impression of an organized antiaircraft defense, especially and at least at night, this forced the aircraft to fly higher and it made aerial observations and bombing as difficult as they were capable of making it.

One must always bear in mind the primitive methods employed in these air missions, especially on the part of the Republicans.

On the Northern and Aragón fronts, they also used rockets, but with their mission limited specifically to propaganda. They were called message launchers and had a range of 400 meters."

The last paragraph seems to confirm the above-mentioned quote from Von Braun.

3. Technical Space Studies Concerning Astronautics /1

3.1. Introduction

"All of Andalusia knows my name and knows that I am Domingo Gonzáles, a gentleman from Sevilla, one of the most celebrated cities in Spain, where I was born in the year 1552."

From "The man in the moon, or the fantastic voyage made to the world of the moon, recently discovered by Domingo Gonzalez, Spanish adventurer, also famous for his flying mail."

This quotation introduces the well-known work of the English bishop, Francis Godwin, published in 1638, in which he describes the adventures of a Spaniard who arrives on the moon. The "spaceship" is a flying machine that is very "sui generis" since it consists of a modest harness saddle attached to a rig pulled by geese that have been trained by the hero [42].

We should, therefore, consider Domingo Gonzáles as the first Spanish astronaut, even though he is merely the involuntary hero of a novel of extraordinary adventures. Nevertheless, this indicates that during this period the great adventures, the astounding deeds of valor and human ingenuity had to be assigned to Spaniards, which cannot help but please us.

3.2. Theoretical studies and projects carried out by Spaniards

Once the theoretical study of astronautics had begun and the first practical launch tests had been completed by the pioneers Goddard and Oberth, it was not long before articles expounding the latest developments in this new and exciting science began to appear in specialized Spanish revues. They served to expose this science and to study it.

3.2.1. Propulsion

One of the most outstanding men in this field is the military and aeronautical engineer Don Manuel Bada Vasallo who, in the years 1932 to 1936, published a series of articles on astronautical themes in the Revista de Aeronáutica, (sometimes signing the articles with the Greek initial of his last name), which was published by the official aeronautical organs of the Republic of Spain.

Basing himself on the tests and work of Goddard, Opel and, later on, A. B. Scherschewsky, Ziolkowsk and Oberth, he studied jet propellants [43], jet propulsion [44 and 45], the thrust of jet engines (rockets) [46], the best fuels [47] and the power developed by these engines [48]. /11

He likewise studied the stratosphere airplane, the maximum development of which is the orbitable airplane, for which he fixes the "circular" velocities, or what we would now call the orbital velocities at different altitudes [49].

It should be noted that even though Oberth had already published, by this time, the results of his studies of rocket fuels, Bada continues to calculate thrust as the result of stoichiometric chemical reactions, without taking into consideration the "Oberth effect."

3.3. Bioastronautics

3.3.1. The precursors

In Bioastronautics those who, prior to the inception of the space age were already studying human behavior in the rarefied air of high altitudes have to be considered as the precursors. They studied the body's reaction to subatmospheric pressures through the use of low pressure cameras. They also studied the body's reaction to accelerations that were superior or inferior to that of gravity, using centrifuge devices, free fall or ballistic flight.

In this sense we will first cite the book Historia Natural y Moral de las Indias, by Professor Jose de Acosta, S. J. (Published in Sevilla in 1590). As explained by Dr. Luis de la Serna in a magnificent triptych published in 1964 for IBERIA Airlines of Spain, [51], one can and must consider the author, whom Humbold called the "Pliny of the New World," as a pioneer of bioastronautics. On page 144 of the first edition, which is reproduced on the left side of the above-mentioned triptych (on the right side is the page corresponding to page 148 of the English edition of 1604) it says: "That the air component is so subtle and delicate there, that it is not enough to supply human breathing, since man requires that it be denser and more temperate, and this I believe to be the cause of such violent cases of upset stomach and the breakdown of the entire subject."

Contained in this phrase is the basis for the study of altitude sickness as a result of rarefied air and this is how Dr. Luis de la Serna, in the above-mentioned document, presents it to the Aerospace Medical Division.

Dr. Nieto Boqué, a specialist in biostronautics, cites as the first Spanish experiment in astronautical medicine, the experiment done in Madrid in 1793 [52]. This involved the first balloon-ascent made in Spain (Lunardi), /12 in which, at the insistence of the Duke of Roca, the aeronaut took along a bottle full of water which he emptied upon reaching maximum altitude, filling the bottle with "superior air," which could thus be analyzed upon returning to earth. The result of the analysis of this air, obtained at 3,400 feet, was published in the Diario de Madrid, on 8 January, 1793.

3.3.2. The Monturiol experiments

In this section we shall quote, and we believe that this is the first time this has been done with respect to bioastronautics, Narciso Monturiol, the celebrated inventor and builder of the submarine Ictineo.

In effect, his basic preocupation was how man could develop and survive in hostile environments, of which he distinguishes three. In his own words:

"The poles of the earth, the bottom of the sea, the high regions of the atmosphere, here are three conquests that, undoubtedly, are reserved for the near future." [53]

The death of a diver fishing for coral in Cadaqués made him decide to dedicate himself to the underwater environment and thus was born the Ictineo (1858). Who knows if the injured man, instead of being an underwater fisherman, had been an aeronaut, Monturiol might have dedicated himself to inventing a craft capable of sailing through space.

According to the opinion of his contemporaries, as can be read in an article by J. Estrany, an electrical therapist, (published in a series of articles in La Vanguardia of that period, entitled "The Ictineo and Science," and since collected by Servat), Monturiol, upon building his ships "purposely and expressly designed and made a highly complex device for physiological experiments." [54]

All of the projects and studies carried out by the gifted inventor to test man's endurance in a hermetically sealed chamber may likewise be considered as forerunners of tests on man's ability to live in a small hermetical sealed stratospheric vehicle or a manned spaceship. Monturiol tells his stockholders, and he stresses it when speaking to them of the danger of having to abandon the construction of the Ictineo and of the fact that they and Spain pay him little heed, "Our country would be unworthy of possessing a chamber that in future centuries will be applied to the immense art of traversing spaces that cannot sustain human life. As a result of the means offered by the natural physical and exact sciences the practice of this art has begun in the chamber of the Ictineo." [55]

Thus he conducts breathing experiments in a sealed chamber (1858-1860), with birds first and then with three to six persons enclosed in the Ictineo. He determines in this way the minimum amount of air needed by man without being resupplied, succeeding in the experiments to remain for 2 1/2 hours without replenishing the air.

He studies the problems and solutions for regenerating and purifying vitiated air by pumping oxygen, absorbing carbon dioxide and condensing the water vapor. In this way he manages to remain for three hours in a sealed chamber [56]. He also studies ways of producing oxygen through various systems such as burning /13
a mixture of soft iron shavings and pulverized chlorate inside Ictineo II.

He builds, as an adjunct to the installation, a refining bottle for measuring the oxygen and carbonic acid content of the air [57].

He completes his study of the atmosphere with experiments on the increase temperature in a sealed, inhabited enclosure as a function of work done, refrigeration and the time of year [58].

Monturiol should also be recognized as a precursor of psychological problems stemming from the cohabitation of crews living together in enclosed areas, when he says: "For this kind of research (in sealed chambers) it is necessary to adopt with respect to the companions with whom one is confined, all possible measures of prudence dictated by the personalities of each one so that the imagination of the enclosed people does not get excited, which creates pains, anxieties and illusions." [59]

3.3.3. Aeronautical medicine

In the Spanish edition (1881) of the work on human physiology by Luis Figuier [60], a study is made of the aeronaut's sickness, which is described in full detail, but aeronautical medicine, as the foundation of aerospace medicine, begins to develop in the Thirties, when it reaches a climax due to the development of aviation and especially high-altitude flights. The studies begin in Spain under the direction of Dr. Luis Figueras Ballester, a naval aeronautics physician. These studies deal with human behavior in low-pressure chambers, and he presents the results to the "Convention Air Safety", held in Paris in 1930.

Subsequently Dr. Adolfo Azoy participates in his studies and experiments displaying the results obtained at the "Second International Convention on Sanitary Aviation," held in Madrid in 1933 [61]. In 1931, Dr. Figueras publishes the results of his experiments in the Revista General de Marina [62], while Dr. Azoy who, to personally experience the problem, became a private pilot and takes course in aerial acrobatics. In 1933, he publishes in the Revista de Psicología y Pedagogía his psycho-physiological study of the aviator's profession [63].

In this article, among other things, Dr. Azoy speaks of the influence of the rapid changes in altitude and atmospheric pressure, the use of pressure chambers according to work done at Le Bourget Medical Center and the research conducted jointly with Dr. Figueras in the laboratory of the Escuela del Prat, of the Department of Naval Aeronautics.

These studies, investigations and practical experiments are, along with similar experiments done in the U.S. and the U.S.S.R., a starting point for the study of bioastronautics.

3.3.4. The stratosphere suit of Lieutenant Colonel Herrera /14

Finally, also of great interest is the stratospheric ascent of Lieutenant Colonel Don Emilio Herrera Linares, whose project, set up for completion in 1936, was interrupted by the outbreak of the civil war. This project deserves to be cited in connection with Bioastronautics because, for this ascent, Herrera studied, planned and tested a stratosphere suit that may well be considered the forerunner of today's spacesuits. The suit was needed because the ascent took place in an open balloon-basket, i.e., according to a line of thought that is

totally opposite the one that has since been imposed by Piccard which uses a closed airship-car (airtight) and is the precursor of today's space capsules.

Herrera describes his suit thus: "The crewman's protection will be provided for by a special suit with diving-dress in order to avert the pressure loss coming into contact with the body, insulating it from the cold via electric heating and from the excessive heat of solar radiation by means of shades or curtains. In addition, of course, the suit would be provided with oxygen inhalers and cartridges of potash to absorb the carbonic acid in the exhaled air [64].

3.4. Space law

As happened with Bioastronautics, which has its origins in aeronautical medicine, space law as such has its origins in the laws governing aerial navigation.

The regulations in this law, which were extrapolated and adapted to space, have served as a basis for studies that have brought about the international space treaties which are currently in force. Therefore, we consider it of interest to relate, at this point, the origins of this law in Spain.

As in other countries, in Spain too there are legal consultants to whom the ever-increasing development of aerial navigation at the beginning of the century, by means of balloons and dirigibles and the sputterings of the airplane, which would come of age as a consequence of the First World War of 1914-18, would serve as an inducement to face the problem of aviation law.

One can consider the author's grandfather, Don Juan Maluquer y Viladot, a Catalonian legal counsellor as a precursor in this field. While President of the Academy of Jurisprudence and Legislation of Barcelona, he delivered a speech at the inauguration of the 1911-12 course of the academy, which bears the suggestive title The Dominium of Space in Relation to Law, under which title it was published [65].

Although the above-mentioned speech establishes the bases for a law dealing with aerial navigation by aircraft lighter and heavier than air, in a paragraph of the article it states textually: "Dominium of space and not of the air, I have said, because I consider the first term to be more appropriate."

"The air cannot be possessed so long as it has not been collected in a container and, outside of a container, it is something impalpable, that belongs to nobody because it belongs to everyone, is everyone's common property, just as the Institute states in Title 1 of its Second Book." /15

He seems to foresee in the above that a day will come when space will have a much broader meaning than simply that of the atmosphere.

Three years later Juan Manuel Cendoya y Oscoz presented his doctoral thesis under a very similar title, although it already specifies that it is dealing with aerial space: The Law of Dominium over Air Space.

In the bibliography of the above-mentioned thesis [66] he cites, as the only Spanish works preceding his own, the one of Maluquer and Viladot, of 1911, cited above, the one of Ernesto Amador, titled Dominium of the Atmosphere, which was published in Salamanca in 1912.

The third conclusion reached by Cendoya in his thesis is a curious one, which we have used as a basis for presenting him here as one of the precursors in the development of Space Law to Aeronautical Law. He states the following [67]:

"Third, because they rest on identical foundations, we can use as a guide the international conventions and laws now in force regulating wireless telegraphy, the travel of messenger pigeons and automobile traffic."

Two years go by and, in 1929, aerial transportation, ever on the increase brings Rafael Gay de Montella to write a book that is a classic in the literature of Aeronautical Law, titled The Laws of Aeronautics [68].

Evidently none of these works outline the problem of law in interplanetary space, but, as we have already stated, they constitute the basis on which modern space law was being developed at the inception of the space age.

3.5. Astronautical publications

It is up to the magazines with a large circulation to provide the public at large with information concerning the more or less spectacular tests on rocket and jet propulsed vehicles that the pioneers of astronautics are carrying out, which, during the Thirties, were done almost exclusively by Oberth's team or some other independent German scientist.

The first worth mentioning is Iberica, the scientific publication that has been published by the Jesuits in Barcelona since 1913. It is curious that, even though it publishes a broad range of information on scientific and technical developments, given the deserved importance of astronautics (including the stratospheric ascents) and astronomy until July 1936, the date of the last issue published during the magazine's first period of existence, it has only been possible to find two articles related to astronautics: "The Rocket as an Engine," /16 which gives a detailed description of Von Opel's rocket car and cites in passing the rocket work of Max Valier and Oberth [69], and "The Goddard Rocket," which announces the next rocket launching to be carried out by the above-mentioned researcher to study high atmosphere and explains this work in this field [70].

The next publication that stands out is Blanco y Negro of Madrid which, in 1932, in its recently created Scientific Publications section, published, among other articles, a highly documented article on astronautics, under the initials A.B.V. Its title is "Toward the Great Altitudes." The article describes Von Opel and Max Valter's tests of automobiles and sleds, the Reinickendorf rocket testing ground, as well as the tests conducted by Oberth and Tiling [71].

Some years later, in the magazine Astronautica, an official organ of the Undersecretariat of Aviation in Barcelona, an article was published during our Civil War (1937) by José Vázquez Garriga concerning the achievements in astronautics up to that time and was based on the work Racketenflug by Saenger [72].

Also the magazine Aire, patronized by the Third Aerial Region (Barcelona), published an article [73] in which, based on Piccard's stratospheric ascents, its states that interplanetary voyages are possible in the not too distant future.

4. The Space Science Fiction Novel in Spain /17

"...It will not be easy for me to convey to you the impression made on me by a heavenly body that was, in appearance, fifty times larger than the sun. The heavenly body, which I saw at night and which expands and shrinks like the moon, has a celestial blue color that is very pleasant to the eye and reflects so much light, when the entire disk is visible, that it makes the nights more pleasant than the days, because one can see almost as well, but without the annoyance caused by solar rays. I knew immediately that this body was the earth..."

4.1. Catalonian precursor

This quotation, which agrees almost word for word with the earth's description as seen by Borman and his companions while orbiting the moon in the flight of Apollo VIII in December 1968, is found on page 10 of the First Notebook of Lunigrafia which was written 113 years earlier [74] by a Catalonian.

A documented study by Ramon Carreras entitled Miguel Estorch, a Catalonian Precursor of Jules Verne [75], furnishes a series of details on the work of this lawyer, poet and writer of great genius, who was born in Olot (Province of Gerona) in 1809 and who died in Madrid in 1868. Among his many works, the one entitled Lunigrafia is composed of nine notebooks, as indicated in his bibliography [76], which were published between 1855 and 1858 in Barcelona and Madrid.

This work is discussed in some depth by Agustí Duran i Sampere [77] in a small pamphlet published by Ayma of Barcelona to celebrate the Christmas of 1957, the year in which the space age was initiated. It was also cited by Antonio Paluzie Borrell, grandson of the bibliography's author and also a founding member of the Agrupación Astronáutica Española, in his work The Marvels of the Sky [78].

It is curious to observe, as Carreras says, that in the first notebooks, Estorch only lets himself appear to be the translator of the work, which he says was written in German by M. Krotse. According to what the author later states this was due to the "fear that it would not be read because it was the work of a Spanish writer unknown in the Peninsula," and the wish "that it be judged without taking the author into consideration" [79].

What Carreras does not tell us, but which is extremely obvious, is that Krotse is Estorch in reverse. In catalorian pronunciation, the "ch" sound is written "k". Later we shall see the reason why we oelieve this worthy of interest.

Estorch, who is a professor of mathematics and has also published a Compendio de astronomía has a sufficient scientific foundation to write a classical science fiction novel. But in his Lunigrafia he practically casts /18
science aside to dedicate himself to developing, after a brief description of the voyage to the moon, a compendium of the good customs found among its inhabitants, the Lunicolas. The moon is an ideal country where life is simple, clear and clean.

Thus, everything that is an annoyance on earth has been eliminated.

Among other things, it deserves mentioning that wars on the moon are unknown, that there are no lawyers because the laws are few, brief and clear. On the other hand, because all Lunicolas receive the same physical, intellectual and moral education, there are no differences of opinion. A bound volume of this work (only up to Notebook 8) is located in Barcelona's Central Library and the readers can see for themselves what a pleasant book it is.

In what we could term the astronautical part of the novel, Krotse describes how he conducts a series of tests with a special carbine. He carries out these tests on "one of the most elevated spots of the Himalayan Mountains," so as to flee the attraction of gravity and the resistance of the atmosphere as he explains elsewhere in the novel.

In view of the results obtained, Krotse orders a cannon to be built in England, capable of hurling a projectile two feet in diameter (0.61 meters), which he is considering shooting toward the moon, and the hero says the following: "...I conceived the bold idea of placing a living being inside the shell..." [80]. The astronaut in this case is Krotse's little servant, a native of Calcutta by the name of Leugim Seuqis. Please note that in this case also the astronaut's first and last names are the first and second surname of the novel's author spelled in reverse.

The shot is fired as follows: "...Our Calcuttan placed himself inside the machine agreed upon, inside an iron ball made in such a way that he could breath and which had on its outer side some drag-hooks that were supposed to unfold during the descent and serve as a parachute. I waited until the moon was in its zenith and fired the cannon." [81]

Estorch published all this ten years before Jules Verne published in 1865 his famous From the Earth to the Moon and, in reality, the coincidences between these two authors are noteworthy because it is almost certain that Jules Verne was completely unaware of the modest fascicles of Estorch's work. The coincidences that we wish to highlight are as follows:

First, the means used to go to the moon, i.e. a monstrous cannon capable of launching a manned shell toward the moon; second, as the case of Krotse and Seuqis, which corresponded to the author's last names read in reverse, in the case of Jules Vern's hero, his name. Ardan, corresponds to the last syllable

followed by the first, written in reverse, of Nadar, a famous aeronaut of that period whom Jules Verne used to create his hero.

There is no doubt that we can consider the Catalonian Estorch to be at least a predecessor of the French novelist and the first to conceive the idea of a manned cannonball to reach the moon.

4.2. The theater and science fiction /19

After Estorch comes Juan Molas y Casas, a playwright who wrote plays for festivals, who was born and died in Barcelona (1855-1904), whose works include From the Earth to the Sun [82], which is also cited by Duran y Sampere [83] and written in catalan in collaboration with Don Narcís Campmany. The work's subtitle indicates that it involves a "fantastic, improbable, farcical, danceable and very spectacular voyage in three acts and eleven scenes," ... "in prose and verse set to music by the master, Dr. Nicolau Manent." It opened with great success at the Tivoli Theater in Barcelona on August 23, 1879. On the work's title page the authors already state that it is based on Jules Verne's novel From the Earth to the Moon.

The first part of the voyage, i.e. from the earth to our satellite, is described in the following words [84]:

"Whoever wants to go to those regions merely has to place himself inside a projectile, in an empty ball of half the size of the tower of the cathedral (of Barcelona) and this ball, properly designed, should be fired from a colossal cannon with a diameter the size of the fountain in the Plaza Palacio (Barcelona) and as long as from here (calle del Paradís in the center of old Barcelona) to Badalona..."

"... The cannon will have to be aimed precisely at the point of the zenith and fired at sunset on a day when the moon is full and it will take, to the precise second, four days to reach the moon."

"... Within the projectile there will be food supplies, a kitchen, library, air supply, and beds."

Further on he indicates that the launch will take place from the beach of Mar Viejo behind Barceloneta, as follows: "They climb one by one up a big

ladder placed alongside the cannon [85], open a kind of valve located on top and, once all are inside, close it back. The uniformed men light the cannon's touch-hole and, immediately afterwards a monstrous detonation is heard."

4.3. The foreign classics

Just as in other countries the genre that today is called science-fiction has been very cultivated in Spain. Consequently, there also appear novels the central theme of which is astronautics, whether based on terrestrial expeditions to other worlds or the landing of extraterrestrial beings on earth.

The majority of the novels that were precursors to the science-fiction classics were translated and published in Spanish, such as: Voyage to the Moon, by Cyrano de Bergerac (1648), which, among the eight systems it describes for reaching our satellite, the third is based on the use of rockets [86].

Also written by the same author is the A Comical History of the States and Empires of the Sun [87]. /20

Among the outstanding novels describing interplanetary voyages are Jules Verne's two works, From the Earth to the Moon [88] and Around the Moon [89] which were written in 1865 and 1866 respectively. The former is noteworthy because it includes a correct estimate of the velocity at which a spaceship should be launched (in this case, a shell fired by a gigantic cannon) in order to reach the moon, but he does not take into account that enormous acceleration needed for the projectile to attain the necessary velocity could not be endured by any human being.

In Hector Servadac, Adventures and Voyages Throughout the Solar System [90] another novel that is not usually cited as a forerunner of astronautic science fiction, Jules Verne describes the space voyage of 36 persons. This voyage takes place on a piece of earth that includes the Island of Formentera and part of the Mediterranean Sea, which have been ripped away by a comet that collides with our planet. In short, a piece of Spanish territory is converted into a gigantic spaceship, thus anticipating the present day plan of landing on an asteroid in order to carry out a space voyage aboard it.

From H.G. Wells, another of the great science fiction novelists of the latter part of the 19th century and the beginning of the 20th, we have translated the

two famous classics of the astronautic theme The War of the Worlds [91] and The First Men on the Moon [92]. These have not only been brought to the screen but one of them, The War of the Worlds, in which Martians invade the earth, was also converted by Orson Wells into a news report broadcast in 1938. It caused a veritable panic in the U.S. and several European countries, a panic that did not occur in Spain since Spain was at the height of the Civil War and, therefore, the people were much more attentive to the air-raid sirens than to radio news reports such as the one described above.

4.4. The adventure novel and the novel of fantasy

Once the concept of astronautics and interplanetary voyages is divulged by the work of Oberth and his team, there are many Spanish publishing houses that edit collections of more or less fantastical adventures and some works on the theme are published. Among the works published we wish to particularly mention the Colección Aventura, published by Editorial Juventud, and El Disparo al Infinito, by Otto Willy Gail [93], which is based on Oberth's studies and experiments. As I have already stated in my first book on astronautics, it can be considered as a classic descriptive novel of interplanetary voyages [94].

The above-mentioned collection was published under the previous title La Tierra Invavida por Marte [95].

Other similar collections are: La Novela de Aventuras, edited by Joaquín Gil, which includes, among others, several astronautical themes, such as: /21
La Isla Caída del Cielo [96], and El Enigma del Espacio [97], while in Colección Popular de Aventuras, by Jimenéz de Letano, El Fin de Una Expedición Sideral, Viaje a Marte is published [98].

The great success of science fiction novels among young people gave rise to the publication of specialized collections, among the most outstanding of which is La Novela Fantástica, published over 30 years by Prensa Moderna Madrid, at the truly accessible price of 50 centavos per issue. Its titles include: Los Monstruos del Rayo [99], and En el Centro de la Luna [100].

Other publishing houses also publish novels of this type, as for instance, Mas Alla de las Nubes, published by Editorial Cumbres [101].

4.5. Colonel Ignotus work

Under this pseudonym, so familiar to the youth of the tens and twenties, is concealed a Spanish technical specialist who was fascinated with science and especially with astronautics. This was Lieutenant Colonel of the General Staff, Don José de Elola y Gutiérrez who was a professor at the General Military Academy and the Superior War College. Decorated several times for his scientific achievements, he invented a number of things, and published important scientific works and interesting novels. However if we include him here it is because of his excellent science fiction novels that, in the first decades of this century, were the delight of the youth of that time. Many are the editions of his Biblioteca Novelesco Científica, among the best of which are editions published by U. H. Sanz Calleja y Sucesores de Rivadeneyra, in Madrid.

In the spaceships, which he describes as being spherical thus anticipating the Vostok, the propulsion system utilized, as I remember, is based on electricity obtained from electrons, which is yet another anticipation of something still under study. The practical realization of which is possible and will soon be a reality.

Colonel Ignotus novels are grouped into three series of three, two and three novels, respectively. The first series, entitled Viajes Planetarios en el Siglo XXIII, comprises the following titles: De los Andes al Cielo [102], Del Océano a Venus [103], and El Mundo Venusiano [104] (Volumes I, II and III of the above-mentioned collection). In the second series, entitled La Desterrada de la Tierra, Aventuras Extraterrestres, the following volumes were published: El Mundo Luz [105], and El Mundo Sombra [106] (Volumes IV and V). The third and last series, Segundo Viaje Planetario is composed of La Profecía de Don Jaume [107], El Hijo de Sara [108], and El Secreto de Sara [109] (Volumes XV, XVI and XVII).

These eight novels on the theme of astronautics, written by Colonel Ignotus, may be considered as constituting a whole work that is truly interesting and worthy of being included in any anthology of the space science fiction novel.

5. Conclusion /22

The data compiled in this work, of which most, if not all, is probably known

in each instance by the corresponding specialist, can be found in a series of documents, pamphlets, books and magazines scattered among many libraries and archives.

As a result, it is difficult for the student to achieve a view of the whole of what we might call the prehistory of Spanish astronautics.

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2. Biblioteca de la Escuela de Náutica de Barcelona
3. Biblioteca del Ilustre Colegio de Abogados de Barcelona
4. Biblioteca del Colegio de Médicos de Barcelona
5. Biblioteca del Museo Arqueológico de Barcelona
6. Biblioteca del Museo Marítimo de Barcelona
7. Servicio Histórico Militar, Madrid

OBSERVATIONS

When citing documents that it was impossible to obtain, the origin of the quote is indicated. The remainder of the documents, except for the works of "Colonel Ignotus," which, although I read them in my youth, are not in my possession, have been consulted directly in libraries or are from the author's private archives.

Barcelona, May 1970.

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