Developing science in a developing country. From early astronomy of position to modern astrophysics in Mexico

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ABSTRACT: The creation of the National Astrophysical Observatory of Tonantzintla, Puebla, in 1942, sets the beginning of the later establishment of modern astrophysics in Mexico. What happened in the 1940s that made it possible to overcome previous obstacles? According to the analysis done here, it can be explained as a consequence of the interaction between Harlow Shapley, former director of the Harvard College Observatory and Luis E. Erro, member of the Mexican Government and amateur astronomer, in a very particular moment of the history of the relationship between Mexico and the United States. Since the story took place within the context of the Second World War, the influence of geopolitical affairs must be recognized. The paper analyzes the historical and social circumstances under which it was possible to overcome the early situation and modernize local astronomy. As a case study it should serve to contribute to the knowledge of the development of science in developing countries and their integration into the international community. Additionally, the study offers some answers to the main question that have stimulated the discussion among sociologists and historians of science: how and to what extent scientific activity is facilitated or inhibited by social and historical factors?

KEYWORDS: Science development, Mexican astronomy, Harvard College Observatory, Tonantzintla Observatory.

1. INTRODUCTION

This essay attempts to clarify the historical circumstances that explain the late emergence in Mexico, around 1940, of self-sufficiency in the field of modern astrophysics, with respect not only to scientific personnel, but also to technological resources. One could ask why it is important to focus on Mexican science as a case study. Science, as it is often said, has no national boundaries. The operations and laws of nature are universal, and scientists from many nations have contributed to increasing our knowledge of them. However, if science has no national boundaries it is also true that science is socially embedded. Scientists, like everyone else, are constrained by the forms of the particular society to which they belong. At the very least, most would agree that at the level of practice, social and historical circumstances exert powerful influence on scientific work. Why has science flourished in one time and place and not another? Under which circumstances did the leadership in a certain field of science move from one country to another, and how did such a change affect the field elsewhere? Questions such as these would remain unsolved if science were to be considered only an international enterprise.

This is especially true in the field of History of Astronomy. A survey made by Stephen G. Brush shows that Germany enjoyed unquestioned leadership in astronomy during the first half of the nineteenth century, but suffered a precipitous decline thereafter, mitigated by the contribution of physicists Wirchhoff, Helmholtz, and Einstein. The British reached their astronomical peak in the 1860s and 1870s; Eddington and other theorists preserved their reputation in the twentieth century. The French lost their high standing in physical science after the death of Laplace (1827) and never recovered it despite the isolated triumphs of Leverrier and Poincare in celestial mechanics. Italy provided some important work in the nineteenth century, such as that of Giovanni Schiaparelli, but it was exploited in the United States. In the twentieth century, Italian astronomical work was overshadowed by Holland's [3].

The rapid growth of astronomy in the United States during the late nineteenth and early twentieth centuries was so remarkable that by the mid-twentieth century the country had risen to world leadership. Starting from essentially zero, by the beginning of the nineteenth century American astronomers had overtaken Germans, jumping into second place by the end of the century and was already challenging the British for the top spot. By 1930 the United States was ahead of all other countries, an achievement that David W. Chambers considers as the establishment of a new scientific center in the world. Chambers defines a scientific "center" as the locus of a particular set of strategies that have proved to be successful in establishing scientific authority and exercising professional control [4].

While the Americans consolidated their prominent role in contemporary astrophysics worldwide, Mexican astronomy languished within the problems of the post-revolution, the difficulties of the international project *Carte du Ciel* and the lack of financial support and trained personnel. Despite all the country's efforts to build scientific institutions, public and private support was sporadic, fragmented, weak, and directionless. The establishment of modern astrophysics in Mexico marked the beginning of a new stage of local science. Such an achievement was reached by a group of young Mexican scientists with the support of the Harvard College Observatory. Since the story took place between 1938 and 1942, the influence of geopolitical affairs must be underlined.

2. THE FACTS

All the initiatives for modernization of Mexican astronomy registered between 1842 and 1942 came from the government and particularly from influential politicians who were interested in astronomy. In 1842 General García Conde erected an astronomical observatory in the central tower of the Chapultepec Castle and purchased three large instruments of good and beautiful construction. But the idea died with its sponsor and the study of the sky was forgotten until 1862, when instruments again were set up in Chapultepec Castle. Of the three instruments brought from Europe in 1842, only the astronomical pendulum was still working, thanks to the fact that it was in the hands of an astronomer who had appreciated its value. The others were victims of negligence, and had become useless. In 1866 and 1867, a transit telescope, an astronomical pendulum and a chronograph arrived in Mexico for the purpose of reviving the concept of a National Observatory. Unfortunately, the lack of financial support and the difficulties caused by the civil war between liberal and conservative forces prevented the government from creating minimal conditions for doing any scientific work at all. As a result, the excellent instruments brought from Europe were damaged, lost or destroyed.

During the Porfiriato, conditions improved. Thanks to official support—both financial and political--to scientific activities, the Observatorio Astronómico Nacional was founded in 1876. From the very beginning, the new Observatory received first-quality observational instruments and started taking part in astronomical research, even at international level, such as its participation in the *Carte du Ciel*. However, the political and financial support given by the government to the emerging field of astronomy was due more to the importance given to science as a symbol of progress in Mexico than a genuine interest in science itself. From such a viewpoint, the politicians who favored development of astronomy were not interested in promoting science itself, but rather in using it as a symbol of Mexican modernization. Thus, it was always easier to acquire instruments than to create suitable conditions for doing scientific work on a continuing basis.

This kind of symbolical interest in science was reinforced by intellectuals concern. The episode of Mexican participation in the *Carte du Ciel* shows the negative consequences of following the influence of the European scientific environment at a time when leadership in the field of astronomy was moving to the United States. Under such circumstances, it is reasonable to assume that the horizon of the early Mexican astronomers could never go beyond the limits of the old astronomy of position.

The change for Mexican astronomy came about at the end of the presidency of Lázaro Cárdenas (1934-1940), when Luis E. Erro, a distinguished politician and amateur astronomer, managed a project that led Mexican astronomy scientists toward its encounter with modern astrophysics. In the middle 1930s, Erro was a young revolutionary leader that collaborated closely to president Cárdenas. Two years before leaving the government, General Cárdenas felt that the time had come to reward Erro for his services to the revolution. So he asked Luis Enrique what he wanted for himself. The reply was: "A National Observatory for Mexico". Cárdenas agreed, but he asked Erro right away how he was going to achieve this goal in his country, without technical expertise and where there was only one sleepy major observatory, Tacubaya Observatory, directed by Joaquin Gallo. Erro replied that he had good contacts at Harvard Observatory, where he had come to know, via Leon Campbell and the AAVSO, the great Harlow Shapley [2].

Harlow Shapley was one of the great leaders of the astronomical community in the twenty century. According to Owen Gingerich, his career could be divided into two periods [5]. The first belongs to the time in his life when he was particularly productive scientifically. During this period, Shapley published over one hundred papers, mostly thanks to his position as a staff astronomer at Mount Wilson, which gave him the opportunity to work with some of the most magnificent instruments then in existence. His most significant contribution to astronomy was when he was still in his thirties [5]. After this highly productive period, he became increasingly involved with administrative affairs, including the Establishment of the California Institute of Technology as well as the formation of the National Academy of Sciences and during World War I, the National Research Council.

This "second" career included the effort made to commit the US government to a program of continuing support for basic research, an effort that culminated in the establishment of the National Science Foundation in 1951. From 1939 to 1944, he served as president of the American Academy with Hudson Hoagland as secretary, and together they sought to transform the Academy into something more than a local honorary society. Don K. Price, pointed out that at the time Shapley entered the political arena, few American scientists were openly concerned with questions of public policy. But the relation between science and politics changed radically in the United States and, according to Price, much of that change is reflected in the various political activities of Harlow Shapley. The first and principal concern underlying Shapley's public interest from the 1920’s through the 1940’s was "internationalism". It began with the attempt to bring German scientists back into the international astronomical community after World War I and continued with his efforts on behalf of the international cooperation [9].

So it came about that Erro turned up at Harvard Observatory in 1939. Harlow Shapley organized at Harvard Observatory several informal meetings to which Cecilia Payne-Gaposchkin, Fred Whipple, Donald Menzel, George Dimitroff and Bart Bok were invited. It was there where a basic plan emerged and slowly led to

the founding of Tonantzintla Astrophysical Observatory, in Puebla, Mexico, opened on February 17, 1942. In one of her essays, Paris Pismis wrote:

> After working in Harvard almost a year, Erro reappeared playing a new role: he seemed to be more active and forceful than during the preceding visit to Harvard. He came in and out of Shapley's office joined by Carlos Graef; obviously something very important was being organized; as we knew afterwards it was the beginning of a new era for Mexico, the dawn of astrophysics in Mexico [8].

On December 18 1940, Enrique Erro wrote to Shapley communicating that finally "the establishment of an Astrophysical Observatory has been decided upon by our Government". Tacubaya should continue the Service of Time, computation of the Anuarium and Ephemerides, the *Carte du Ciel* and its other activities, whereas the new institution should be entirely devoted to astrophysical research. The budget available for the new proposed astronomical observatory would be between 15,000 and 20,000 dollars [11].

The Observatory was being located on a hill near the village of Tonantzintla, 8 miles from the city of Puebla, and it was chosen because Manuel Ávila Camacho, a native of the State of Puebla and a longtime friend of Erro, urged that the new observatory be built inside his State. In this aim he was strongly supported by Governor Dr. Gonzalo Bautista [2]. Erro knew that it was not the best place possible in Mexico, but he argued that, "Of all the things that could be done, the better is the one that is actually done". Besides the president's request, he wanted to begin the construction as soon as possible because of the opposition of Dr. Gallo, who had become annoyed since the project of building a new observatory was managed behind Tacubaya's back. On this matter, Erro just assured to Shapley that they were going to show the "old Guard" in Mexico "what could be done when one has the right friends and the right spirit" [12]. Erro was completely sure that he counted on Shapley.

> The question of what technical assistance we may expect from you I do not ask, because you see that I have already taken it for granted [10].

Erro was right. Shapley wrote right away telling that it had been good of him "to write the whole background of the astronomical maneuverings in Mexico". Shapley let Erro know that he admired very much the vigor with which he and his closest friends went after the Observatory project. Concerning the budget available for it, he believed that much could be done in assembling powerful and useful equipment with $20.000. Some astronomers shared Shapley enthusiasm. Even before receiving letter from Erro, two of Shapley’s most fertile and active astronomers expressed to him their desire to spend a month or so at Mexico City, in the interests of astronomical projects [13]. In the first days of January, Shapley would call a Junta to make preliminary plans for Erro's visit [13].

The main instrument of the new observatory opened in February 1942, the Schmidt was a 27-31 telescope with reflector optics company Perkin-Elmer and mechanical workshop of the Harvard Observatory. This was a brand new instrument identical to others that were built simultaneously by Harvard. Its name comes from an optician of the Observatory of Hamburg named Bernard Schmidt who, in 1932, released the benefits of a new type of telescope that brought together the best features of refractors and reflectors and allowed visualize stellar and nebular at high quality. The rapidity with which the photographs could be obtained celestial prototype built by Schmidt, and the possibility of a single plate cover for large sections of the sky, opened new horizons for the development of astrophysics in those years. The technical characteristics of this device as its size made for a short time the telescope was installed at Tonantzintla, the world’s largest telescope of its kind.

How was it possible that Mexico made a telescope of this size and would have been built so quickly, amid the general mobilization of American society due to the entry of his country in World War II? According to the analysis done here, it can be explained as a consequence of the interaction between Harlow Shapley and Luis E. Erro in a very particular moment of the history of the relationship between Mexico and the United States within the context of the Second World War.

3. THE CONTEXT

On the one hand, during the government of president Lázaro Cárdenas (1934-1940), there was a divided public opinion between those who wanted to go deeply into nationalism and socialism and those who wanted a change. The Mexican political life as a whole was focused in the question of who will be the official candidate that will run for president for the next elections. So, the process of the selection of the official candidate was especially hard-fought in 1939-1940. After two years of struggles inside the governing party, a very violent election took place on July 7, 1940. In several districts the police and the army had to intervene to stop the confrontation between the followers of the official party and the opposition. In Mexico City around 30 people died and so it happened in several cities of the country, such as Ciudad Juarez, Monterrey and San Luis Potosi [7].

On the other hand, domestic political life began to be strongly influenced by the international situation. First of all, the strategy of Almazán, leader of the opposition, was to conduct a revolt from the United States, whose interests had been damaged by the recent nationalization of the oil industry. Secondly, the outbreak of the Second World War pushed the North American government to adopt the "Good Neighbor Policy." Nationalism in Mexico had been always remarkable. But, on the other hand, given that many times the regime was considered illegitimate by the opposition, the group in power sought official recognition from the United States. Hence, the elected president Ávila Camacho accelerated the steps and sent an

emissary to Washington, communicating that the new government of Mexico was interested in friendly conflict resolution for the pending matters between the two countries.[1]

Despite the resentment caused by the nationalization of the oil industry and with an upcoming war that convulsed the world, the White House and the Department of State preferred not to interfere in the internal affairs of Mexico, and refused to meet with the leaders of the Mexican opposition [7]. According to Luis Medina, Elliot Roosevelt, son of president Rooselvet, seemed to have some preference for the Almazan's movement. As a proof of the official wish to restore the links of friendship between the two countries, the American Government sent Vice-President Henry Wallace to the ceremony of the installation of President Ávila Camacho. In a speech made at the Chamber of Deputies in January 1941, Wallace pointed out that the most practical goal for this hemisphere was Pan Americanism because without solidarity in the hemisphere the peace needed for prosperity in agriculture, work and business could not be assured [7]. He predicted the establishment of a new era in the relationship between Mexico and the United States, within which the astronomical project very soon would start to play a remarkable role. As a proof it, it can be mentioned here that two years later, Vice President Wallace transmitted a message to Harlow Shapley in which he indicated that Franklin D. Roosevelt and the White House would appreciate an invitation of the U.S. astronomers to the Dedication of the new Mexican Observatory. In that case, they would all go to Mexico for the occasion, war or no war [2].

Bart Bok expressed a similar point of view in a letter directed to Harlow Shapley, on the problems that might be encountered with the prior materials needed for the construction of the Mexican Schmidt camera. In that case, suggested Bok, should be told to those above that a pound of aluminum for new Schmidt camera meant for national defense as much as a ton of steel or propeller to the front lines. With the same spirit, Bart Bok added that so far he had only met with a copy of Nazi propaganda in Mexico, but despite the blockade the Germans had managed to deliver three transformers for the new giant Polytechnic Institute in Mexico City, which stressed the successful completion of the Schmidt camera would be a real boost to American prestige.

4. THE MEXICAN PROJECT AT HARVARD

World War II challenged astronomers' loyalty to an international community and scattered the observatory staff in a dozen directions [6]. Consequently, there was a distinction between the experience of Harvard astronomers devoted to national defense and those most concerned with continuing astronomical research and communication. Attitudes changed in the course of war. Bok was training navigators for the invasion of Europe and Japan. Even Harlow Shapley, who favored international cooperation, opposed U.S intervention in World War II up until Pearl Harbor, and differed about how much the observatory should rely on contracts from the Department of Defense. He encouraged defense department funding for projects at the Harvard Observatory such as the Optical Shop of Harvard, and the Mark I computer.

The Optical Shop of Harvard became the government-funded Optical Research Laboratory with Harlow Shapley as the main researcher. It was one of the first defense projects undertaken by observatory staff and the largest wartime program directed by the Observatory itself [6]. The laboratory built lenses for aerial reconnaissance cameras under the direction of James G. Baker. By April 1941, Harvard University had signed a contract with the U.S Army Air Corps to produce four prototype lenses. Under Shapley's general supervision, Baker set up a crowded shop under the storage rooms of the Harvard plate stacks. Glass optical equipment and other supplies came in through the windows or down the narrow basement stairs. The Optical Research Laboratory delivered its first lenses in the summer of 1942. The Army much appreciated the quality of the product, and urged the Office of Scientific Research and Development to fund an expanded program. The shop soon moved into larger quarter and by April 1943 the initial group of about a dozen people had grown to twenty-nine. The turnover was high: more than a hundred people would be associated with the laboratory in the course of the war [6].

Given the facts, it is very easy to understand the benefits obtained by projects like the Mexican Observatory during the war. On the one hand, it was possible by virtue of the support given by people like Shapley, particularly interested in strengthening international links among astronomers. On the other hand, it received the benefits of being supported by the largest wartime program carried out by the Harvard College Observatory. On March 13, 1941, Shapley wrote to the Mexican Consul General:

> "I suggested in the conversation and especially in a long letter to Dr. Erro, it might be much better for us to use some of the patterns we have here available and get a considerable part of the telescope made by our own shop. Such procedure would much expedite the completion of the telescope, and also save a good deal of money [15].

From the standpoint of economy and speed of construction, this procedure seemed to be very good, and much the best. Shapley assured that there was no chance at all to have a telescope mounting made in a reasonable time by any of the American manufacturers. Over all that at a later time there was a possibility that the government would not allow private enterprises to use aluminum of good quality. Shapley pointed out that if they were authorized to proceed immediately, they would have made for Mexico at the best bargain possible the fundamental castings. He assured that for a short while

[1] On August 6, Miguel Alemán gave an interview to Summer Wells,.

aluminum castings could be obtained at prices that were not exorbitant; and concluded: "If after consulting your colleagues in Mexico you authorize us to proceed, we can within two days have the patterns in the foundry" [13]. On May 5th, during President Ávila Camacho's visit to the construction site of the Observatory, Erro gave to the Press the information concerning the "generous cooperation received for the construction of the Schmitd Camera from the Harvard Shop" [14].

The inauguration of the modern observatory, in February 17, 1942 was a majestic occasion/event. High-level politicians from around the country came to the opening, representatives of different Mexican universities, students, businessmen, members of the armed forces, press correspondents and local farmers. Although there were many absences because of the war, among the international guests were Harlow Shapley, director of Harvard Observatory, Henry Norris Russell, director of the Observatory of Princeton, W. S. Adams, director of the Mount Wilson Observatory, Otto Struve, director of the Yerkes Observatory of the University of Chicago, J. A. Pearce, director of the Dominion Astrophysical Observatory in Canada and a group of astronomers from the likes of Robert Mc. Math, Joel Stebbins, Donald Menzel, Fred. L. Whipple, spouses Gaposchkin, Bart Bok and mathematician George D. Birkhoff. Nicolaitan University conferred honorary degrees Morelia Sandoval Vallarta, Norris Russell, W. S. Adams and Harlow Shapley.

Several American astronomers reported the emergence of the Tonantzintla Astrophysical Observatory and the political significance of this scientific fact was reflected in his writings. Donald Menzel noted that the speech by the governor of Puebla, Gonzalo Bautista, had stressed the importance of a united hemisphere in every field, from defense to education and scientific research. His words, said Menzel, left no doubt that Mexico was with the United States and against the aggressive forces. From his point of view, the international situation had intensified the significance of the meeting since it served to strengthen the bonds of friendship between the two countries in one of the most critical periods of all time.

5. CONCLUSION

This essay has been an attempt to understand the process of transference of modern science outside Western Europe and the United States to the wider world, focusing on the establishment of modern astrophysics in Mexico [1]. In this particular case, the influence of social and historical circumstances was most dramatically visible. Away from the main European or American centers of scientific authority, scientific institutions transferred to Mexico found themselves to be dependent, not only intellectually but also technically, on external help.

The situation was complicated by the fact that the relationships among the main centers changed over time. The local astronomical community that was at one time influenced by the important metropolitan center, Paris, later came under the influence of another scientific astronomical center, the United States. The essay illustrates how Mexican astronomy responded to these shifting patterns of intellectual authority over time.

Between 1842 and 1874, political instability and civil war prevented the government from creating minimal conditions for doing any scientific work at all. As a result, the excellent instruments brought from Europe were damaged, lost or destroyed. During the Porfiriato, conditions improved and thanks to official support— both financial and political— to scientific activities, the Observatorio Astronómico Nacional was founded in 1876. From the very beginning, the new Observatory received first-quality observational instruments and started taking part in astronomical research, even at international level, such as its participation in the *Carte du Ciel*. However, the kind of astronomical activities could never go beyond the limits of the early astrometry.

At the end of the government of General Lázaro Cárdenas, new political circumstances directed Mexican astronomy along the path of modern astrophysics, as demonstrated by the construction of the Observatorio Astrofísico de Tonantzintla in 1942. On previous occasions, it was necessary to turn to one person with political influence and interest in astronomy to achieve this project. But on this particular occasion, Erro's political and astronomical experience moved him to seek help in the United States and to count on the assistance of Harlow Shapley, who was particularly sensitive toward the projects for the modernization of science, such as the Mexican Tonantzintla Observatory. Simultaneously, the particular situation of the Mexican political arena at the end of the 1930s and the entry of the United States in the Second World War, made that political and diplomatic goals became inevitably intertwined with intellectual ones in the collaborative efforts of the astronomers from both nations.

From a scientific point of view, the construction of the Astrophysical Observatory proved to be highly successful; but equally significant were its effects on good-neighbor relations. On the one hand, the Good Neighbor Policy affected the relationship between Mexico and the United States, turning a specifically scientific project into an object of geopolitical interest. On the other hand, the war-time transformation of Harvard in general, and Shapley`s position in Harvard`s Shops in particular, made it possible for the war-time program to be carried out by the Harvard College Observatory and to produce an excellent scientific instrument: the Mexican telescope.

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